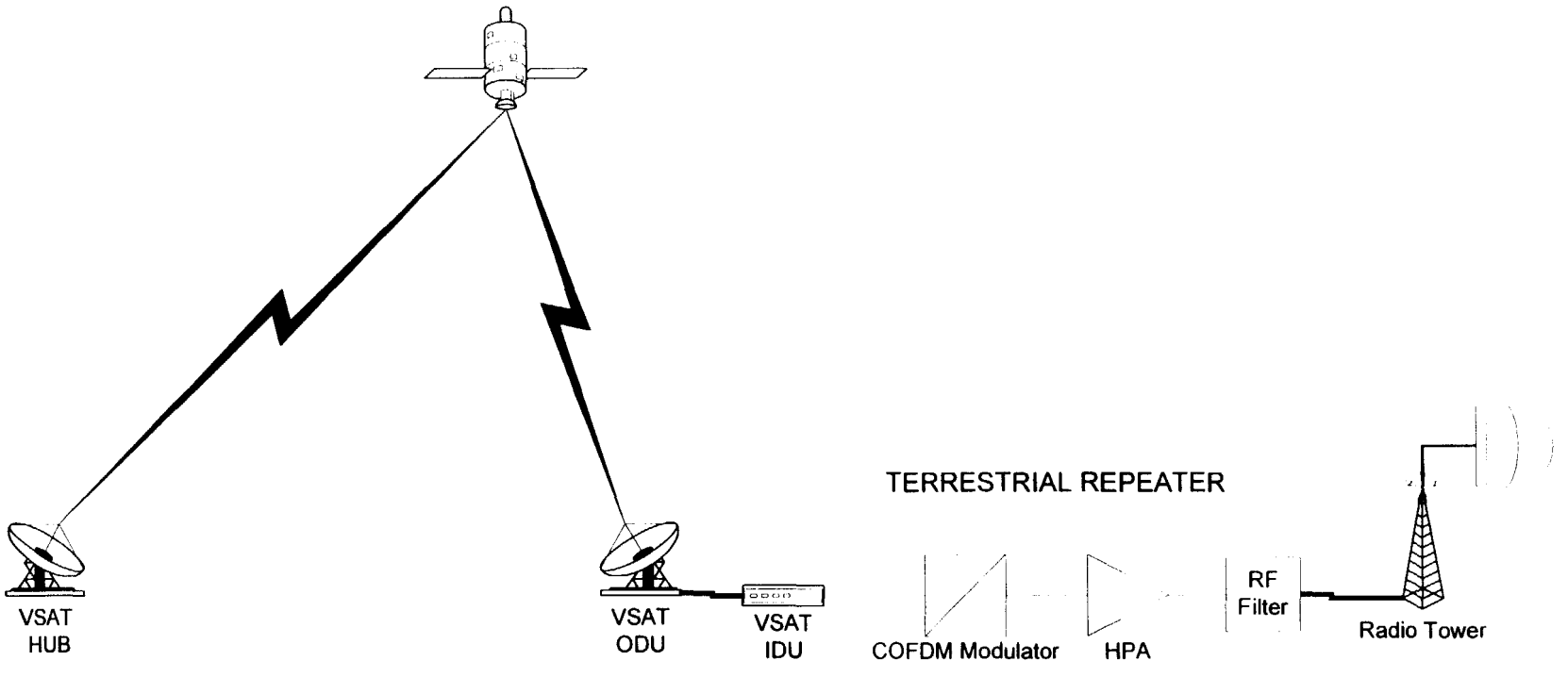


ODU=Outdoor Unit
IDU=Indoor Unit
HPA=High Power Amplifier
COFDM=Coded Orthogonal Frequency Division Multiplex

FIGURE 2
TERRESTRIAL REPEATER BLOCK DIAGRAM

2. Probability Of Overload Interference Between A 40 kW EIRP Repeater And Wideband MMDS/MDS/ITFS Legacy Analog Receivers

2.1. Introduction

As described in Sirius' Supplemental filing and further detailed in Section 3 of this Exhibit, the S-DARS out of band emissions specification is the most stringent of any fixed wireless service. The analyses presented in the Supplemental filing demonstrated that the out of band emissions from S-DARS terrestrial repeaters pose no interference threat to adjacent services when the repeaters operate at transmit powers up to at least 40kW EIRP. The only remaining issue raised by the commenters is with respect to wideband legacy analog receivers having no pre-LNA filtering, which are being (and must be) swapped for new digital equipment.

The analysis presented here shows that this concern is vastly overstated and that, even when requiring the S-DARS complementary repeater network to provide protection to receivers with no front end filtering, the probability of overload is extremely small in practice. It is further shown that there is a negligible risk of overload under any circumstances between the complementary repeater network operating at 40 kW EIRP and the current generation of MMDS/MDS/ITFS receivers.

Previous analyses of the potential for MMDS/MDS/ITFS (hereafter referred to as "MDS") analog receiver overload (such as those used by the commenters in the original WCS proceedings) omitted fundamental issues such as the potential for cross polarization of receiving and repeater transmit antennas and the impact of MDS system deployment architecture in reducing the probability of alignment of repeater and receiver mainbeams. These two items alone can add more than 35 dB additional to the path loss between a repeater and an MDS receiver and further reduce the already small probability of overload.

The following circumstances ALL have to be present for receiver overload actually to occur:

1) An S-DARS terrestrial repeater (hereafter referred to as "repeater") has to be located within the MDS coverage area. If it is outside the coverage area, the MDS receiver antenna front to back ratio (>20 dB) effectively excludes this overload mechanism, regardless of repeater placement. Because of the fundamental differences in the services being offered, it is highly likely that repeaters would NOT be located in MDS coverage areas where the wideband analog receivers would be deployed **AND**
2) The MDS receiver then has to fall within the overload distance of the transmitter, otherwise the separation distance precludes interference regardless of repeater location ($R_{overload}$<4096 meters[1]) **AND**
3) The polarization of the MDS receiving antenna has to be vertical otherwise the polarization discrimination of the receiving antenna (>25dB) effectively precludes interference regardless of repeater location since all the repeaters use vertical polarization **AND**
4) The repeater sectorized antenna has to be pointing in the correct direction, towards the receiver, otherwise the front to back ratio of the repeater antenna (>20 dB) precludes interference regardless of repeater location **AND**

[1] This number is calculated using the −12 dBm overload level specified by the Commenters and assumes free space path loss.

5) The off-axis angle between the MDS receiving antenna and the repeater antenna has to be within 10 degrees otherwise the discrimination of the receiver antenna pattern (>10dB at off-axis angles >10 degrees) precludes interference **AND**
6) The MDS receiver has to be wideband legacy analog[2] with no filtering before the LNA of the repeater signal at 2326.25 MHz.

The analysis shows that the overall probability of these six circumstances occurring is much less than 0.1%, leading to the conclusion that the commenters concerns are vastly overstated and should not be used as a basis for setting rules for S-DARS repeaters.

2.2. Analysis Approach

The analysis presented here proceeds as follows:

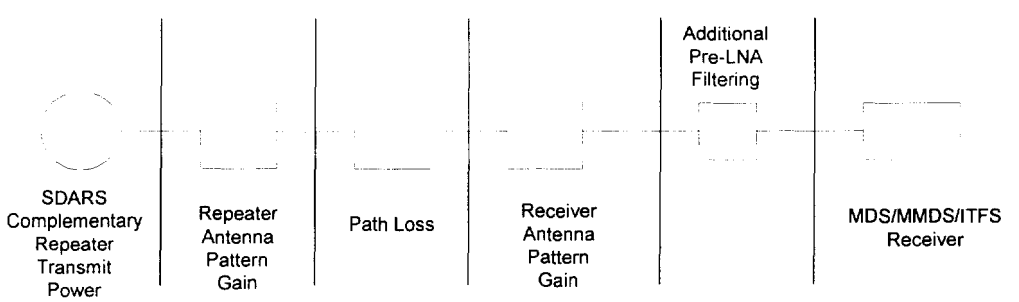
1. A description of the basic legacy wideband analog receiver overload mechanism.
2. Confirmation that the legacy wideband analog receivers are the ONLY type of MDS receiver with the potential to be affected.
3. A listing of the potential overload scenarios for wideband analog MDS receivers interacting with repeaters and a general calculation of the probability of each type actually occurring in practice.
4. Summary and overall characterization of the probability and number of receivers potentially affected.

2.3. Analysis

2.3.1. Receiver Overload Mechanism

Figure 3 illustrates the elements that factor into assessing the separation distance within which an overload condition might be experienced between a repeater and an MDS receiver. We consider each element in turn:

Figure 3 Repeater/ MDS Receiver Path Model



[2] Mention was made in the WCA Petition for Expedited Reconsideration in GN-96-228 (see P 12) of "digital ready" devices with the same lack of pre-LNA filtering and overload problems as legacy analog receivers. Since the overload mechanism is presumed the same in both cases and no specific information is available regarding the number of these "digital ready" devices deployed, they are not considered further here. In any event, the least-cost method of avoiding interference in this case would be the addition of a simple and inexpensive filter on the MDS receiver.

2.3.1.1. Repeater Transmitter Power

Sirius intends to deploy repeaters with three different transmitter power levels:

- 350 Watts
- 650 Watts
- 1000 Watts

The analysis described in this document uses the configuration, which represents the worst case, namely 1 kW (where the power is measured at the transmitter output.)

2.3.1.2. Repeater Antenna Pattern

Sirius intends to deploy 3 types of vertically polarized antenna configurations (note: gains are net and include cable loss):

- Omni, 10 dBi gain
- Single Sector, 16 dBi gain, 120 degree 3 dB beamwidth
- Multiple sector, 16 dBi gain.

Front to back ratio of sectorized antenna: >20 dB

The analysis presented here uses the worst case combination of repeater transmitter power and antenna, namely a 1 kW configuration with a single 120 degree sectored antenna of 16 dBi gain. Other combinations give rise to less total EIRP and therefore have the same or less overload potential.

2.3.1.3. Path Loss

The most conservative path loss model is used, namely the so-called "free space" model. This assumes line of sight between the repeater and the MDS receiver and predicts the minimum path loss that could possibly occur, thereby overstating the MDS receiver sensitivity to overload.

In practice it is increasing common to include estimates of actual excess terrain induced loss in these kinds of arguments since the results of using free space predictions tend to overestimate significantly the potential for interference. Design and placement of high-powered repeaters limit their use to dense urban areas where path loss is typically found to be significantly in excess of free space. Notwithstanding that, this analysis employs the free space model for consistency and to emphasize further the overstatement of the overload issue by the commenters.

The path loss model used in the calculations described below is[3]:

$L = 20\log(f) + 20\log(D) + 32.44$ dB, where f is in MHz, D is in km

2.3.1.4. MDS Receiver Antenna Pattern

Assumed Receiver Antenna Characteristics: Gain[4] 24dBi (includes any cable loss).

---

[3] P. 69, Foundations of Mobile Radio Engineering, M. Yacoub ,CRC Press ISBN 0-8493-8677-2

[4] This is the gain assumption used consistently in the WCS proceeding, see, e.g., Statement in Support of Petition for Expedited Reconsideration", GN-Docket 96-228, comments of EdNet, Exhibit E.

Additional characteristics[5]

- Front to back ratio: >20 dB
- Cross Polarization Discrimination: >25 dB

Sirius has created a pattern for the MDS receiver antenna gain that uses an analytical approximation for a description of the mainbeam.[6] This pattern provides results consistent with existing commercially available antennas[7] and allows estimation of the 10 dB down off-axis beamwidth at approximately 10 degrees (i.e., a total beam width at the 10 dB down points of 20 degrees).

2.3.1.5. MDS Receiver And Additional Pre-LNA Filtering

2.3.1.5.1. Impact of Pre-LNA Filtering on Receiver Overload

The commenters base their concerns regarding overload of existing MDS receivers on arguments put forward in the WCS proceedings. The fundamental assumption regarding overload utilized in the WCS proceedings is that the threshold of interference for blanket overload of legacy analog MDS receivers with no pre-LNA filtering is –6 dBm with "good engineering practice" dictating adding 6dB to give a target overload level of –12 dBm.

There appears to be some confusion in the original submissions regarding whether or not there is any pre-LNA filtering actually used in the type of receiver considered here. For example the WCA's petition for reconsideration[8] states:

"...However it can lead the reader to believe that the block downconverters, and specifically dual band block downconverters, have no filtering in the frequency range 2.162-2.5 GHz to lessen the interference potential of signals at these frequencies not employed by MDS/ITFS operators. That is not correct. Filtering does exist and filters the unwanted signals from present operation in that band."

whereas the FCC's M&O[9] concludes:

"....All have similar construction and, according to Hardin associates, the downconverter construction for all major manufacturers is essentially identical. The interference issues raised by the WCA petition relate to the possibility that WCS signals could overload the low noise amplifier ("LNA") input stage of this equipment. This stage is directly fed by the receive antenna and thus has little or no isolation. Between the receive antenna and the LNA, this equipment does not employ any filtering related to the block of frequencies between 2162 MHz and 2500 MHz."

These statements are contradictory and, absent the comprehensive quantitative information that would normally justify such an argument (such as was supplied in the Clarity petition[10] for use of OFDM for example), Sirius has in this analysis assumed the worst case scenario as described in

---

[5] See e.g. California Amplifier part number 130094/130135.
[6] ITU-R Recommendation F.699-4, 2.2.
[7] E.g., see Pacific Wireless Model PMANT25 (http://www.pacwireless.com).
[8] WCAI Petition for Expedited reconsideration GN Docket No. 96-228, March 10 1997
[9] 12 FCC Rcd 3977, 1997 FCC LEXIS 1693 (April 2, 1997) page 7, Sect.12.
[10] 14 FCC Rcd 4121, 1999 FCC LEXIS 1119 (March 19, 1999).

the WCS filings, namely the protection of a legacy analog receiving device with no front end filtering over a 400 MHz range in a congested area of the spectrum.

There are three types of receiver considered in this analysis whose characteristics are summarized in Table 1. These receiver types are differentiated by the amount of pre-LNA filtering used. The values for contemporary receivers come from data sheets for advertised products. In contrast to the ubiquity of wideband analog receivers with no pre-LNA filtering implied by the commenters, Sirius was unable to find an existing MDS receiver product line that did not include options for significant pre-LNA filtering against PCS, Weather and Airport surveillance radar, microwave ovens and WCS service. Clearly contemporary manufacturers recognize the need for protection of the MDS receivers against these widely deployed forms of interference.

Table 1 Comparison of MDS receiver types

Type of receiver	Pre- LNA filtering in the frequency range 2305 to 2360 MHz (dB)	Example commercial receiver
Legacy wideband analog	0	
Contemporary, "resistant"	60	Andrew Corp., Mag Grid Series 5447/5437
Contemporary "minimum"	25	California Amplifier Part number 2230/011

2.3.2. Additional Factors Not Originally Considered In Previous MDS Receiver Overload Analysis

The following factors, which mitigate overload interference, were not considered in the previous analyses contained in the WCS proceedings.

2.3.2.1. Impact of Mainbeam Angle Differences Between The Repeater And The Receiver

The misalignment of repeater mainbeam direction and MDS receiver mainbeam causes a reduction in the received signal level proportional to the gain reduction of the antenna pattern. For the extreme case of a 180 degree misalignment (essentially the repeater mainbeam is pointing at the back of the receive antenna), the gain reduction is limited to the front to back ratio of the antenna, typically 20 dB or more. For lesser off-axis angles of 10 degrees, the drop in antenna gain is 10 dB or more.

2.3.2.2. Impact of Different Transmitter / Receiver Antenna Polarization

Sirius repeaters use vertical polarization exclusively. In the free space conditions between repeater and MDS receiver which are assumed in the overload analysis used in the WCS proceedings, an MDS receiver which utilizes an antenna adjusted for horizontal polarization (which occurs in MDS deployment) would see the repeater signal attenuated by the cross polarization discrimination value of the receiver antenna, typically >25 dB. A similarly polarized antenna (i.e. vertical) would see no signal reduction.

It should be noted that the technical study cited by the WCA in the WCS proceedings[11] does not consider the case of cross-polarized antennas or the impact of the repeater mainbeam and MDS

[11] EdNet comments Exhibit E.

receiver mainbeam not being aligned in the analysis. A review of an available MDS FCC database[12] indicates that about 50% of transmitting antennas are horizontally polarized implying that about 50% of MDS receivers are connected to horizontally polarized antennas.

2.3.3. Calculation Of Receiver Overload Distances

Using the commonly accepted methodology of calculating the mainbeam to mainbeam worst case overload range, assuming a "free space" path loss, the overload ranges are calculated for the different MDS receiver types for the worst case repeater EIRP, namely 46 dBW (40 kW) single sectored antenna. A conservative MDS receiver overload point of –12 dBm was used as referenced by the Commenters.

Applying the information derived above and utilizing Table 1, the potential overload range for each type of receiver is given in Table 2. A receiver antenna gain of 24 dBi is assumed.

Table 2 Comparison of Potential Overload Range for MDS receiver types, Single Sector, 46dBW (40 kW EIRP), Mainbeam to Mainbeam[13]

Type of receiver (in all cases these are assumed to be receiver/ antenna combinations covering the entire range 2150 to 2686 MHz)	Receiving antenna polarization	Cross Polarization attenuation (dB)	Assumed pre- LNA Filtering of WCS range 2305 to 2360 MHz (dB)	Total attenuation of repeater signal (dB)	Potential receiver overload range (miles)
Legacy analog	H	25	0	25	0.144
Legacy analog	V	0	0	0	2.55
Contemporary, resistant	H	25	60	85	0.00014
Contemporary, resistant	V	0	60	60	0.003
Contemporary minimum	H	25	25	50	0.008
Contemporary minimum	V	0	25	25	0.144

The conclusion to be reached from Table 2 is that the ONLY MDS receiver where the overload mechanism is of potential relevance is a legacy analog receiver without any pre-LNA filtering, connected to a vertically polarized antenna. In all other cases the repeater would have to be co-located with the legacy analog receiver to cause a problem. This is an unlikely occurrence.

2.4. Potential Overload Scenarios Between Repeaters And Legacy Analog MDS Receivers

There are three possibilities for considering the possible spatial relationships between a repeater and an MDS analog receiver:

[12] FCC OET Supplied Database, 1996.

[13] As previously established this represents the worst case.

1. The repeater can be located outside of the serving area of the MDS system. In view of the anticipated small number of repeaters this scenario is quite likely.
2. The repeater can be co-located with the serving MDS transmitter. This is unlikely in the majority of cases, due to the service area objectives being so different between complementary repeaters for a satellite service and an analog wireless cable service area.
3. The repeater can be located somewhere within the MDS coverage area, but not co-located with the MDS transmitter. The probability of this is also less than 1. The actual impact depends on the separation distance between the repeater and the serving MDS transmitter as established in the analysis that follows.

2.4.1. Scenario 1. Repeater located outside of the serving area of the MDS system

In this situation, quite likely in small and medium size MDS serving areas, there is no impact to legacy MDS analog receivers since, regardless of the orientation of the repeater antenna, the receiving antennas are pointing almost directly away from the repeater and so the additional isolation of the front to back ratio of the receiving antennas (>20 dB) ensures that the receivers will not be overloaded due to an order of magnitude reduction in the distance at which such conditions can arise.

2.4.2. Scenario 2. Co-Location with an MDS transmitter

In terms of the potential overload area affected by a single repeater, this represents the worst case since, by design, all the receiving antennas are aligned with this location (i.e. the mainbeam angle of the receiver is aligned with the repeater mainbeam angle). Again, in practice, this will be a rare occurrence. If, however, two such transmitters were co-located, the actual area affected can then be simply estimated by calculating the area of a single sectored 40 kW EIRP repeater.

From Table 2 the overload distance is 2.55 miles. The potential impacted area (i.e. the area within which a receiver could be overloaded) can then be calculated as one half the area of a circle centered on the MDS transmitter, namely $0.5 * \pi \times R_{overload}^{2}$ (=0.5*3.1415*6.5)

Table 3

Repeater	Overload Area, square miles
Single Sectored, 40 kW	20.4*0.5=10.2 the factor of 0.5 arises since the front to back ratio of the sector is >20 dB, receivers in one half of the area around this antenna will not be affected

2.4.3. Scenario 3: The repeater can be located somewhere within the MDS coverage area, but is not co-located with the MDS transmitter.

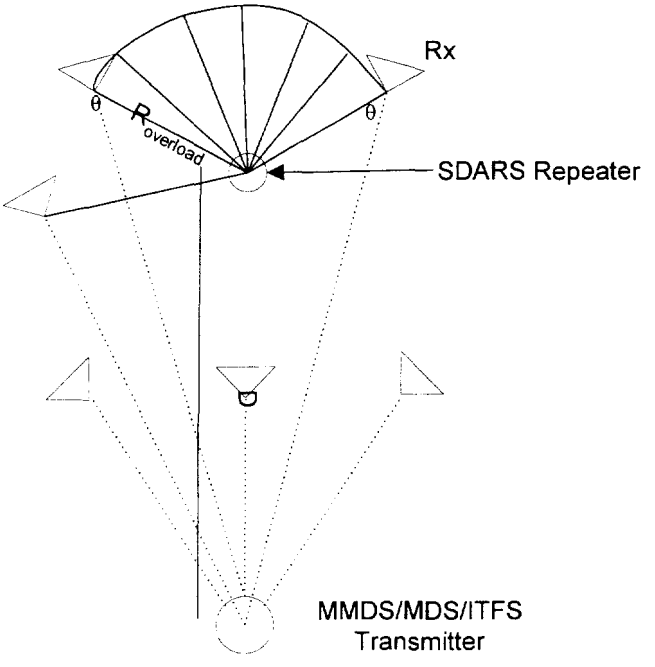
In this case, the affected area depends critically on the separation between the MDS transmitter and the repeater. As shown in Figure 4, the only receivers affected are those whose mainbeams fall within a certain value of the repeater mainbeam. Due to the alignment, by design, of the receiver antennas with the MDS transmitter, fewer receivers are impacted the further away the

repeater is from the MDS transmitter due to misalignment of the receiver mainbeams with the repeater mainbeam.

To simplify the analysis of this case, Sirius has examined various values for the maximum off-axis angle at which the fundamental overload mechanism is present. A 10 degree off axis value was chosen. At this off axis look angle, the receiving antenna gain is 10 dB down from the maximum,[14] significantly reducing the distance at which the overload mechanism takes place. The objective of the calculation therefore is (for a given repeater/MDS transmitter spacing), to identify the total area within which receivers would meet the two overload conditions, namely (1) be within the overload distance of the repeater and, (2) have a look angle to the repeater of 10 degrees or less.

From Figure 4, the relevant area is represented (to a close approximation) by the fractional area of a circle, centered on the repeater and subtended by potential receiving locations whose look angles to the repeater represent the maximum considered (i.e. 10 degrees). Receivers outside of this partial circle do not suffer overload since they are either outside of the overload range, or have look angles greater than 10 degrees to the repeater and so have a 10 dB gain reduction of the received repeater signal.

Figure 4 Overload Geometry



- Angle between receiver mainbeam and repeater mainbeam = θ
- Distance of Repeater from MDS/MDS/ITFS Host = D
- Radius around S-DARS site at which −12 dBm signal is experienced at input to the LNA of an MDS Receiver = $R_{overload}$

Figure 5 illustrates the geometry required to calculate this area as follows:

[14] See 2.3.1.2 of this document.

Using the Sine Rule :

$$\frac{D}{\sin(\theta)} = \frac{R_{overload}}{\sin(\varphi)} \qquad (1)$$

and so

$$\varphi = Arc\sin((\frac{R_{overload}}{D}) \times \sin(\theta)) \qquad (2)$$

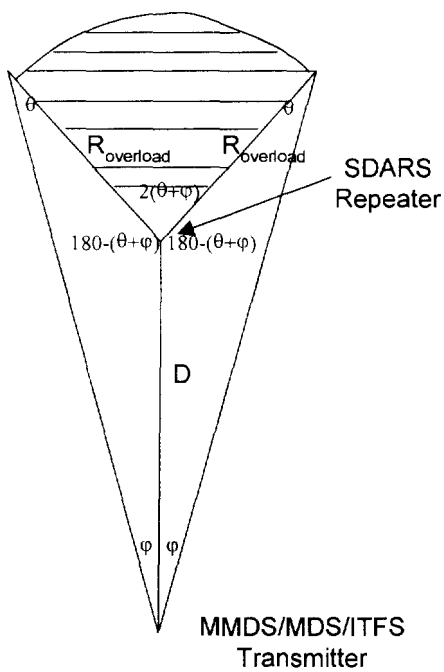
and

$$\text{Overload Area} = (\frac{2(\varphi + \theta)}{2\pi})\pi R_{overload}{}^2 \qquad (3)$$

where φ is given by (2), all angles are in radians and distances are measured in the same units.

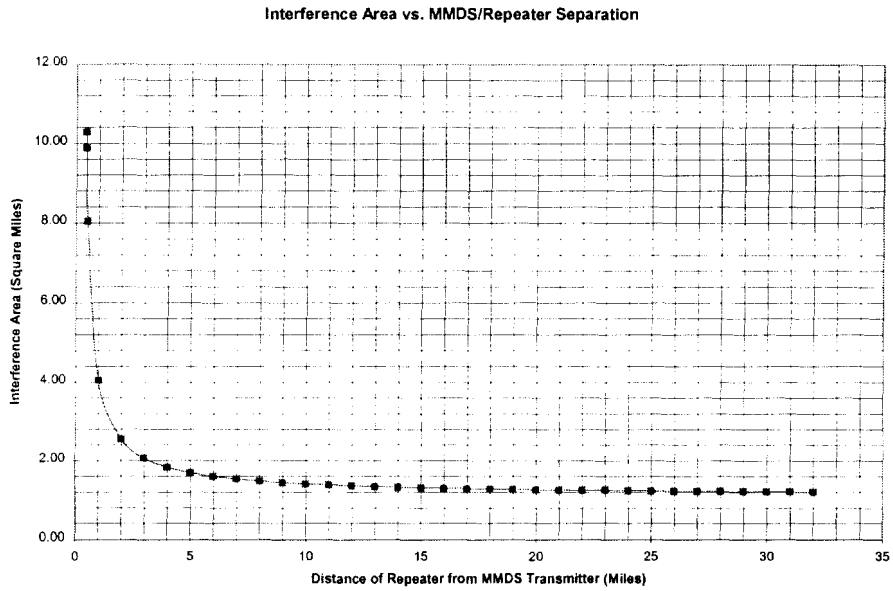
Applying this analysis to the situation of a 40 kW repeater gives the potential area within which a receiver could be impacted (shaded area) vs. repeater/MDS transmitter spacing curve (Figure 6.)

Figure 5



As can be seen, for even a small distance separation, the area within which MDS receivers can be affected decreases very rapidly as the repeater/MDS transmitter distance increases, due to the effect of an increasing look angle to a majority of receivers.

Figure 6 Overload Area vs. Repeater/MDS Transmitter Spacing



In Figure 6, the overload area becomes zero outside of the maximum MDS area (e.g. for distances > 30 miles). Using this analysis, the following estimates of the potential areas impacted by a single repeater, assuming the repeater lies within the MDS coverage area, can be made:

Table 4

Scenario	Situation	Possible area of overload for a single repeater, legacy analog receivers. (square miles)
1	Repeater outside of MDS coverage area	None
2	Repeater co-located with MDS transmitter	10.2
3	Repeater 9 miles from MDS transmitter	1.44
3	Repeater 19 miles from MDS transmitter	1.27
3	Repeater 29 miles from MDS transmitter	1.22

2.5. Summary And Characterization Of Overall Probability Of Overload For Installed Base of MDS Legacy Analog Receivers

We have established estimates of the possible impact on legacy analog MDS receivers in terms of overload area caused by repeaters operating at 40 kW EIRP. An estimate of the magnitude of overload problems caused by this mechanism in practice can be obtained by assuming a uniform distribution of receivers within MDS coverage areas. While this assumption may not take into account small local concentrations of receivers, it is valid when trying to identify the overall potential nationwide scope of the issue. The ratio of the total potential nationwide overload area due to S-DARS repeaters to the estimated nationwide MDS coverage area then provides a measure of the number of receivers likely to be affected.

As already described, there are six main conditions necessary for the overload mechanism to actually occur in any given MDS system.

The first and most obvious one is that one or more repeaters must be located within the coverage boundary of an MDS system. This probability is hard to estimate but is most likely significantly less than 1 due to the different service objectives between MDS wireless cable and repeater satellite coverage gap filling and the relatively small number of Sirius repeaters. Clearly, the smaller the MDS coverage area, the smaller is this probability. Sirius has taken a very conservative view and set the probabilities of a repeater being inside an MDS coverage area as in Table 5. These assume that the repeater fills a satellite coverage gap (most likely in a dense urban core) that also lies within an MDS coverage area (most likely suburban/ rural for the legacy analog wireless service under consideration).

Table 5

MDS Serving Area Coverage Radius (miles)	MDS Coverage Area (square miles)	Probability of a repeater being inside the MDS coverage area
10	314.2	0.5
20	1256.6	0.6
30	2827.4	0.8

It should be noted that very few MDS coverage areas would have more than one repeater.

Conditioned upon a receiver falling within the overload area of a repeater, the receiver needs to be utilizing a vertically polarized antenna for there to be a problem. The overall probability of this is taken to be 0.5[15]

Conditioned upon the receiver utilizing a vertically polarized antenna, the repeater antenna needs to be pointing towards, rather than away from the receiver. The overall probability of the terrestrial antenna pointing in the receiver direction =0.5

Conditioned upon all the circumstances above the receiver has also to be of the type that would be affected, namely a wideband legacy analog product. While neither BellSouth nor the WCS has provided accurate data concerning the distribution of these, it is assumed that at least some small reduction in the installed base has occurred since the FCC's WCS MO&O of three years ago, requesting a reduction in inventory. A conservative, small 10% penetration of robust receivers is assumed here. The probability of the receiver being analog is therefore taken as 0.9, likely a worst case.

As each of the above conditions is necessary for an overload situation to exist, a nationwide estimate of the potential impact can be made as follows:

Total Receivers Potentially At Risk=$N_{rec}*P_4*P_5$ = 675,000

> This is the total set of nationwide receivers that, should a repeater be within the overload distance and all other conditions are met, could possibly be affected and factors in an assumed base of 1.5 million receivers, 10% robust receiver penetration and receiver antenna polarization being vertical.

Total Potential Repeater Overload Area Coverage = $N_{rep}*P_1*P_2*(P_3*A_{1c}+(1-P_3)*A_{1nc})$

[15] FCC MDS database 1996.

This is the total potential nationwide repeater coverage area within which receivers meeting all the other conditions could potentially suffer from overload.

Where

N_{rec} =Total Number of Receivers (1.5 million)[16] [17]The actual number of current receivers is estimated from the California amplifier reference (1.5 million with 220 systems). The Norstrad reference lists 1.75 million with 170 systems. It should be noted that in the WCS proceedings the estimate of the number of these analog receivers was 1 million. The lower the actual number, of course, the less the universe of potentially interfered-with receivers.
N_{rep} = Total Number of Repeaters Operating At 40 kW EIRP.[18]
P_1=Probability of a repeater being within an MDS coverage area of a certain size (see Table 5).
A_{1c} = Average overload area per co-located repeater (Table 4) (20.4 square miles) assuming omnidirectional coverage (sectorization is taken into account in P_2).
A_{1nc}= Average overload area per non co-located repeater (1.44 square miles) (see Table 4).
P_2= Probability of repeater antenna pointing in receiver direction (0.5 for single sectored).
P_3= Probability that Repeater is co-located with MDS transmitter (assumed to be 0.05).
P_4=Probability of receiver being connected to a vertically polarized antenna (0.5).
P_5 = Probability of the receiver being a legacy analog receiver (0.9).
A_2=Total nationwide MDS Coverage Area (assumes 220 MDS systems of the average size listed, i.e. small, medium, large[19]).

The number of potentially affected receivers is then estimated by multiplying the ratio of the total (i.e. nationwide) repeater overload area coverage to the total MDS nationwide area coverage by the number of receivers that could be affected (675,000) as shown in Table 6.

---

[16] see for example http://www.calamp.com/Products/Wireless/MDS_Video_and_Scrambling/History_of_MDS/history_of_MDS.htm.
[17] http://www.nostrad.com/technology.htm.
[18] The total number of Repeaters operating at 40 kW EIRP is estimated at 105. This is a very conservative assumption since lower powers would certainly be used in small multi-transmitter networks.
[19] See for example http://www.calamp.com/Products/Wireless/MDS_Video_and_Scrambling/History_of_MDS/history_of_MDS.htm.

Table 6

Assumed Average MDS Coverage Size, radius (in miles)	Estimated Nationwide MDS Coverage Area, Square Miles[20]	Nationwide Area of Potential Legacy Analog Receiver Overload Area Due to S-DARS Repeaters Square Miles	Ratio of Area of Potential Nationwide Receiver Overload Due to S-DARS to Nationwide MMDS Coverage Area	Estimated Nationwide Number of Receivers Potentially At Risk From S-DARS Repeater Overload
10 (small)	69115	62	0.0009	605
20 (medium)	276460	75	0.0003	183
30 (large)	622035	100	0.00016	108

The interpretation of Table 6 is as follows:

Each row represents an independent scenario where the first column contains an assumption of the average coverage radius of the nationwide population of MMDS/MDS/ITFS systems. This average value is then used as the basis for calculating the total area coverage of MMDS/MDS/ITFS systems nationwide.

For a fixed nationwide total of MDS receivers the larger the assumed total land area covered by these systems, the lower is the average area density of receivers. Therefore, for a fixed total nationwide coverage area around repeaters within which receivers would be affected, the lower the MDS receiver area density, the less receivers would be impacted. Offsetting this reduction in impacted receivers is an increasing probability of a repeater being located inside an MMDS/MDS/ITFS coverage area and a consequent increase in total nationwide potential overload area due to repeaters.

Therefore, each of the impacted receiver totals represents a separate and stand-alone nationwide scenario. In practice, the actual number impacted will be a weighted average of the separate cases described. It is very unlikely however, that the number would exceed the 605 value (for the worst case assumption that all MDS systems have relatively small coverage areas).

However, it can be seen that out of about 1.5 million receivers, the potential number affected is under 1000, even with the most conservative, worst case, assumptions. In practice, the number is likely to be significantly smaller; if MDS licensees supplied a current figure for legacy analog receivers, Sirius could refine these calculations.

[20] Assumes 220 systems as referenced previously. This coverage area probably represents an underestimate since a review of the MDS inventory file from the FCC reveals more than 1200 MDS transmitters. As explained above, the larger the actual total nationwide coverage area for MMDS, the less the average receiver density is. Although the probability of a repeater being inside the coverage area increases with a larger MMDS coverage area, the total nationwide repeater overload area is capped by the small number of repeaters to be deployed at 40 kW. In general, the net impact of increasing the number of MDS systems is for the number of potential receivers impacted to decrease.

2.6. Conclusion

The conclusion is that, in general, the probability of 40 kW EIRP S-DARS repeaters causing any significant overload interference to MDS legacy analog receivers without LNA filtering is **negligible.** Even under the worst case assumptions, less than 1000 receivers nationwide could be affected out of a worst case total of 1.5 million. Indeed, assuming a maximum number of 605 affected receivers, this represents only about 0.04 percent of MDS receivers. These rare cases could be easily resolved by the addition of simple filtering.

With contemporary MDS receivers that are designed to accommodate the operation of adjacent services, there is a negligible probability of receiver overload occurring.

The commenters concerns are therefore vastly overstated and should not be used as a basis for requiring interference protection beyond that already afforded in the Sirius Supplemental Comments.

3. Comparison Of S-DARS Repeater Out Of Band Emissions Limits To Other Services And To MDS Co-Channel Protection Limits

3.1. Introduction

Sirius is deploying a state of the art satellite broadcast system augmented by a terrestrial repeater network. In order for this hybrid system to deliver high service levels in dense urban cores, it is necessary to ensure that an S-DARS receiver can receive the satellite signal while in close proximity to a terrestrial transmitter site operating at 40 kW EIRP. Sirius has utilized patented amplifier linearization technology and extensive high power filtering at each transmitter site to achieve unprecedented level of suppression of out of band emissions and ensure appropriate reception of the satellite signal by a receiver.

The purpose of this analysis is to demonstrate that the proposed S-DARS out of band emissions limits for 40 kW EIRP transmitter operation are lower than any other fixed wireless service regulated by the FCC. It is specifically shown that Sirius 40 kW repeaters have a lower out of band emissions levels than 2 kW WCS and PCS transmitters

To further illustrate that the repeaters pose no interference threat to existing MDS services, this analysis shows that the emissions limits proposed are entirely consistent with the co-channel protection limits already established to protect the MMDS/MDS/ITFS services.

The inescapable conclusion is that the Commenters request for an additional 14 dB emissions rejection is unreasonable and without merit.

3.2. Repeater Out Of Band Emissions Limit

The S-DARS operators have proposed an out of band emissions limit of 75 + 10 log (P_{EIRP}) dB, when measured in a 1 MHz bandwidth using no less than a 10 kHz resolution bandwidth for integration. It should be noted that, as described in the supplemental filing,[21] this specification far

[21] See Sirius Supplemental Comments, at 4 & Exhibit 1 at 2-3.

exceeds the requirements of 25.202(f). Two key things should be noted with respect to this specification method:

- The specification is defined with respect to actual radiated power (i.e. EIRP) as opposed to transmitter output power. This results in a far more accurate value than, for example, the transmitter output power specification methodology used for PCS, WCS and MDS service since any antenna gain is included. Since high gain antennas are used in PCS, WCS and MDS deployments, the actual out of band emissions levels for those services will be 10 to 15 dB higher than the specifications listed in the FCC rules.

- The specification method actually results in the maximum radiated out of band emission level being specified as an absolute level, namely –45 dBm, measured in a 1MHz bandwidth. Therefore the maximum radiated out of band emission level for a 40 kW EIRP repeater is only –45 dBm in a 1 MHz bandwidth, a truly remarkable achievement when compared to other services.

In creating an equipment specification, Sirius has assumed the worst case single sectored antenna gain and cable loss to be approximately 15 dB and so the actual repeater specification in terms of transmitter output power is (as is the specification approach used in WCS, PCS and MDS service) is:

$90 + 10 \log (p)$ dB

where p is the transmitter output power in watts.

This is equivalent to a maximum out of band emissions levels out of the transmitter of –60 dBm in a 1MHz bandwidth. It should be noted that the emission level is achieved while operating at a nominal transmitter power of 1 kW and is equivalent to 114 dBc of emissions suppression. This is the ratio between the total transmitter power (i.e. 1 kW in a 4 MHz bandwidth) to the total out of band emissions level, also in a 4 MHz bandwidth (i.e. –60 dBm + 6 dB bandwidth correction factor=-54 dBm). dBc = 60+54=114 dBc.

3.3. Comparison Of S-DARS Out Of Band Emissions Level With Other Services

To help put these numbers into context it is helpful to compare these numbers with other services:

3.3.1. WCS Service

There are actually three separate out of band limits for WCS service.[22] One refers to emissions from WCS into the S-DARS band, one to intra-WCS service interference and the other refers to emissions into all other bands. These specifications are as follows:

3.3.1.1. WCS into S-DARS[23]

The regulations here are:

[22] §27.53 Emission limits.
[23] §27.53 Emission limits, a), 1.

"(1) For fixed, land, and radiolocation land stations: By a factor not less than 80 + 10 log (p) dB on all frequencies between 2320 and 2345 MHz;"

Here p is the transmitter power in watts, not the EIRP. This gives rise to an equivalent emissions level at the transmitter output of –50 dBm, measured in a 1 MHz bandwidth. This is fully 10 dB higher than the equivalent emissions level from highest power S-DARS transmitter operating at 1kW transmitter output power (i.e. 40 kW EIRP) into the WCS band. Therefore, a 40 kW EIRP Repeater generates 10 dB less out of band emissions into the WCS band than WCS transmitters generate into the S-DARS band.

3.3.1.2. Intra-WCS and WCS into other services such as MMDS/ITFS/MDS[24]

The regulations here are:

"(3) For fixed, land, mobile, radiolocation land and radiolocation mobile stations: By a factor not less than 70 + 10 log (p) dB on all frequencies below 2300 MHz and on all frequencies above 2370 MHz; and not less than 43 + 10 log (p) dB on all frequencies between 2300 and 2320 MHz and on all frequencies between 2345 and 2370 MHz that are outside the licensed bands of operation."

In this case the equivalent absolute emission level is –13 dBm for Intra-WCS emissions and –40 dBm for the other frequencies. This is fully 20 dB higher than the equivalent emissions level from the highest power 40kW EIRP repeater.

3.3.2. PCS Services[25]

The regulations for this service state:

"(a) On any frequency outside a licensee's frequency block, the power of any emission shall be attenuated below the transmitter power (P) by at least 43 + 10 log (p) dB."

p here is also transmitter power. The equivalent absolute level in this case is –13 dBm, measured in a 1 MHz bandwidth. This is 47 dB higher than the proposed S-DARS limit for the highest power repeater at 40 kW.

3.4. Comparison of Corresponding Distances At Which Out Of Band Emissions Cause Interference to MDS Service

For the purposes of this analysis, significant out of band emissions are defined to occur when the level received at a legacy analog receiver degrades the industry recommended 45 dB C/I for co-channel protection. Therefore we are calculating how close an interfering transmitter must be to generate no more interference than is permitted a co-channel licensed MDS transmitter.

This distance is calculated using the usual parameters:

- Free space path loss model
- MDS receiver antenna gain 24 dBi

[24] §27.53 Emission limits, a), 3.
[25] §24.238 Emission limits, a).

No benefit due to cross polarization is included since we are looking at the level emissions that are significantly separated in frequency from that of the transmitting antenna and therefore whose polarization cannot be guaranteed to be the same as the antenna.

The results are shown in Table 7.

3.5. Conclusions

1. Because of the state of the art emissions suppression used in the repeaters, the 40 kW EIRP transmitter would have to be co-located, mainbeam to mainbeam with an MDS receiver for the out of band emissions level received at the receiver to exceed the co-channel protection limit used by the MDS service.

This comparison illustrates the critical point that the out of band emissions from 40 kW repeaters, as potentially received by MDS receivers, will in general be at a significantly lower level than would be expected from MDS co-channel transmitters operating in the same service according to appropriate FCC rules.[26]

2. In contrast, transmitters in the PCS service, despite using a lower EIRP have the potential to violate the co-channel protection limit without being co-located. In particular, the PCS service could violate the co-channel protection limit at separation distances up to 5 miles due to out of band emissions.

This comparison illustrates that out of band emissions to be expected from widely deployed PCS, dominate the emissions likely to be received by MDS receivers. These emissions are likely to exceed the MDS co-channel protection limit at distances of up to 5 miles from a PCS base station. In contrast, S-DARS repeaters would have to be virtually co-located with the MDS receiver for this condition to arise.

3. WCS systems, despite operating at the lower EIRP of 2 kW produce out of band emissions 17 dB higher in the MDS bands than do 40 kW S-DARS transmitters. As an additional note, even with the most conservative assumptions, and despite operating at higher EIRP (40 kW vs. 2 kW), the absolute emissions levels from repeaters into WCS systems is more than 7 dB less than the level of emissions accepted by the S-DARS service from WCS fixed systems.

This comparison illustrates the that the out of band emissions from satellite DARS 40 kW Repeaters, as potentially received by MDS receivers, are at a significantly lower level than the out of band emissions that would be received from WCS fixed systems, despite WCS systems having less EIRP. Again, the point is that any interference from Sirius terrestrial repeaters to legacy MDS systems is far less that such systems will receive from WCS.

[26] §21.902 Interference, b), 3).

Table 7 Comparison of Emissions Levels and Distances at Which Co-channel Protection Limit Would Be Violated For MDS Services For Out of Band Emissions from Other Services.

Service	EIRP (Watts)	Assumed antenna gain, net of cable loss (dBi)	Maximum out of band emission level radiated from antenna, in a 6 MHz bandwidth	Distance at which MDS co-channel protection limit would be violated (miles) [27]
PCS	1640	12 (sectored)	+6.8 dBm	5.2
WCS emissions into S-DARS band	2000	12 (sectored)	-30.2 dBm	N/A
WCS into WCS	2000	12 (sectored)	+6.8 dBm	N/A
WCS out of band (except S-DARS)	2000	12 (sectored)	-20.2 dBm	0.23
S-DARS Terrestrial Repeater out of band emissions	40000	15 Sectored	-37.2 dBm	0.0.033

4. Impact Of PCS Systems On Legacy Analog MDS Receivers

4.1. Introduction

The purpose of this analysis is to demonstrate that legacy analog MDS receivers, because of their low quality design, are subject to extensive interference from widely deployed PCS services. Because of the interference mechanism involved, namely image frequency reception, the distance from a PCS base station at which this interference is caused will significantly exceed that of the potential overload distance from an Repeater (see Table 8 of this Section) even though the EIRP of PCS transmitters is less. In fact, as is shown, a PCS base station can produce interference to an MDS receiver at distances of more than 40 miles from the base station. Further, since there are more than 10 thousand PCS base stations,[28] the probability of this interference mechanism exceeds the probability of any overload-related interference from Repeaters by several orders of magnitude.

[27] Assumes a receiver at 20 miles from transmitter (130 dB path loss), 24 dBi gain antenna, 2000 Watt EIRP MDS transmitter, nominal receive level –43 dBm at LNA, requiring that received total emissions in a 6 MHz bandwidth be less than –88 dBm at the same point. This corresponds to a received level at the antenna of –112 dBm in a 6 MHz bandwidth. The calculation also assumes a frequency of 2500 MHz.

[28] From http://www.wow-com.com/wirelesssurvey/ there are presently more than 74,000 wireless base stations in the USA. A very conservative estimate would put the number of these that are at PCS frequency at about 15% or 10,000.

The significance of this form of interference, and its prevalence as a motivator for the deployment of appropriately designed receivers is recognized in statements from equipment manufacturers such as Conifer,[29] namely:

"The brickwall concept originated in the late 1980's as the de-facto standard for MDS downconverters. However, as the market for analog wireless video services grew in rural geographies, so did the availability of low noise downconverters from a number of off-shore manufacturing companies. Problems began to arise in 1996 with the rollout of PCS systems nationwide. These high powered systems wreaked havoc with many of the existing installed low noise downconverters and resulted in substantial retrofits for a number of operators. "PCS retrofits cost a lot of people a lot of money," noted Brown, "our technology is cheap insurance against this happening again."

In fact, this statement would seem to imply that widespread upgrading of legacy analog receivers had already occurred, contrary to the Commenters implication that the scope of the overload problem remains essentially as it did three years ago. If WCA and BellSouth are correct, a significant number of analog wireless cable subscribers must *already* be experiencing poor quality reception as PCS networks continue to expand significantly. As is shown in this and other Exhibits, 40 kW EIRP Repeaters add no additional interference either due to out of band emissions or overload.

In fact, due to the potential interference mechanism and the widespread deployment of transmitters, PCS systems clearly are the dominant source of interference to analog MDS receivers.

4.2. PCS/MDS Interference Mechanism Description

The interference mechanism (image frequency reception between PCS systems and legacy analog MDS systems) is described in the attached technical notes from California amplifier,[30] one of the premier suppliers of MDS receiving equipment. As described in the technical note, based on the lack of front end filtering in these receivers[31] and the particular local oscillator frequency used there exists the potential for PCS transmitters using the frequency range 1930 to 1990 MHz to produce signals that are downconverted, un-attenuated (except for LNA and antenna gain roll off) to the appropriate IF within the receiver.

4.3. Distances Around PCS Base Stations At Which Interference Would Be Detected by Analog Receivers

We apply the same basic arguments as applied elsewhere in this response to calculate the distance at which legacy analog receivers would be affected:

---

[29] See Appendix 1 to this document.

[30] California Amplifier, Technical Support-Application #13010-1/97 "PCS and MDS Interference" and "PCS/WCS Interference Primer," attached as Appendix 2.

[31] See 7 CR 519, 12 FCC Rcd 3977, 1997 FCC LEXIS 1693 (April 2, 1997) , 12., footnote 21 "Following the LNA is an RF Diplexer which consists of two bandpass filters, one to pass 2150-2162 MHz and one to pass 2500-2686 MHz. This output feeds another RF amplifier, bandpass filter, mixer, and intermediate frequency ("IF") stage. The local oscillator is set to 2278 MHz, which provides a 116-128 MHz output from the 2150-2162 MHz band and a 222-408 MHz output from the 2500-2686 MHz band."

1. Free space path loss
2. Receiver uses a 24 dBi antenna
3. PCS antennas are exclusively vertically polarized

From a Technical Note authored by California Amplifier, a leading design and manufacturing operation in this spectrum, we can establish that:

- Industry recommended C/I for analog MDS/MDS/ITFS systems = 45 dB
- Assuming an MDS EIRP of 2000 Watts (63 dBm)
- PCS transmitters utilize an EIRP up to 1640 Watts (62.1 dBm.)

The separation distance between the PCS transmitter and the MDS receiver within which the PCS transmitter will deliver a signal to the receiver that violates the MDS co-channel protection limit (i.e. deliver a signal larger than 45 dB down from the main MDS signal) is shown in Table 8 for different values of MDS transmitter/receiver spacing. This sets the potential radius around a PCS site within which a legacy analog receiver would experience interference.

The PCS interference radius is calculated by determining the path loss required from the PCS transmitter, (operating at 1640 W EIRP) to the MDS receiver to attenuate the PCS signal until it is at least 45 dB below the level of signal that would be received from a serving MDS transmitter (operating at 2kW EIRP). This path loss is then converted into an effective distance assuming a free space propagation law.

Table 8 Comparison of Distance around PCS Sites at Which Image Frequency Interference Would Occur to Legacy Analog MDS Receivers

Distance of MDS Receiver From MDS Transmitter (miles)	Receiver Antenna polarization [32]	MMDS/MDS/ ITFS Signal received at Antenna (dBm)[33]	Received PCS Signal Meeting Co-Channel Protection Limit as received at Antenna[34] (dBm)	Required Path Loss From PCS Transmitter to MMDS/MDS/ ITFS Receiver (dB)	Distance from a PCS transmitter at which transmitter would interfere with analog MDS Receiver (miles)[35]
5	H	-55	-98	135	(>44 miles)
5	V	-55	-98	160	(>100 miles)

4.4. Conclusion

The conclusion from this analysis is that PCS transmitters at 1.64 kW EIRP pose a far greater and more prevalent source of interference to analog MDS receivers than do repeaters at 40 kW EIRP. As shown in section 3 of this Exhibit, not only do PCS transmitters present significantly more

[32] When receiving antenna is horizontally polarized an additional 25 dB of isolation is assumed
[33] Assumes 2 kW EIRP TX , free space law.
[34] Assumes 22dBi receiver antenna gain (i.e. gain is reduced at PCS frequency from MMDS/MDS/ITFS band gain), see California Amp Technical Note, attached as Appendix 2 to this Exhibit.
[35] Assumes Free Space Model, 1900 MHz Frequency.

interference in terms of out of band emissions, but due to an unfortunate co-incidence, lead to significant image frequency related interference. Such interference is present at distances far in excess of the S-DARS overload distance. Due to the extremely large number of deployed PCS transmitters (>10,000) and the rapid growth in this area, it is unlikely that MDS analog receivers with little LNA and/or image filtering will be able to deliver adequate service levels to wireless cable customers in the future regardless of S-DARS deployment.

Appendix 1

NEWS RELEASE
CONIFER CORPORATION
P.O. BOX 1025
BURLINGTON, IA 52601

Conifer Concludes Implementation of Brickwall Filtered MDS Downconverters

Burlington, IA USA – January 20th, 1999 - Conifer Corporation announced today that it has concluded their previously announced effort to integrate pre-amplifier filtering into all of their latest version MDS downconverter products. The series, known as the ***brickwall*** concept, has been implemented to protect the amplifier from out-of-band, high power carriers such as PCS, WCS, weather radar, and port transmissions. More significantly, however, the unit is protected against future authorized services near MDS arising from new auctions, revised rulemakings, or the repositioning of preexisting services.

"We're offering the marketplace a unit that could turn a no-go into a paying customer" notes Charlie Brown of Conifer, "and, just as significantly, protect them from future retrofit costs that could arise due to new interference." The brickwall filter approach goes beyond the stopgap measures of specifically tuned notches and bandstops and protects the unit from potential interference at all frequencies. The technology utilizes an interdigital style mechanical bandpass filter, which offers extremely sharp skirts with low insertion loss. The result is a high performance, low noise pre-LNA filter for ultimate protection. All of Conifer's integrated antenna/downconverter solutions are available in brickwall configurations including models in both the Mag Grid and Microceptor Planar Series.

The brickwall concept originated in the late 1980's as the de-facto standard for MDS downconverters. However, as the market for analog wireless video services grew in rural geographies, so did the availability of low noise downconverters from a number of offshore manufacturing companies. Problems began to arise in 1996 with the rollout of PCS systems nationwide. These high powered systems wreaked havoc with many of the existing installed low noise downconverters and resulted in substantial retrofits for a number of operators. "PCS retrofits cost a lot of people a lot of money," noted Brown, "our technology is cheap insurance against this happening again."

About Conifer Corporation

Conifer[II] Corporation designs and manufacturers wireless transmission and reception equipment used for the delivery of video, voice, and data services. Headquartered in Burlington, IA USA the company provides full service manufacturing from initial product design to final shipment. Conifer is registered to the ISO 9001 International Quality Standard. For more information, please contact Conifer's sales department at 800-843-5419 or 319-752-3607, or via email at conifer@conifercorp.com. The company's website can be found at http://www.conifercorp.com/.

APPENDIX 2

Technical Support - Application #13010 - 1/97

Subject: PCS and MMDS Interference

The Personal Communication Service (PCS) band is licensed to provide a wide variety of advanced mobile communication services such as telephony, data, advanced paging and other services. It operates in a digital format, unlike regular cellular (analog) service.

The PCS band is FCC regulated and is divided into three categories:

- Broadband
- Narrowband
- Unlicensed

Roadband PCS
Frequency Spectrum: 1850-1910 & 1930-1990 MHz (120 MHz total)
Effective Isotropic Radiated Power (EIRP): 1640 W (62.15 dBm)

Spectrum Allocation: This Broadband PCS band is divided into six frequency blocks, either Major Trading Areas (MTAs) or Basic Trading Areas (BTAs), which are based on the Rand McNally Commercial Atlas and Marketing Guide. There are 51 MTAs and 493 BTAs in the United States. These 544 licenses were sold in an FCC auction that ended in January 1997. The breakdown is as follows:

Block A 30 MHz MTA
Block B 30 MHz MTA
Block C 30 MHz BTA
Block D 10 MHz BTA
Block E 10 MHz BTA
Block F 10 MHz BTA

Narrowband PCS
Frequency Spectrum: 901-902, 930-931, 940-941 MHz (3 MHz total)

Unlicensed PCS
Frequency Spectrum: 1910-1930 MHz (20 MHz total)
Application: Low power, limited transmission duration, and short range applications, such as LANs.

Impact of PCS on MMDS

Since a portion of the broadband PCS band falls within the image band of MMDS, it can cause interference with MMDS channels which correspond with those PCS image frequencies.

Further, since PCS is licensed to operate up to 1640W EIRP, high PCS signal levels incident at the input of a downconverter will cause LNA saturation and even irreversible damage, especially at a receive site in close proximity to a PCS transmitter.

In order to eliminate any image band interference, these image signals must be suppressed to an acceptable level relative to MMDS signal. This ratio between the desired MMDS signal and the undesired PCS differs in a digital vs. analog MMDS environment.

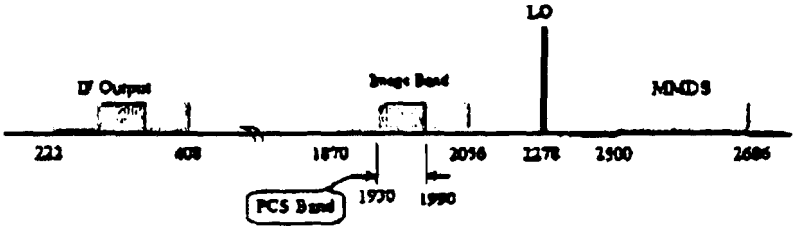
What is an Image Band?

An image band is the band of frequencies which will yield the same IF output band as the desired input band when mixed with the same LO frequency.

Example:
A MMDS RF Input Band: 2500 - 2686 MHz
LO Frequency: 2278 MHz
IF Output Frequency: 222 - 408 MHz
Image Band: 1870 - 2056 MHz

Mathematically
IF Band (desired) = MMDS RF Input - LO
IF Band (undesired) = LO - Image Band

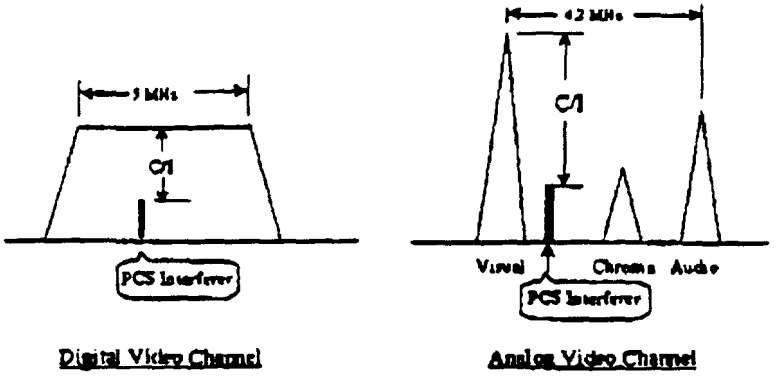
Graphical representation:



MMDS to PCS Requirements (C/I)

A threshold figure of merit known as Carrier to Interference (C/I), must be maintained in order to prevent any degradation to the video or data being transmitted caused by any interfering signal. Such interfering signals can be either internal or external to the system. Internally generated interfering signals can be present in the form of CSO, CTB, or cross modulation distortion; all are caused by system inherent non-linearities, or from crystal related harmonics in a PLL system. External interfering sources are those received by the system from an outside transmit source which can present a serious problem to the system due to its signal levels and/or its frequency in relation to the desired signals, such is the case in PCS. Industry recommended C/I for analog and digital MMDS are:

- Analog System: C/I = 45 dB
- Digital System: C/I = 27 dB for 64 QAM



Digital Video Channel Analog Video Channel

Worst Case PCS Levels in an Analog MMDS Environment

Assumptions:
MMDS EIRP: 59 dBm (50W TX)
PCS EIRP: 62 dBm (1600 W)

MMDS TX from RX: 40 mi (Path Loss: -137 dB)
PCS TX from RX: 300 ft. (Path Loss: -78 dB)

	Dipole	LNBY
MMDS Pinc at D.C Input:	-54 dBm	-60 dBm
PCS Pinc at D.C Input:	+6 dBm	-3 dBm
Antenna Gain at PCS (assumed)	22 dBi	13 dBi
MMDS/PCS at D.C Input:	-60 dB	-57 dB

For a desired C/I of 45 dB:

Required Image Rejection:	105 dB	102 dB
Pre-LNA PCS filtering:	25 dB	25 dB
Post-LNA PCS filtering:	80 dB	77 dB

Worst Case PCS Levels in a Digital MMDS Environment

Assumptions:
Threshold C/I = 7 dB
MMDS EIRP = 53 dBm (10W TX)
PCS EIRP = 62 dBm
Receive Antenna (RX) gain = 24 dBi (Antenna Gain at PCS band = 22dBi)
Downconverter Gain = 32 dB

No obstructions, fade, or multi-path loss is considered

Path Losses:
at MMDS = -137 dB (40 mi.)
at PCS = -75 dB (200 ft.)

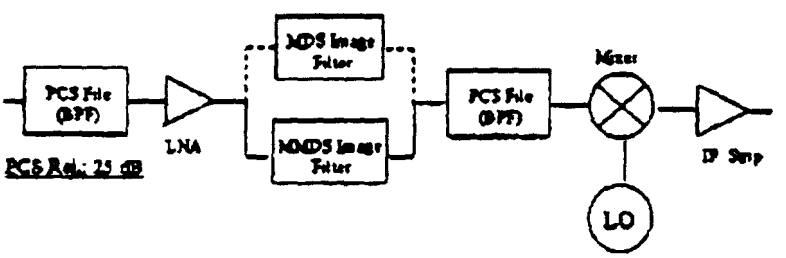
Incident Power Levels:
MMDS = -84 dBm at Receive Antenna, -52 dBm at downconverter input
PCS = -13 dBm at Receive Antenna, 9 dBm at downconverter input

Incident Power Level Ratio:
MMDS to PCS (C/I) = -61 dB

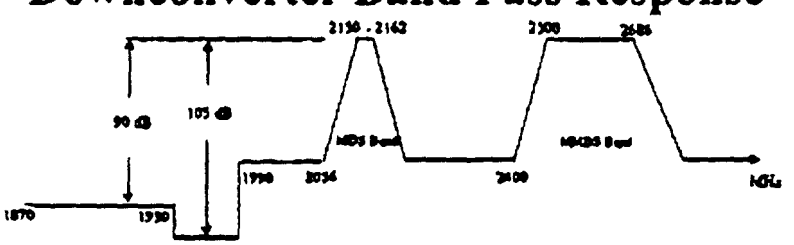
Recomendation:

- For a desired C/I threshold of 27 dB, the required PCS rejection of the downconverter should be -88 dB min.
- +9dBm at the downconverter input will cause serious saturation of the LNA. To prevent this requires a presselector filter with at least 25 dB of rejection at the PCS band. This will yield an acceptable level of -16 dBm at the downconverter input!

Proposed PCS-Immune MMDS Downconverter Block Diagram



Downconverter Band Pass Response



PCS-Immune MMDS Products

In January 1997, California Amplifier was the first company to offer PCS filtered products. Its PCS filtered product family has grown to include integrated dipole downconvertes, integrated yagi antenna-downconverters (LNBYs), standalone downconverters, and the unique field retrofitable filter for use with previously installed Cal-Amp standalone downconverters.

◄ Previous Page - Back to Index - Next Page ►

Copyright 1997 California Amplifier, Inc. All Rights Reserved

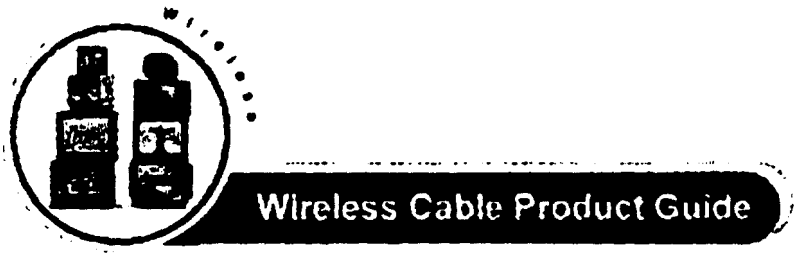
This Page Last Updated February 6, 1998

Comments about the Website? Contact us at webmaster@calamp.com.

Another site by Over TheNet(sm)

California Amplifier

Corporate Investor Products Support Employment



PCS/WCS Interference Primer

Introduction

The PCS band is FCC regulated and is divided into three categories: Broadband, Narrowband, and Unlicensed. In January 1997, the FCC completed its auction of the Broadband PCS spectrum, which spans the frequencies of 1850-1910 and 1930-1990 MHz for 120 MHz total. This slice of spectrum was divided into six frequency blocks, either Major Trading Areas (MTAs) or Basic Trading Areas (BTAs), which are based on the Rand McNally Commercial Atlas and Marketing Guide. There are 51 MTAs and 493 BTAs in the United States. The breakdown is as follows:

Block A	30 MHz	MTA
Block B	30 MHz	MTA
Block C	30 MHz	BTA
Block D	10 MHz	BTA
Block E	10 MHz	BTA
Block F	10 MHz	BTA

Personal Communication Service (PCS) is licensed to provide a wide variety of advanced mobile communication services such as telephony, data, advanced paging, and other services.

Impact of PCS on MMDS

As PCS services continue to deploy nationwide, it is imperative that MMDS operators take the necessary steps to shield their transmissions from PCS interference. This interference shows itself

as a set of diagonal bars in the television picture for analog transmissions and complete picture breakdown in digital reception. To understand the logistics of PCS interference, one must explore some basics of the RF spectrum and operation of typical wireless cable downconverters.

Spectrum in MHz

Wireless cable uses the MDS frequency band (2150-2162 MHz) and the MMDS frequency band (2500-2686 MHz) A wireless cable downconverter receives a radio frequency (RF) signal and "mixes" it with its own internally generated local oscillator (LO). The result is termed its intermediate frequency (IF) signal; this is the difference between the RF and LO. However, "mixing" occurs on both sides of the LO, thus, the resultant IF output will also result in an additional RF input of different frequency. This forms the image band, a mirror image of the desired band from the LO. Interference in either band will disrupt the desired transmissions.

PCS base stations transmit between 1930-1990 MHz at power levels up to 1640 watts EIRP (Effective Isotropic Radiated Power). PCS Mobile stations transmit between 1850-1895 MHz, but are limited to 2 watts EIRP peak power. Because PCS mobile stations are low in output power compared to MMDS transmissions, they do not adversely affect wireless cable transmissions.

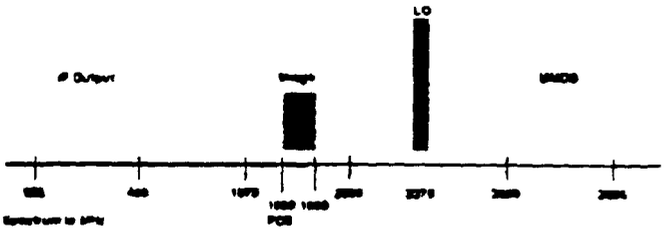
PCS Case Example:

MMDS RF Input Band:	2500-2686 MHz
LO Frequency:	2278 MHz
IF Output Frequency:	222-408 MHz
Image Band:	1870-2056 MHz

Mathematically:

IF Band (desired) = MMDS RF Input - LO
IF Band (undesired) = LO - Image Band

Graphically:



Since the PCS band falls within the MMDS image band, it can cause interference with MMDS channels which correspond with those PCS image frequencies. (Channels D2-E3, 289-343 MHz downconverted)

Narrowband PCS (901-902, 930-931, 940-941 MHz) does not affect MMDS due to where it falls in the spectrum. Unlicensed PCS (1910-1930 MHz), used for short range applications such as LANs, does not affect MMDS due to its low power and limited transmission durations.

PCS Filtered downconverters

The widespread deployment of PCS and its inherent complications with MMDS transmissions requires that operators employ downconverters with adequate image rejection. Further, since PCS is licensed to operate up to 1640 EIRP, high PCS signal levels incident at the input of a downconverter will cause LNA saturation and even irreversible damage, especially a receive site in close proximity to a PCS transmitter.

In order to eliminate any image band interference, these signals must be suppressed to an acceptable level relative to the MMDS signal. This ratio between the desired MMDS signal and the undesired PCS differs in a digital environment to that of an analog. Digital MMDS reception requires at least 80dB of rejection, while analog systems require over 95dB. These calculations stem from a threshold figure of merit known as Carrier to Interference (C/I). This is a threshold which must be maintained in order to prevent any degradation to the video or data being transmitted.

In the downconverter, PCS signals must be removed before they reach the mixer. If the filtering is effective, the mixer will only receive the intended RF frequencies. It is important to note that there must be enough PCS rejection before the LNA to prevent saturation and the remainder behind the RF filter to allow adequate signal delivery.

WCS

In April 1997, the FCC auctioned the rights to the frequencies

2305-2320 and 2345-2360 MHz for the use of Wireless Communications Services (WCS). Awarded were two 10 MHz WCS licenses for each of 52 Major Economic Areas (MEAs) and two 5 MHz WCS licenses for each of 12 Regional Economic Area Groupings (REAGs). The final rules are very flexible in terms of licensees usage of the allotted spectrum and allow for power levels of up to 2000 watts EIRP.

WCS does not introduce frequency overlap problems like PCS, but does have potential adverse effects on MMDS if left unchecked. The WCS spectrum's vicinity to MMDS, along with its probable high power levels, could interfere with wireless cable transmissions much like microwave ovens or airport weather radar. These signals, like other RF interference, must be suppressed at a sufficient level compared to the MMDS signal.

PCS/WCS Solutions for Wireless Cable

In January 1997, California Amplifier was the first company to offer PCS/WCS filtered products. The PCS/WCS filtered family includes integrated dipole downconverters, integrated yagi antenna-downconverters (LNBY™), standalone downconverters, and field retrofitable filters for use with previously installed California Amplifier standalone downconverters.

California Amplifier's image rejection technologies are both the most comprehensive and advanced in the industry. Its diverse family of products offers a solution for any scenario in today's interference plagued environments.

- Return to Wireless Cable Product Guide
- Digital Primer
- Wireless Cable Primer

Industry Links

Keyword(s): Search

Exact Match Search

California Amplifier

Corporate Investor Products Support Employment

Copyright 1998 California Amplifier, Inc. All Rights Reserved

Comments about the Website? Contact us at webmaster@calamp.com

This Page Last Updated 11/12/98

Another site by Over_TheNet(sm)

CERTIFICATE OF SERVICE

I, Vivian M. Martin, hereby certify that on this 8th day of March, 2000, I caused copies of the foregoing **Reply Comments of Sirius Satellite Radio** to be mailed via first-class postage prepaid mail to the following:

Bruce D. Jacobs
Stephen J. Berman
David Konzcal
Fisher Wayland Cooper Leader
& Zaragoza LLP.
2001 Pennsylvania Avenue, N.W., Ste. 400
Washington, DC 20006

Lon C. Levin
Senior Vice President, Regulatory
XM Satellite Radio Inc.
10802 Park Ridge Boulevard
Reston, VA 20191

M. Scott Johnson
Gardner, Carton & Douglas
1301 K Street, N.W., East Tower #900
Washington, DC 20005

Catherine Wang
William B. Wilhelm, Jr.
Swidler & Berlin, Chartered
3000 K Street, N.W., Suite 300
Washington, DC 20007

Paul J. Sinderbrand
William W. Huber
Wilkinson Barker Knauer, LLP
2300 N Street, N.W., Suite 700
Washington, DC 20037

Cheryl Tritt
Morrison & Forester
2000 Pennsylvania Ave., Ste. 5500
Washington, DC 20006

Gary Klein
Ralph Justus
George Hanover
The Consumers Electronics
Manufacturers Association
2500 Wilson Boulevard
Arlington, VA 22201

Henry L. Baumann
Valerie Schulte
National Association of Broadcasters
1771 N Street, N.W.
Washington, DC 20006

Robert B. Jacobi
Cohn and Marks
1333 New Hampshire Ave., N.W., #600
Washington, DC 20036

Charles T. Morgan
Sr. Vice President
Susquehana Radio Corp.
140 East Mark Street Corp.
York, PA 17401

William B. Barfield
Thompson T. Rawls, II
1155 Peachtree Street, N.W
Suite 1800
Atlanta, GA 30309

Keith Larson*
Mass Media Bureau
Federal Communications Commission
445 12th Street, S.W., Room 2C420
Washington, D.C. 20554

Thomas P. Stanley*
Wireless Telecommunications Bureau
Federal Communications Commission
445 12th Street, S.W., Room 3-C460
Washington, D.C. 20554

John Reiser*
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 7-B438
Washington, D.C. 20554

Rockie Patterson*
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room, 6-B524
Washington, D.C. 20554

Larry W. Olson*
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 7-A669
Washington, D.C. 20554

Ronald F. Netro*
Wireless Telecommunications Bureau
Federal Communications Commission
445 12th Street, S.W., Room 3-C163
Washington, DC 20554

Rosalee Chiara*
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-A521
Washington, D.C. 20554

Linda L. Haller*
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room, 6-C747
Washington, D.C. 20554

* *via hand delivery*

Vivian M. Martin

Vivian M. Martin