BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of the Petition of SATELLITE CD RADIO, INC. For Amendment of Section 2.106 and Part 25 of the Commission's Rules To Establish a Satellite/Terrestrial CD Quality Broadcasting Service	)	RM - 7400

SUPPLEMENT TO PETITION FOR RULEMAKING

Satellite CD Radio, Inc. (hereinafter "CD Radio, Inc.") hereby supplements the above-captioned Petition for Rulemaking which it filed on May 18, 1990 (hereinafter the "Petition"). In the Petition, CD Radio, Inc. sought the establishment of a new digital, CD-quality radio service in the bands from 1460-1530 MHz which would be provided in part by satellites (complemented by terrestrial repeaters) and in part by a new terrestrial radio service whose licensees would be current AM and FM broadcasters. This supplement clarifies and/or expands on the discussion of several aspects of CD Radio, Inc.'s proposal.1/

1/ The Commission placed CD Radio, Inc.'s Petition on Public Notice dated June 18, 1990 (Report No. 1817). The filing of this Supplement does not have any effect on the comment cycle established in that Public Notice. The only aspect of CD Radio, Inc.'s proposal being changed by this Supplement is the proposed design of vehicular receivers. In all other respects, this Supplement merely provides additional information to support statements in the original Petition. CD Radio, Inc. has served copies of this Supplement on all entities which have previously requested a copy of the Petition from CD Radio, Inc.

I. TERRESTRIAL REPEATERS AND TRANSMITTERS

At pages 8-10 of the Petition, CD Radio, Inc. describes the architecture of the proposed satellite system and how it would operate. CD Radio, Inc. notes that the system would include a large number of urban area terrestrial repeaters which would simulcast the satellite signal and thereby compensate for shadowing in urban areas. In connection with this discussion, CD Radio, Inc. wishes to clarify the distinction between "terrestrial repeaters" and "terrestrial transmitters" and to elaborate on the technical characteristics and service objectives of such equipment. Thus, the following should be added at page 10 after the first full paragraph (ending with "transmissions will be different"):

> "Terrestrial repeater" refers to the facilities and equipment by which the 66 programs broadcast via satellite are received on the ground, amplified, frequency shifted, and retransmitted at high power. In contrast, the term "terrestrial transmitter" refers to the facilities and equipment used by local broadcasters to deliver CD-quality, stereophonic local entertainment and information programming on the 34 terrestrial radio channels in the adjacent band. (<u>See</u> <u>infra</u> Section IIC.3, pp. 13-14, and Section V, pp. 28-29.) However, the equipment used for the terrestrial repeaters and the transmitters is virtually identical.
>
> The use of terrestrial repeaters is essential to ensuring the availability of an uncompromised, CD-quality stereo broadcasting service in heavily shadowed urban areas that would be otherwise extremely difficult to serve wholly by satellite. Similarly, terrestrial transmitters are essential because they increase the audio quality of currently available local radio programming.
>
> Together with the satellite, the terrestrial repeaters and terrestrial transmitters will make up an integrated, high-quality, radio broadcasting service that will provide 100 program channels in urban areas and 80 channels elsewhere throughout the United States.

Service Objectives. From the link calculations shown in Table 1 of the Technical Appendix to the CD Radio, Inc.'s applications, it may be shown that the nominal field strength delivered by satellite at the edge of the service areas is about 27 dBu(V/m). At this level, there is a link margin in excess of 6 dB to account for all additional losses. (These include blockage by buildings and vegetation and equipment implementation losses, etc.)

This same level of 27 dBu(V/m) has been chosen as the objective for the median field strength (the value exceeded 50% of the time) at the edge of the coverage area provided by either a terrestrial repeater or a terrestrial transmitter. That field strength will provide about the same level of performance at 50% of locations within the service area as the CD Radio satellite signal at the edge of its coverage area. An antenna height of 1.5 meters, typical of an automobile antenna installation, has been assumed. (The greater antenna heights typical of home installations would result in higher field strengths and even better performance.)

To estimate the required characteristics of the terrestrial transmitters and repeaters, CD Radio, Inc. has assumed that coverage is desired of an urban area out to a distance of 40 kilometers from its center.

The objective for field strength set forth here is a nominal value. Similarly, the e.i.r.p. to produce that field strength has been calculated assuming nominal conditions. The actual conditions encountered in specific installations may be considerably different from the assumptions used here. The actual terrain, the availability of suitable transmitting antenna locations, the density of vegetation and the height, location and construction of buildings, and, most important, the geographic coverage and quality of service sought by the terrestrial station operator are among the factors that can vary widely.

Repeater and Transmitter Characteristics. A terrestrial repeater is assumed to be sited in the middle of the urban area to be served, with a transmitting antenna at an effective height of approximately 200 meters. The transmitting antenna is assumed to be circularly polarized, to have an omnidirectional azimuthal pattern and to have a gain of approximately 6 dBic. Typical transmitting antennas having these characteristics include helix, crossed-dipole, slanted-dipole, and ring-panel types.2/

The radiated power required to produce a field strength of 27 dBu(V/m) at a distance of 40 kilometers is on the order of 32.2 dBW.3/ Assuming an antenna gain of 6 dBic and a feed line loss of 2.2 dB, the transmitter power would be about 700 watts.

Modulation Format. The modulation format of the signal transmitted by the terrestrial transmitters and repeaters will be identical to that used on the satellite broadcasting channel, that is, OQPSK, at 256 kb/s, with Dolby AC-2 encoding.

II. USE OF THE BAND BY AERONAUTICAL TELEMETRY

At pages 15-17 of the Petition, CD Radio, Inc. discusses the particular public interest benefits of the 1470-1530 MHz band as a primary allocation to digital satellite broadcasting. In this section, CD Radio, Inc. notes that the 1435-1530 MHz band is now allocated domestically for aeronautical telemetry operations and it explains why use of the band for digital satellite broadcasting would not have an adverse impact on aeronautical telemetry operations. CD Radio, Inc. wishes to clarify and expand on this discussion in the following ways.

2/ R.C. Johnson and H. Jasik, Antenna Engineering Handbook, Second Edition, McGraw-Hill Book Co., New York, ch. 28, 1984.

3/ This may be determined by reference to Figure 41 (d) of Y. Okumura, E. Ohmori, T. Kawana, and K. Fukuda, "Field Strength and Its Variability in VHF and UHF Land-Mobile Radio Service," Rev. Elec. Commun. Lab (Japan), Vol. 16, Sept.-Oct. 1968, pp. 825-873. Similar curves appear in CCIR Report 567-3. See Methods and Statistics for Estimating Field-Strength Values in the Land Mobile Services Using the Frequency Range 30 MHz to 1 GHz," CCIR Report 567-3, Vol. V, XVI Plenary Assembly, Dubrovnik, 1986, pp. 298-312.

1. Add the following at the end of the third paragraph on page 15 (which begins: "The band proposed..."):

> Most communications consist of telemetry links used during testing of aircraft or their major components.4/ Use of the band is coordinated by the Aerospace and Flight Test Radio Coordinating Committee (AFTRCC).5/

2. Delete from the middle of page 16 the sentence beginning "However, the use of frequency synthesizers. . ." and substitute the following:

> Because of the experimental nature of the service, most of the users of the band employ transmitters that can operate on many frequencies within the band. The use of frequency agile transmitters (e.g., those with frequency synthesizers) is becoming widespread.

3. Add the following on page 16 after the paragraph ending with "prevent interference with other users":

> Under the reallocation of spectrum proposed by CD Radio, Inc., which is described below in detail, there will be minimal disruption of existing users. Under the plan, only 4.2 MHz (less than 5% of the existing allocation to Mobile Aeronautical telemetering), would be precluded to it in all areas. Outside of urban areas, an additional (and different) 20 MHz in the band 1470-1530 MHz would be used for satellite transmissions in each of the three regional beams, but flight test activities already coordinated through AFTRCC could continue on a primary basis, and all

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4/ Aviation Services (Flight Test Telemetry), 56 Rad. Reg. 2d (P&F) 1413 (1985). Frequencies from 1435-1485 MHz are used for unmanned aircraft; frequencies from 1485-1530 MHz are used for manned aircraft and missiles.

5/ See Frequency Coordination in the 1435-1535 Mc/s Band, 15 F.C.C.2d 831 (1969).

other flight test transmissions would be authorized on a secondary basis.

Few flight test operations are conducted in urban areas. At the same time, satellite sound broadcasting transmissions may suffer blockage or multipath interference in 'urban canyons.' CD Radio, Inc. proposes to take advantage of these different geographic frequency requirements by using an additional 20 MHz in designated urban areas for terrestrial repeaters that will 'simulcast' the satellite transmissions. In this way, CD Radio, Inc.'s listeners in cities will continue to receive high-quality radio service without affecting flight test operations.

4. Add the following on page 16 after the first indented, single-spaced paragraph (which begins "Another band . . ."):

Indeed, AFTRC itself recognized the relative paucity of use of this band by supporting the recent "carve-out" of 2310-2390 MHz for six specific frequencies for use by private launch operators.6/

5. Add the following on page 17 at the end of the last indented, single-spaced paragraph (which begins "The spectrum allocation . . ."):

The next 6 MHz would be allocated to the terrestrial Broadcasting service in urban areas and to Mobile Aeronautical telemetering outside those urban areas. The next 4.2 MHz would be allocated to the terrestrial Broadcasting service for use in urban and non-urban areas. (That is the segment referred to above as the only one of the current 95 MHz wide allocation that would be foreclosed to the Mobile service.) The last, and highest 60 MHz would be allocated to satellite sound broadcasting on a primary basis, and to terrestrial broadcasting (for the 'simulcast' repeaters) in urban areas. Outside urban areas that 60 MHz allocation could also be used for Mobile Aeronautical telemetering on a secondary basis.

An analysis of sharing between Broadcasting-Satellite Sound and Mobile Aeronautical Telemetering is attached hereto as Appendix 4.

6/ Commercial Space Launch Vehicles, 5 FCC Rcd 493 (1990).

III. FREQUENCY PLAN

At pages 26-29 of the Petition, CD Radio, Inc. discusses how the 1459.8-1530 MHz band would have to be reallocated in order to implement its proposed frequency plan. CD Radio, Inc. wishes to elaborate on this frequency plan by adding the following at the end of Section V on page 29:

> Detailed Frequency Plan. The detailed frequency assignment plan proposed for CD Radio, Inc.'s satellite transmissions and terrestrial repeaters is shown in Table 1.7/ The detailed frequency assignment plan in the adjoining band proposed to be reallocated to terrestrial broadcasting is shown in Table 2. Re-use of frequencies is depicted in Figure 3.
>
> Table 1 shows the division of the overall 60 MHz allocation to satellite sound broadcasting, into three frequency blocks, F1, F2 and F3.8/ Each of the 66 channels in each block will be associated with a specific 300 kHz bandwidth channel. As discussed below, and shown in Figure 3, in each region of the country, one of the blocks will be used for the satellite transmissions and the other blocks will be used for terrestrial repeaters. (Frequencies for terrestrial repeaters must be chosen so that there is no interference from the same frequency used for a satellite channel in the adjacent beam.) Each channel in a block, would be associated with a channel in the other two blocks. For example, the first (lowest frequency) channel in block F1 would be associated with the first channel in block F2 and the first channel in block F3; all the second channels would be associated, and so on through the blocks. Typically, the same program would be broadcast by satellite in another beam (or re-broadcast by a terrestrial

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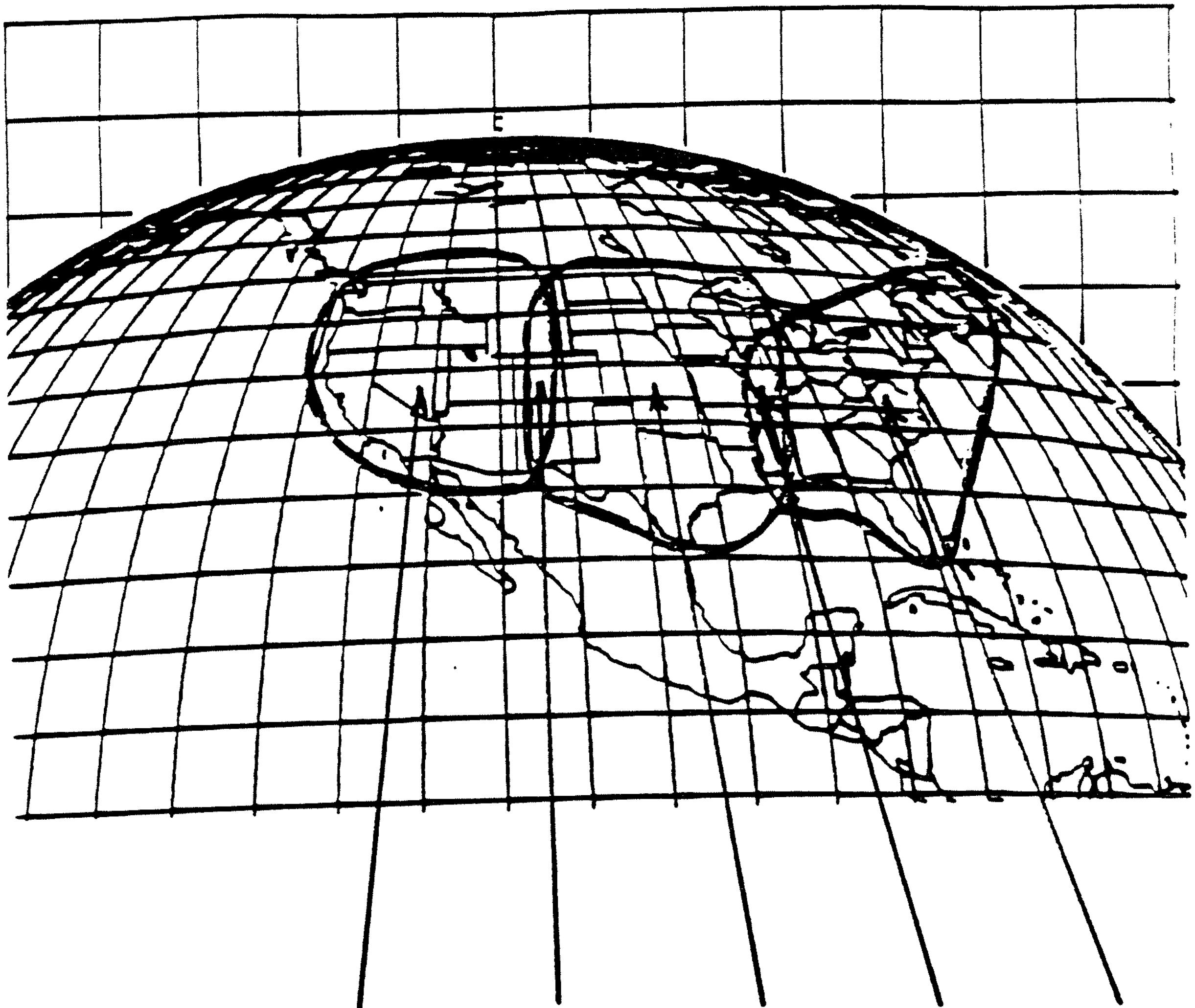
7/ Because of the addition of two tables included with this Supplement, Table 1 in Section VIII, immediately following page 42, is now "Table 3." In addition, in that Table, on the frequency scale of the "Proposed Allocation," the frequency "1465.8" is incorrect. The correct frequency is "1464.0." A revised Table 3 reflecting this correction is attached hereto.

8/ As shown in Figure 3, frequency blocks F1, F2 and F3, will be assigned to the Western, Central and Eastern Beams, respectively. Each of those 20 MHz wide blocks can provide 66, 256 kb/s program channels.

Figure 3

FREQUENCY USE AND REUSE THROUGHOUT THE UNITED STATES FOR SATELLITE AND TERRESTRIAL TRANSMISSIONS, BY BLOCK



SATELLITE:	F1	F1&F2	F2	F2&F3	F3
TERRESTRIAL REPEATERS:	F2&F3	F3	F1&F3	F1	F1&F2
MOBILE (AERO. TELEM.) IN NON-URBAN AREAS:	F2&F3	F3	F1&F3	F1	F1&F2

Note 1: Frequency Blocks F1, F2 and F3, and the channel assignments therein, are defined in Table 1.

Note 2: Additional channels are available for Mobile (Aeronautical Telemetering) in the bands 1435-1459.8 MHz and 1459.8-1470 MHz (see Table 2).

repeater). The purpose of that association is to insure continuous reception as a vehicle moves between urban and non-urban areas, or between one satellite beam coverage area and another.

Vehicular receivers would be designed to constantly compare the received signal strength of the channel being received with that of the two associated channels in the other blocks, and to select the strongest automatically. If a vehicle is moving from one satellite beam coverage area to another, the receiver will automatically switch to the same program being transmitted in the "associated channel" in the adjoining satellite service area. If the vehicle is moving between non-urban and urban areas, the receiver will select automatically on the basis of signal strength, either the satellite signal, or a channel being re- broadcast by the terrestrial repeater which carries the same program material. An overview of the vehicular receiver is attached as Appendix 5 hereto.

The CD Radio, Inc. frequency plan, depicted in Table 1, is based on a re-use factor of 3. That is, each of the satellite beams is assigned one-third of the total available satellite spectrum (i.e., 66 channels). Within each of the satellite beam areas, the remaining two-thirds of the satellite frequencies (i.e., 132 channels) are available for use by the terrestrial repeaters to fill in shadowed areas, except in geographic areas where the satellite beams overlap one another. In those overlap areas, only another one-third of the frequencies (i.e., 66 channels) is available for use by terrestrial repeaters on a noninterfering basis. In the much smaller overlap areas, 33 channels can be provided by the terrestrial repeaters.

In other words, if frequency block F2 is used in the Central beam, channels from block F1 could be used for terrestrial repeaters in the Central region except in its western parts where satellite signals from the Western beam (also in block 1) can be received. Similarly, channels from block 3 could be used for terrestrial transmitters in the Central region, except in its Eastern portions, where signals from the Eastern beam (also in block 3) can be received.

Similarly, Mobile aeronautical telemetering stations can use frequencies throughout that 60 MHz range that are not being used in the satellite beam covering that part of the country, and that are not being used by terrestrial repeaters in nearby urban areas.

IV. ADVANCE PUBLICATION INFORMATION

At page 30 of the Petition, CD Radio, Inc. emphasizes the importance of prompt Commission approval of this allocation proposal in order to maximize the chances of international recognition at the 1992 WARC. Toward this objective, a new Appendix 6 is attached hereto which contains standard ITU Advance Publication information for the CD Radio, Inc. system. The FCC should promptly forward this information to the IFRB to protect U.S. interests in the frequency bands concerned. Although CD Radio, Inc. recognizes that the 1470-1530 MHz downlink is not yet recognized by the ITU, the 30 GHz uplink is so recognized. The U.S. has an obligation to advance publish the 30 GHz uplink as early as possible within the five years before launch. Advance Publication of the 1470-1530 MHz downlink will increase worldwide exposure of this U.S. proposal, thereby enabling better opportunities for discussions of this issue at the 1992 WARC.9/

Respectfully submitted,

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9/ Also attached to this Supplement is new Figure 4 which is a flow chart showing the participation options for local broadcasters under the CD Radio, Inc. proposal and the steps necessary to implement the proposed satellite system.

Figure 4

CD RADIO IMPLEMENTATION & PARTICIPATION OPTIONS UNDER SATELLITE CD RADIO, INC. FCC PROPOSAL

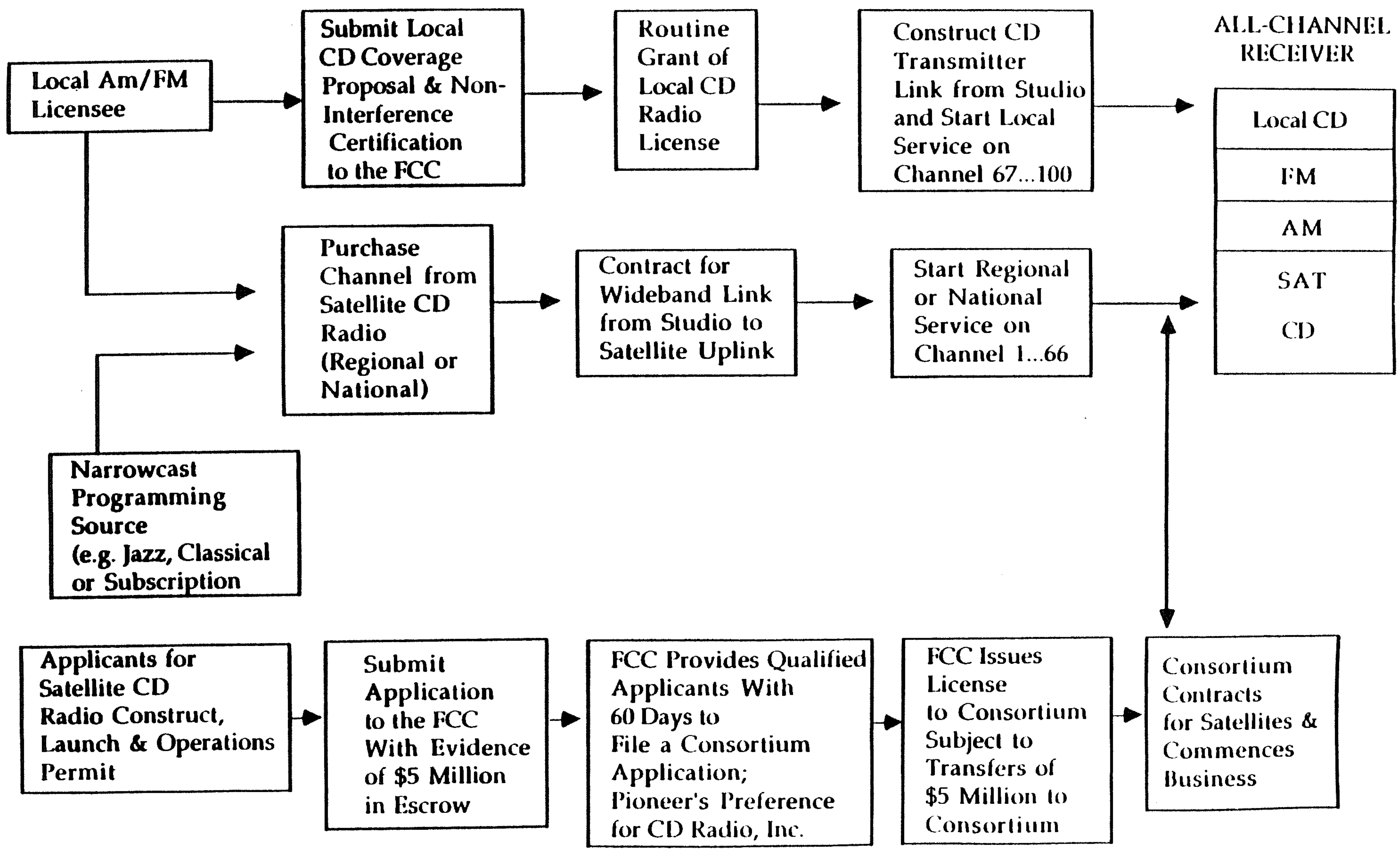


Table 1

Detailed Frequency Plan
For Satellite and Terrestrial Repeaters and
Mobile Aeronautical Telemetry
in the Band 1470.0-1530.0 MHz

Ch	Block F1	Block F2	Block F3
1	1470.0-1470.3	1490.0-1490.3	1510.0-1510.3
2	1470.3-1470.6	1490.3-1490.6	1510.3-1510.6
3	1470.6-1470.9	1490.6-1490.9	1510.6-1510.9
4	1470.9-1471.2	1490.9-1491.2	1510.9-1511.2
5	1471.2-1471.5	1491.2-1491.5	1511.2-1511.5
6	1471.5-1471.8	1491.5-1491.8	1511.5-1511.8
7	1471.8-1472.1	1491.8-1492.1	1511.8-1512.1
8	1472.1-1472.4	1492.1-1492.4	1512.1-1512.4
9	1472.4-1472.7	1492.4-1492.7	1512.4-1512.7
10	1472.7-1473.0	1492.7-1493.0	1512.7-1513.0
11	1473.0-1473.3	1493.0-1493.3	1513.0-1513.3
12	1473.3-1473.6	1493.3-1493.6	1513.3-1513.6
13	1473.6-1473.9	1493.6-1493.9	1513.6-1513.9
14	1473.9-1474.2	1493.9-1494.2	1513.9-1514.2
15	1474.2-1474.5	1494.2-1494.5	1514.2-1514.5
16	1474.5-1474.8	1494.5-1494.8	1514.5-1514.8
17	1474.8-1475.1	1494.8-1495.1	1514.8-1515.1
18	1475.1-1475.4	1495.1-1495.4	1515.1-1515.4
19	1475.4-1475.7	1495.4-1495.7	1515.4-1515.7
20	1475.7-1476.0	1495.7-1496.0	1515.7-1516.0
21	1476.0-1476.3	1496.0-1496.3	1516.0-1516.3
22	1476.3-1476.6	1496.3-1496.6	1516.3-1516.6
23	1476.6-1476.9	1496.6-1496.9	1516.6-1516.9
24	1476.9-1477.2	1496.9-1497.2	1516.9-1517.2
25	1477.2-1477.5	1497.2-1497.5	1517.2-1517.5
26	1477.5-1477.8	1497.5-1497.8	1517.5-1517.8
27	1477.8-1478.1	1497.8-1498.1	1517.8-1518.1
28	1478.1-1478.4	1498.1-1498.4	1518.1-1518.4
29	1478.4-1478.7	1498.4-1498.7	1518.4-1518.7
30	1478.7-1479.0	1498.7-1499.0	1518.7-1519.0
31	1479.0-1479.3	1499.0-1499.3	1519.0-1519.3
32	1479.3-1479.6	1499.3-1499.6	1519.3-1519.6
33	1479.6-1479.9	1499.6-1499.9	1519.6-1519.9

Table 1(Continued)

Detailed Frequency Plan
For Satellite and Terrestrial Repeaters and
Mobile Aeronautical Telemetry
in the Band 1470.0-1530.0 MHz

Ch	Block F1	Block F2	Block F3
34	1479.9-1480.2	1499.9-1500.2	1519.9-1520.2
35	1480.2-1480.5	1500.2-1500.5	1520.2-1520.5
36	1480.5-1480.8	1500.5-1500.8	1520.5-1520.8
37	1480.8-1481.1	1500.8-1501.1	1520.8-1521.1
38	1481.1-1481.4	1501.1-1401.4	1521.1-1521.4
39	1481.4-1481.7	1501.4-1501.7	1521.4-1521.7
40	1481.7-1482.0	1501.7-1502.0	1521.7-1522.0
41	1482.0-1482.3	1502.0-1502.3	1522.0-1522.3
42	1482.3-1482.6	1502.3-1502.6	1522.3-1522.6
43	1482.6-1482.9	1502.6-1502.9	1522.6-1522.9
44	1482.9-1483.2	1502.9-1503.2	1522.9-1523.2
45	1483.2-1483.5	1503.2-1503.5	1523.2-1523.5
46	1483.5-1483.8	1503.5-1503.8	1523.5-1523.8
47	1483.8-1484.1	1503.8-1504.1	1523.8-1524.1
48	1484.1-1484.4	1504.1-1504.4	1524.1-1524.4
49	1484.4-1484.7	1504.4-1504.7	1524.4-1524.7
50	1484.7-1485.0	1504.7-1505.0	1524.7-1525.0
51	1485.0-1485.3	1505.0-1505.3	1525.0-1525.3
52	1485.3-1485.6	1505.3-1505.6	1525.3-1525.6
53	1485.6-1485.9	1505.6-1505.9	1525.6-1525.9
54	1485.9-1486.2	1505.9-1506.2	1525.9-1526.2
55	1486.2-1486.5	1506.2-1506.5	1526.2-1526.5
56	1486.5-1486.8	1506.5-1506.8	1526.5-1526.8
57	1486.8-1487.1	1506.8-1507.1	1526.8-1527.1
58	1487.1-1487.4	1507.1-1507.4	1527.1-1527.4
59	1487.4-1487.7	1507.4-1507.7	1527.4-1527.7
60	1487.7-1488.0	1407.7-1508.0	1527.7-1528.0
61	1488.0-1488.3	1508.0-1508.3	1528.0-1528.3
62	1488.3-1488.6	1508.3-1508.6	1528.3-1528.6
63	1488.6-1488.9	1508.6-1508.9	1528.6-1528.9
64	1488.9-1489.2	1508.9-1509.2	1528.9-1529.2
65	1489.2-1489.5	1509.2-1509.5	1529.2-1529.5
66	1489.5-1489.8	1509.5-1509.8	1529.5-1529.8

Table 2

Detailed Frequency Plan
Terrestrial Broadcasting and Mobile Aeronautical
Telemetry in the Adjoining Band, 1459.8-1470.0 MHz

Broadcasting in Urban Areas and Mobile Aeronautical Telemety Elsewhere

Ch	Frequency
67	1459.8-1460.1
68	1460.1-1460.4
69	1460.4-1460.7
70	1460.7-1461.0
71	1461.0-1461.3
72	1461.3-1461.6
73	1461.6-1461.9
74	1461.9-1462.2
75	1462.2-1462.5
76	1462.5-1462.8
77	1462.8-1463.1
78	1463.1-1463.4
79	1463.4-1463.7
80	1463.7-1464.0
81	1464.0-1464.3
82	1464.3-1464.6
83	1464.6-1464.9
84	1464.9-1465.2
85	1465.2-1465.5
86	1465.5-1465.8

Broadcasting in Urban and Non-Urban Areas

Ch	Frequency
87	1465.8-1466.1
88	1466.1-1466.4
89	1466.4-1466.7
90	1466.7-1467.0
91	1467.0-1467.3
92	1467.3-1467.6
93	1467.6-1467.9
94	1467.9-1468.2
95	1468.2-1468.5
96	1468.5-1468.8
97	1468.8-1469.1
98	1469.1-1469.4
99	1469.4-1469.4
100	1469.7-1470.0

PRESENT ALLOCATION

1435 MHz – 1530 MHz
MOBILE (Aeronautical telemetering)

PROPOSED ALLOCATION

1435 MHz – 1459.8	1459.8 – 1464.0	1464.0 – 1470.0	1470.0 – 1530 MHz
MOBILE (Aeronautical Telemetering)	NOTE 1 BROADCASTING	NOTE 1 BROADCASTING Mobile (Aeronautical telemetering)	NOTE 2 BROADCASTING-SATELLITE (SOUND) Broadcasting Mobile (Aeronautical telemetering)

NOTES:

1. In the band 1459.8-1470.0 MHz, the entire 10.2 MHz would be available for terrestrial broadcasting in major metropolitan areas. Outside those areas, 4.2 MHz of the band could be assigned only for terrestrial broadcasting, and 6.0 MHz could be assigned only for Mobile (Aeronautical telemetering). Terrestrial broadcasting would be limited to 34 channels carrying 256 kb/s transmissions within a 300 KHz bandwidth.

2. The band 1470-1530 MHz is divided into three sub-bands of 19.8 MHz each, for broadcasting-satellite use in Eastern, Central and Western parts of the United States, respectively. Broadcasting-satellite services are limited to 34 channels carrying 256 kb/s transmissions within a 300 KHz bandwidth. The two sub-bands not used in an area for satellite broadcasting, would be available for assignment to terrestrial repeaters of satellite transmissions in urban areas, and for Mobile (Aeronautical telemetering) elsewhere throughout the United States.

Table 3.

PRESENT AND PROPOSED DOMESTIC ALLOCATION FOR CD RADIO SERVICE

Satellite CD Radio, Inc.
Supplement to Petition
for Rulemaking
June 22, 1990

Appendix 4

Sharing Between Broadcasting-Satellite Sound and Mobile (Aeronautical Telemetering)

SHARING BETWEEN BROADCASTING-SATELLITE SOUND AND MOBILE (AERONAUTICAL TELEMETERING)

1. Introduction

This analysis considers sharing between the Broadcasting-satellite (sound) and Mobile (Aeronautical telemetering) services around 1500 MHz. Potential interference between the two services will be considered separately for the two directions of transmission. Interference to telemetry receivers from broadcasting- satellite transmitters, from the terrestrial repeaters rebroadcasting the satellite programs, and from the independent terrestrial broadcasting stations will be considered in Section 2. Interference from telemetry transmitters to portable, vehicular and home BSS receivers will be considered in Section 3.

Interference from the satellite to telemetry receivers is the most important direction of transmission to assess the feasibility of sharing between the two services. That is because the signal from the satellites will blanket the entire country: every telemetry receiver in the United States will be located within one of the satellite beams. On the other hand, the level of interference to telemetry receivers from the terrestrial repeaters and from the terrestrial broadcasting stations, and from telemetry transmitters to BSS receivers, will depend on the separation between them. Thus, sharing will be possible when there is sufficient separation between such stations.

The proposed re-allocation within the 95 MHz-wide band now allocated to Mobile aeronautical telemetry, leaves 25 MHz exclusive and untouched. That segment can continue to be used in areas where telemetry operations are too close to BSS receiver installations to permit co-channel sharing. Other segments of the 95 MHz-wide band can be used in rural areas where there will be no use of these frequencies by terrestrial broadcasting stations or by terrestrial repeaters that will re-broadcast satellite programming in urban areas.

Certain parameters of telemetry systems now operating in the band 1435 - 1530 MHz, have been obtained from the government master file ("GMF"), relevant portions of which were provided by NTIA in response to a request from Telecommunications Systems. A copy of that summary is attached. Other parameters have been derived or assumed, as noted below.

2. Interference to Receivers of Mobile Aeronautical Telemetry

2.1 Interference from Broadcasting-Satellite Transmitters

The increase in the noise threshold of a telemetry receiver caused by undesired signals from the broadcasting-satellites will be the measure of interference for this direction of transmission.

The calculations given below indicate that the receiver noise threshold will be increased by less than one-half a dB. Moreover, this slight increase in noise threshold will be noticed only when the telemetry transmitter is at maximum range from the receiver. At all lesser distances, the receiver will be operating with carrier-to-noise ratios above threshold.

Parameter	Value
Source	
Telemetry receiver sensitivity: (GMF)	-90 dBm
Carrier-to-noise at threshold: engineering	10 dB (Common practice for FM)
Bandwidth: (GMF)	500 kHz

Therefore, Rcvr. noise @ threshold: -90 dBm - 10 dB = -100 dBm
= -130 dBW

Satellite e.i.r.p. per channel: 46.1 dBW (CD Radio Application)

Path loss: -187.7 dB

Rcvr. sidelobe gain : 0 dB (Assumed)

Interfering power: 46.1 - 187.7 +0 = -141.6 dBW/250 kHz
= -138.6 dBW/500 kHz

Degradation of rcvr. threshold = [-138.6 dBW] + [-130 dBW]
= -0.4 dB

2.2 Interference from Terrestrial Repeaters and Broadcasting Stations

Interference to telemetry receivers from both terrestrial repeaters and terrestrial broadcasting stations will be considered together, because the characteristics of these terrestrial stations and, hence, their interference potential, will be similar. Major known characteristics of each are given below:

Mobile Aeronautical Telemetry

Receiver Sensitivity:	-120 dBW
Receiver Antenna Gain:	1 - 42 dBi
Modulation:	FM
Necessary Bandwidth:	500 kHz to 1 MHz
Transmitter Power:	3 - 17 dBW

Terrestrial Repeaters and Broadcasting Stations

Transmitter EIRP:	30 -40 dBW/channel
Modulation:	OQPSK
Necessary Bandwidth:	256 kHz/channel
Receiver Antenna Gain:	Mobile and portable: 5 dBi Home: 10 - 12 dBi
Service Area:	40 km circle around each transmitter

Typically, telemetry receivers will be less than 10 meters above surrounding terrain. Broadcasting repeaters and transmitters will be at elevations of 300 meters or less. Interference can be caused within line-of-sight, and by tropospheric propagation beyond the horizon. Coordination of frequency usage will be required in areas where telemetry operations are conducted.

2. Interference from Telemetry Transmitters to BSS (Sound) Re ceivers

Typically, portable and mobile BSS (Sound) receivers and their antennas (omnidirectional in azimuth) will be at elevations no more than a few meters above surrounding terrain. Antennas of home installations may be at somewhat higher elevations (in the case of multi-story dwellings, office buildings, etc.), but will typically have higher gain (10 -12 dB), and be more directive. Typically, such antennas will be oriented so that their main lobe will be in the direction of the local terrestrial transmitters and repeaters. Those will most often be located in or near the center of cities and other urban areas. In most situations, this relative orientation will provide additional discrimination against interference from airborne telemetry transmitters at flight test centers.

Interference can occur under some circumstances within line of sight, which can be 200 miles in the case of a telemetry transmitter on an aircraft at an altitude of 20,000 feet. Coordination of frequency usage will be required in areas where telemetry operations are conducted.

SUMMARY CHARACTERIZATION OF THE 1435-1535 MHz FREQUENCY BAND

Band MHz	Government Allocation	Non-Government Allocation	Major Government Use	Power (dBW)	Modulation Type and Necessary Bandwidth	Antenna Gain (dBi)		Receiver Sensitivity (dBm)
						TX	RX	
1435-1535 US78 722	MOBILE (Aeronautical telemetering)	MOBILE (Aeronautical telemetering)	Aeronautical Telemetry	33 to 47	Frequency Modulated; 500 kHz to 1 MHz	(1-16	(1-42	-90

Areas of Deployment: Aeronautical telemetry systems are operated by the military services and contractors at various test ranges and facilities nationwide.

Typical Operation: Telemetry is used by the military mainly during flight operations. The military's aeronautical mobile operations provide telemetry support for tests performed at military test ranges, and include ground checkout of telemetry packages prior to flight.

The following footnotes to the National Table of Allocations apply:

This footnote denotes a stipulation applicable to both the Government and non-Government.

US78 The frequencies between 1435 and 1535 MHz will be assigned for aeronautical telemetry and associated telecommand operations for flight testing of manned or unmanned aircraft and missiles, or their major components. Permissable usage includes telemetry associated with launching and reentry into the earth's atmosphere as well as any incidental orbiting prior to reentry of manned or unmanned objects undergoing flight tests. The following frequencies are shared with flight telemetering mobile stations: 1444.5, 1453.5, 1501.5, 1515.5, 1524.5 and 1525.5 MHz. In the band 1530-1535 MHz, the Maritime Mobile Satellite Service will be the only primary service after January 1, 1990.

This footnote comes from the Radio Regulations, Geneva 1982

722 In the bands 1400-1727 MHz, 101-120 GHz 197-220 GHz, passive research is being conducted by some countries in a program for the search for intentional emissions of extra-terrestrial origin.

Appendix 5

Overview of the Vehicular Receiver

Overview of the Vehicular Receiver

An artist concept of the vehicular receiver is shown in Figure 1. A block diagram of the vehicular receiver is shown in Figure 2. It is the CD radio portion of the combined AM/FM/CD radio proposed for vehicular installation. As shown in the figure, the receiver features the use of a single antenna, adaptive equalization, a deinterleaver, and a Viterbi decoder to recover the 256 kbps digital audio data stream for decoding by the Dolby AC-2 decoder. The output of the Dolby decoder includes two analog stereo channels which are fed to the stereo amplifier and then to the speakers.

The significant features of the receiver will be discussed in turn.

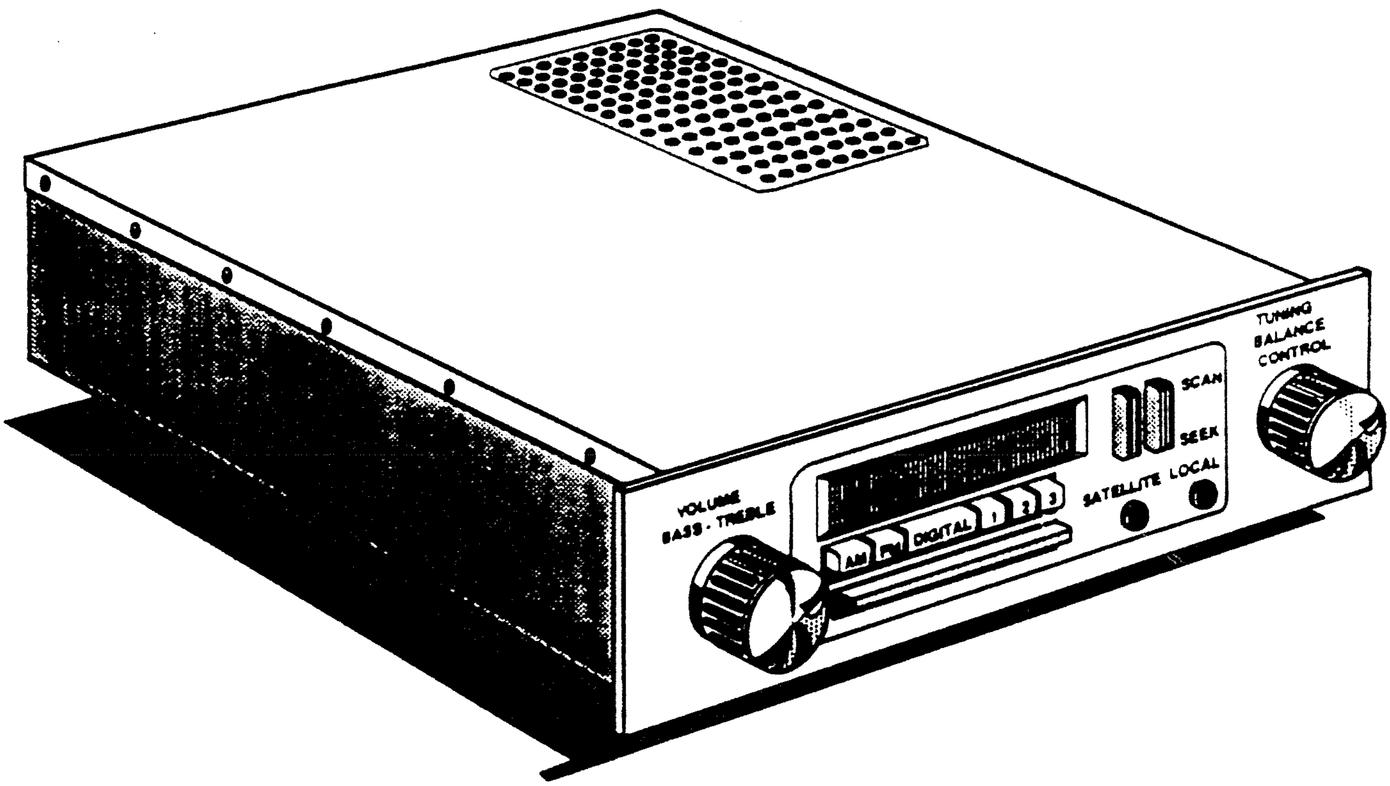


Figure 1: Artist concept of the CD Radio vehicular receiver.

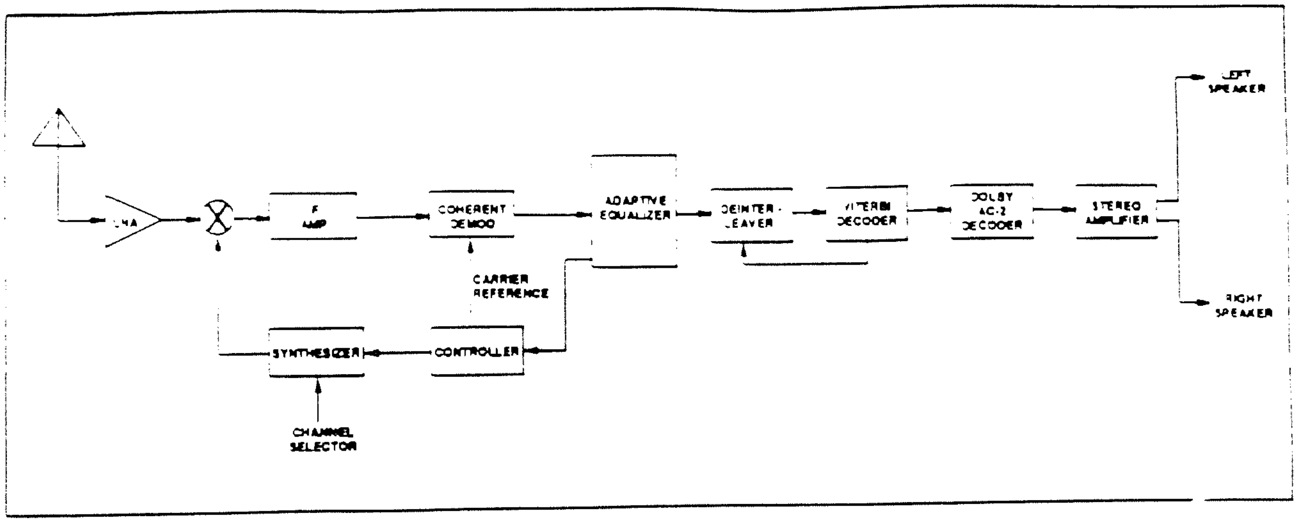


Figure 2: Block diagram of the vehicular receiver.

Receiving Antennas

Several antenna types are under consideration. It is desirable that the vehicular receiving antenna exhibit the following characteristics:

- circular polarization,
- omnidirectional azimuthal pattern,
- 5 dBic gain in the elevation plane between 30 degrees and 60 degrees above the local horizontal plane,
- 5% operating bandwidth,
- low wind profile, and,
- aesthetic package acceptable by the public.

The types of vehicular receiving antennas that are under consideration include:

- normal mode, quadrifilar helix,
- crossed-drooping dipole (inverted U and inverted V types),
- cavity-backed spiral, and,
- shallow-cavity, crossed slot.

Normal Mode, Quadrifilar Helix

A normal mode, quadrifilar helix antenna is shown in Figure 3. Each of the quadrifilar elements consists of a helical portion and two radial portions. The four top radials connect the helical portions to the feed region, while the bottom radials (not visible in the figure) are carried to the center where they are shorted together.

The radiation characteristics of this type antenna have been studied in detail by Kilgus [1]. The radiation characteristics are dependent on the number of turns, the diameter and the pitch of the helix. Figure 4 shows a pattern approximating that required by CD Radio. This pattern is realized with a 5-turn helix, wound on a 1.7 cm diameter rod. The length is on the order of 52 cm for an operating frequency of 1500 MHz.

While the directive gain and radiation pattern are suitable for the CD Radio application, the radiation efficiency tends to be low, the antenna is relatively large compared to a wavelength (performance in a multipath environment could be degraded), and, the radiation pattern is frequency sensitive.

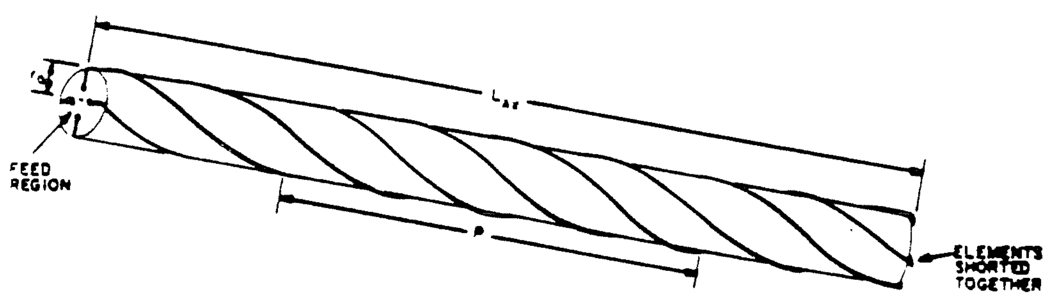


Figure 3: Normal mode, quadrifilar helix antenna [1].

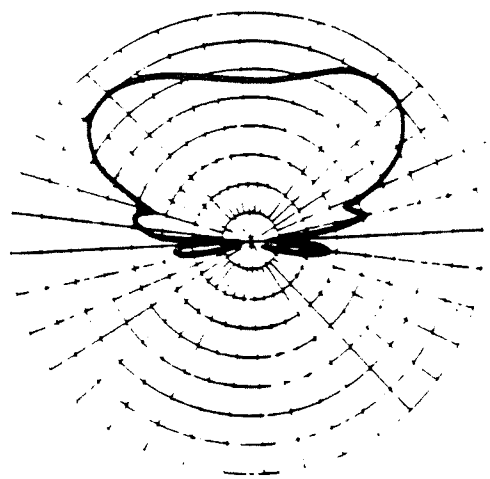


Figure 4: Radiation pattern for a normal mode, quadrifilar helix antenna [1].

Crossed-drooping Dipole (Inverted U and Inverted V types)

Two variations of the crossed-drooping dipole antenna are being considered -- the inverted U and the inverted V as shown in Figure 5. Computed patterns for the inverted U type antenna are shown in Figure 6 [2]. Reference to "Pattern B" in the figure indicates that the inverted U is capable of satisfying the gain-elevation angle requirements when operated over a square ground plane whose size is somewhat less than the roof of a car. The height of the antenna is on the order of a half-wavelength.

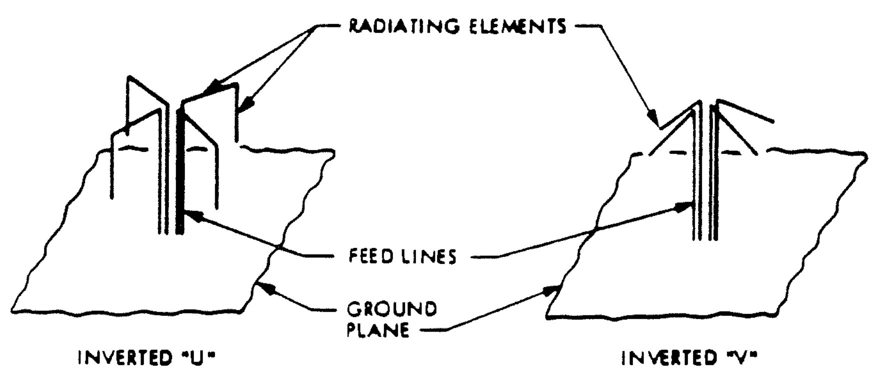


Figure 5: Variations of crossed-drooping dipole [2].

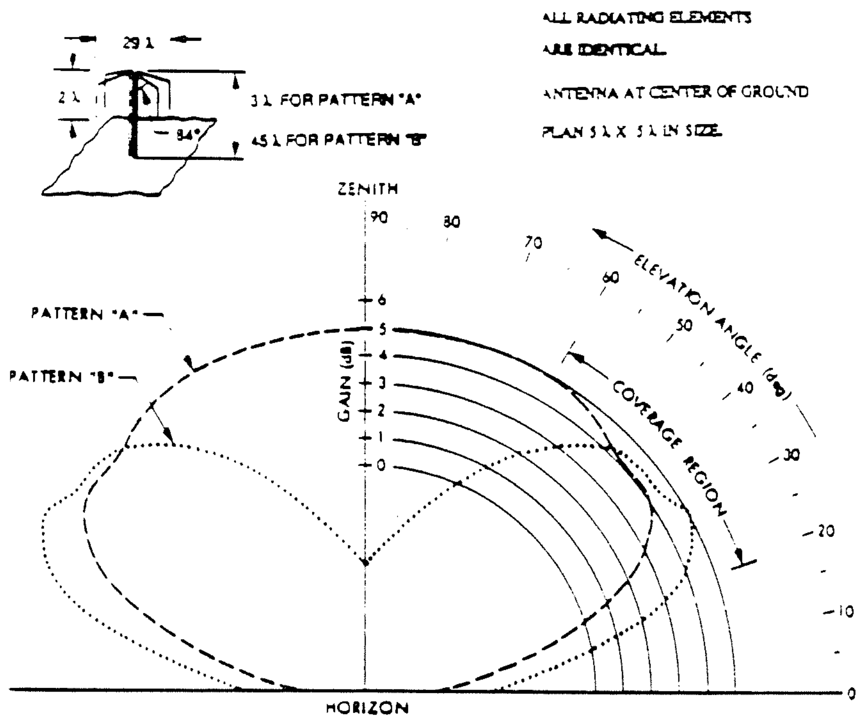


Figure 6: Computed performance of inverted U antenna [2].

Cavity-backed Spiral

A cavity-backed spiral antenna is an inherently broadband antenna that radiates circularly polarized waves in the direction normal to the plane containing the spiral. The optimum depth of the cavity for maximum gain is one-quarter wavelength, whereas the diameter of the cavity is in excess of one-half wavelength. The maximum gain is on the order of 4 dBic in the direction normal to the plane of the spiral [3]. The direction of maximum gain towards zenith is a disadvantage for this type antenna.

Shallow-cavity, Crossed Slot

The shallow-cavity, crossed slot antenna is one of the more promising antennas that is being considered. It is the complement of the crossed dipole antenna (see [4]). The radiation is circularly polarized and is broadside to the plane of slots.

Figure 7 shows several views of the antenna. The view at (a) shows the cavity and the feed posts, while (b) schematically shows the antenna and feed line. The maximum gain of the antenna is on the order of 5 dBic. The dimensions of a typical element designed for operation at 1500 MHz are [5]:

Cavity edge	13 cm
Cavity thickness	1.6 cm
Slot length	18.3 cm

These dimensions may be made smaller with the use of dielectrically loaded cavities.

The lack of a need for a separate ground plane is an advantage of this type antenna.

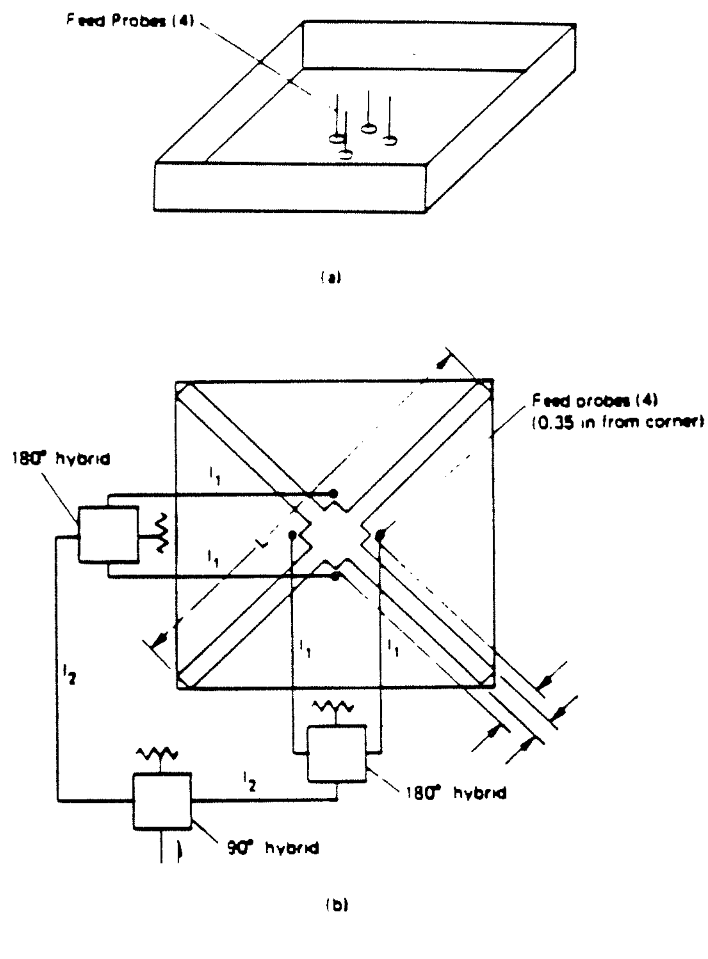


Figure 7: Shallow-cavity, crossed slot antenna.

Receiver RF/IF/Demodulator Sections

As shown in Figure 2, the receiver section consists of a low-noise amplifier (LNA), a mixer-downconverter, an IF amplifier, and a coherent product demodulator. A frequency synthesizer is used to manually select (via a front panel control) the desired CD radio channel. The actual frequency that the synthesizer is set to is determined by the controller. When the maximum signal is received on the satellite frequency, the synthesizer is set to receive that channel frequency by the controller. When the maximum signal is received on the terrestrial channel, the synthesizer is set to receive that channel frequency by the controller. The synthesizer will also be capable of being set from the front panel to receive any of the additional channels that will be available to local terrestrial broadcasters.

The controller also provides an estimate derived from the adaptive equalizer of the received carrier frequency and phase to coherently demodulate the received signal [6].

Adaptive Equalizer

A block diagram of an adaptive equalizer being considered for the CD radio application is shown in Figure 8. This particular one is a 32 tap, fractionally-spaced equalizer that uses the least-mean-square error algorithm [7]. The adaptive equalizer performs adaptive channel equalization, phase tracking and bit synchronization. Unique acquisition and tracking techniques are incorporated into the design to overcome the distortions caused by the multipath fading environment. It is a design that has been demonstrated by Stanford Telecom [6]. The output of the adaptive equalizer is an optimal estimate of the convolutionally encoded serial digital signal.

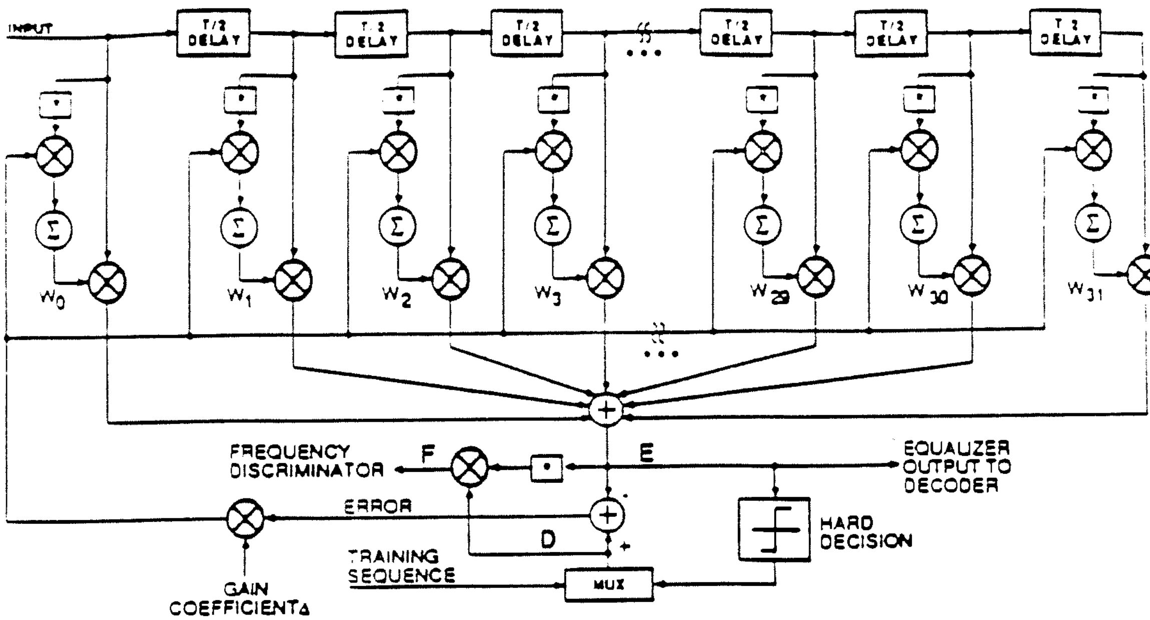


Figure 8: Functional diagram of one section of the adaptive equalizer [6].

Deinterleaver

A deinterleaver consisting of conventional computer memory is driven by the output of the adaptive equalizer. The reason for using an interleaver/deinterleaver is to mitigate the effects of fading on the performance of the vehicular receivers when operating in signal fading environments [8]. The synchronization of the deinterleaver may be accomplished using a technique described in [8]. The technique involves the modulo 2 addition of a synchronization sequence (e.g., a maximal length sequence) with the serial data stream at the transmitter and the removal of the sequence by modulo 2 addition of the serial data stream with the local estimate of the phase of the synchronization sequence at the receiver. When the deinterleaver is not in synchronization, the bit error ratio at the output of the Viterbi decoder will be about 0.5; a condition that is easily detected by the Viterbi decoder. The out-of-sync condition is fed back to the deinterleaver as shown in Figure 2 where it is used to enable or continue the search procedure.

Viterbi Decoder

A block diagram of the Viterbi maximum likelihood decoder available commercially from Stanford Telecom is shown in Figure 9. The decoder extracts the serial data from the channel-corrupted received signal using an efficient algorithm as described in [9].

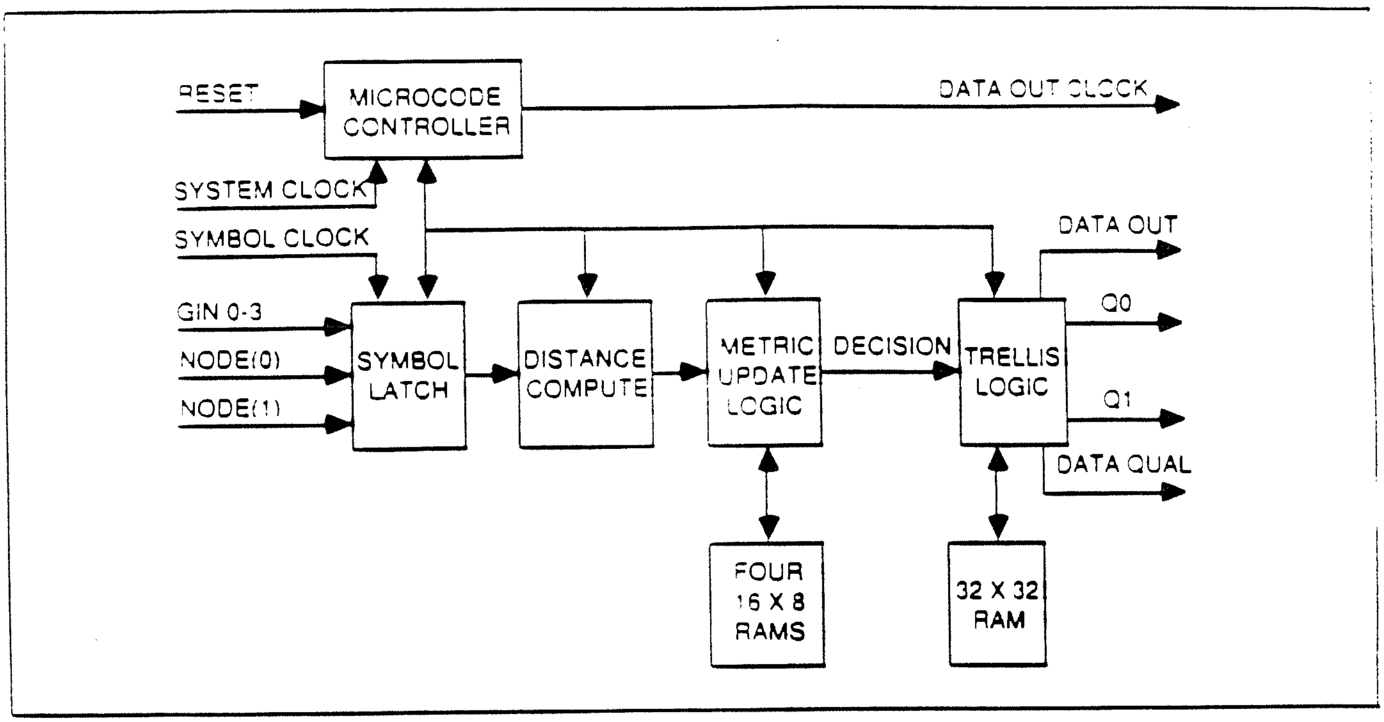


Figure 9: Functional diagram of the Viterbi decoder.

Dolby AC-2 Decoder

A block diagram of the Dolby AC-2 two-channel decoder is shown in Figure 10. It accepts the serial data at a rate of 256 kbps, establishes frame synchronization with the encoded data, and unpacks the formatted data blocks. Any necessary error correction is performed (it is noted that Reed-Solomon coding is used to protect critical sub-band data from random errors) prior to decoding the audio information and outputting the serial PCM data stream to the digital-to-analog (D/A) conversion circuits. In the absence of frame synchronization or during high channel BER, the processor provides a control signal to externally mute the audio. Encoder overload status and auxiliary channel data are similarly decoded and routed to appropriate hardware [10].

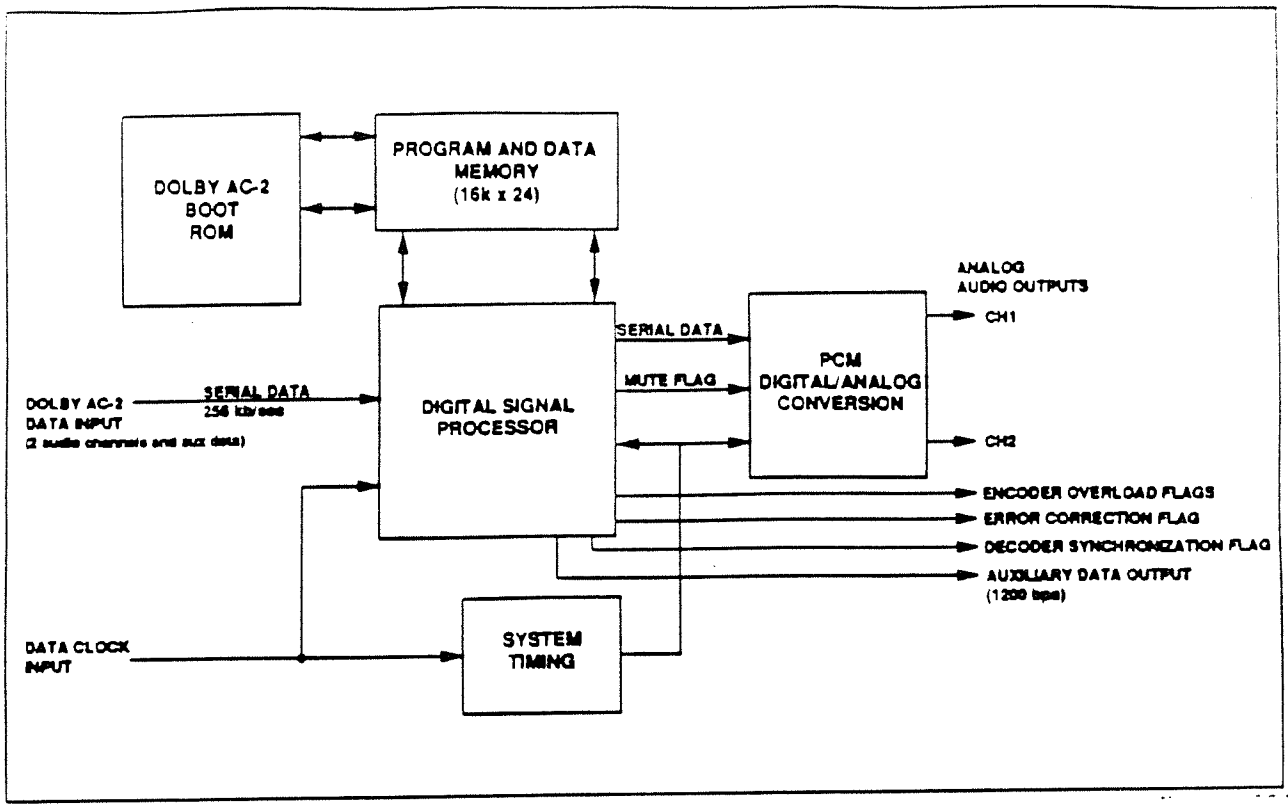


Figure 10: Block diagram of the Dolby AC-2 two-channel decoder.

Stereo Amplifier

The stereo amplifier will be of conventional design and is not expected to be a significant performance driver.

REFERENCES

[1] C.C. Kilgus, "Shaped-Conical Radiation Pattern of the Backfire Quadrifilar Helix," IEEE Transactions on Antennas and Propagation, Vol. AP-23, pp. 392-397, May 1975.

[2] F. Naderi, editor, "Land Mobile Satellite Service (LMSS), A Conceptual System Design and Identification of the Critical Technologies," Part II, Technical Report, JPL Publication 82-19, 15 February 1982.

[3] R.C. Johnson and H. Jasik, Antenna Engineering Handbook, Second Edition, McGraw-Hill Book Co., New York, ch. 14, 1984.

[4] J.D. Kraus, Antennas, Second Edition, McGraw-Hill Book Co., New York, ch. 13, 1988.

[5] C.A. Lindberg, "A Shallow-Cavity UHF Crossed-Slot Antenna," IEEE Transactions on Antennas and Propagation, Vol. AP-17, pp. 558-563, September 1969.

[6] B.J. Currivan, "An Adaptive Equalizer-Based Receiver for QPSK Satellite Downlink Signals in Ionospheric Scintillation," STel-TM-88124, Stanford Telecommunications, Inc., Santa Clara, CA 95054, 15 July 1988.

[7] B. Widrow and S.D. Stearns, Adaptive Signal Processing, Prentice-Hall, Englewood Cliffs, New Jersey, 1985.

[8] "Satellite Sound Broadcasting with Portable Receivers and Receivers in Automobiles," CCIR Report 955-1 (MOD F), 15 January 1990, Doc 10-11S/1011, XVII Plenary Assembly, Dusseldorf, 1990.

[9] G.C. Clark, Jr. and J.B. Cain, Error-Correction Coding for Digital Communications, Plenum Press, New York and London, ch. 6, 1981.

[10] G. Davidson, L. Fielder, and M. Antill, "High-Quality Audio Transform Coding at 128 kbits/s," Proceedings of the IEEE International Acoustics, Speech, and Signal Processing Conference, Albuquerque, NM, April 1990.

Satellite CD Radio, Inc.
Supplement to Petition
for Rulemaking
June 22, 1990

Appendix 6

Information for Advance Publication Under RR 1042
Satellites of CD Radio, Inc.

INFORMATION FOR ADVANCE PUBLICATION UNDER RR 1042
SATELLITES OF CD RADIO, INC.

Section B. General Characteristics

Item 1 Identity of the satellite network

USASAT ___ and USASAT ___ [to be supplied by FCC]

Item 2 Date of bringing into use

1 January, 1994

Period of validity of frequency assignments to the space station

12.5 years

Item 3 Administration or group of administrations submitting the advance information

UNITED STATES OF AMERICA
Federal Communications commission
WASHINGTON, D.C. 20554
FEDCOMCOM, WASHINGTON, D.C.

Item 4 Orbital information relating to the space station

		USASAT [X]	USASAT [Y]
a)	Nominal geographical long.:	103°W	121°W
	Longitudinal tolerance:	+/- 0.1°	
	Inclination excursion:	+/- 5.0°	
1)	Visible arc:	42 - 165°W	60 - 183°W
2)	Service arc:	101 - 139°W	
3)	Reason that arc defined in 2) above, is less than arc defined in 1) above:		

Network design is based on 30° minimum elevation angle to both satellites at all stations in the service area.

Section C Characteristics of the Satellite Network in the Earth to Space Direction

Item 1 Earth to Space service area

Contiguous United States

Item 2 Class of stations and nature of service

TC, TD, CV, EC, ED

Item 3 Frequency range

27,500 - 29,500 MHz

Item 4 Power characteristics of the transmitted wave

a) Maximum spectral power density

+ 7.0 dBW/Hz

b) Typical radiation pattern (relative to isotropic):

G = 55.0 dB

Antenna sidelobes conform to CCIR Rec. 465-2

Item 5 Characteristics of space station receiving antenna

a) Antenna gain contour estimates, see Figure 1

Item 6 Noise temperature of the receiving space station

1,660 K (telecommand only)

Section D Characteristics of the Satellite Network in the Space to Earth Direction

Item 1 Space to Earth service area

Contiguous United States

Item 2 Class of station and nature of service

EB, EC, EK, ER, CV, TC, TK, TR

Item 3 Frequency range

1,470 - 1,530 MHz

Item 4 Power characteristics of the transmission

a) Maximum spectral power density

- 7.9 dBW/Hz

Item 5 Characteristics of space station transmitting antenna

a) Antenna gain contour estimates, see Figure 2.

Item 6 Characteristics of receiving earth stations

a) Lowest total receiving system noise temperature:

200 K (Tracking and telemetry)

1) Lowest equivalent satellite link noise temperature

Figure 1.

Space Station Receiving Antenna
Gain Contour Estimates

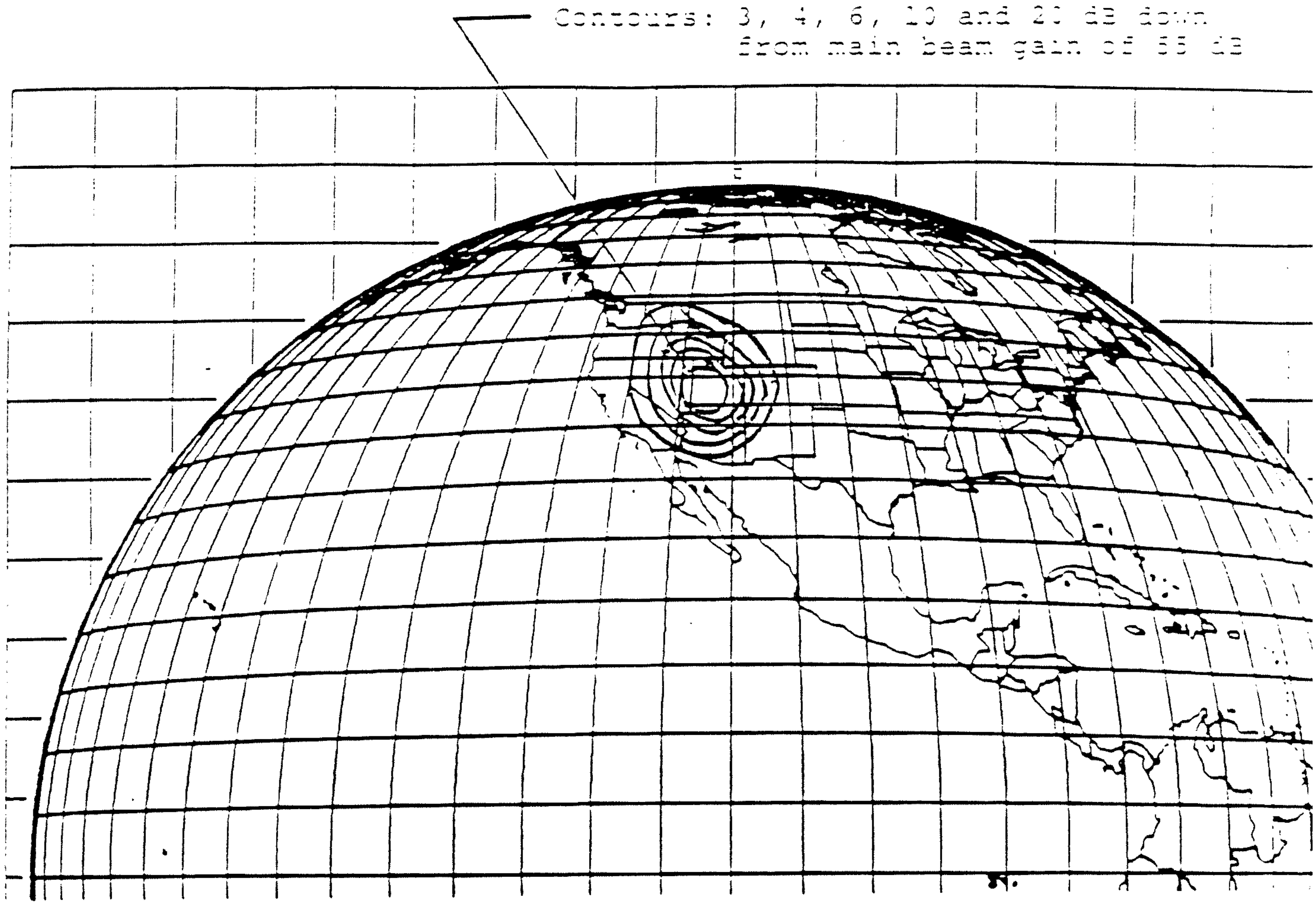
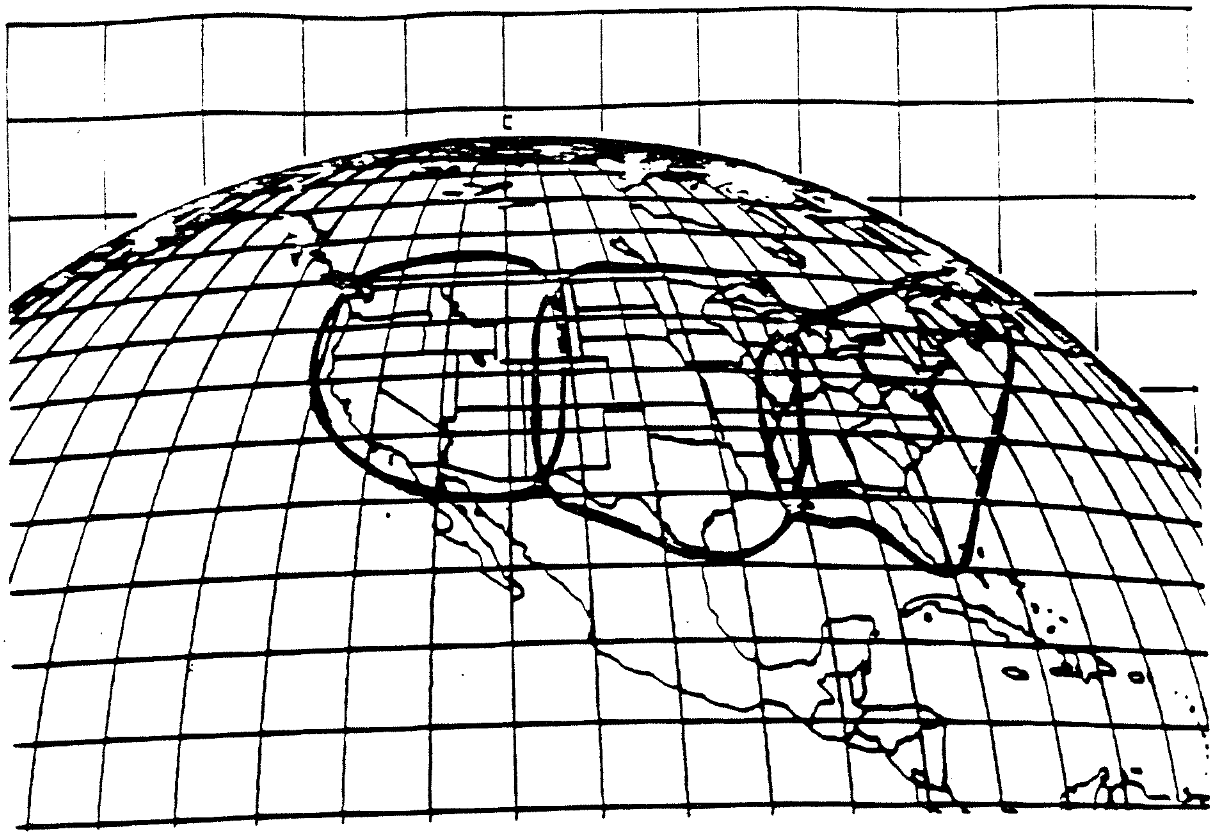
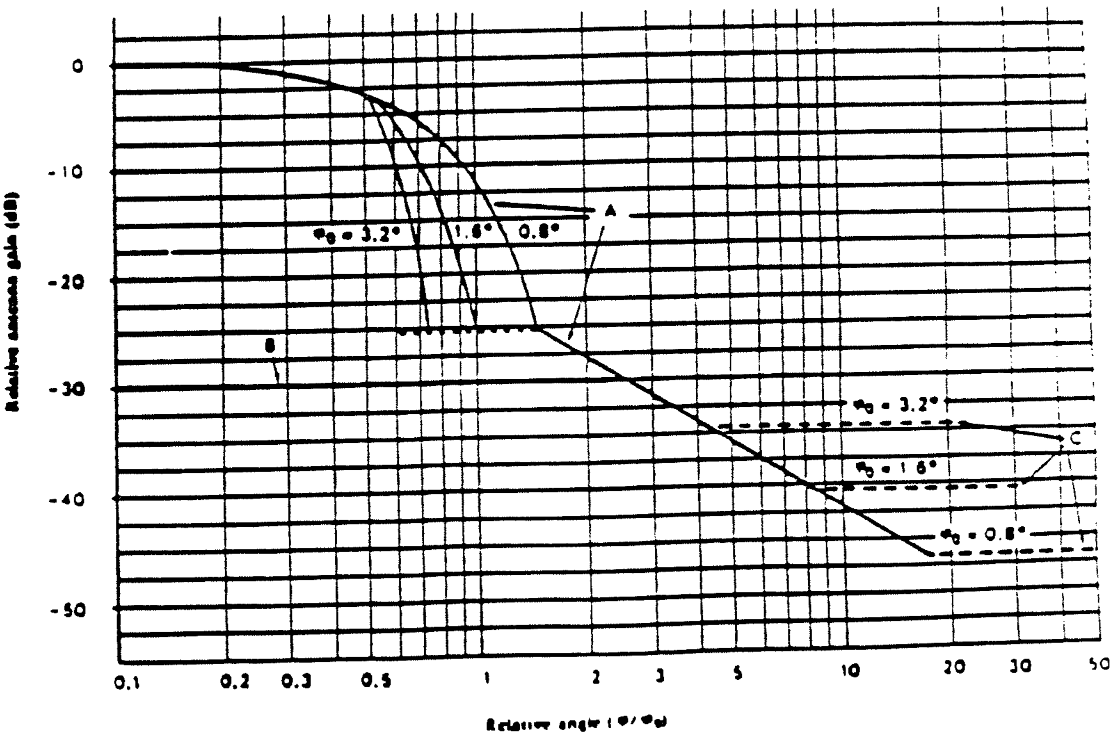


Figure 2
Space Station Transmitting Antenna
Gain Contour Estimates



Contours shown are 3 dB below main beam gain. Outside those contours, gain will decrease in accord with fast roll-off reference pattern shown below.



Reference patterns for co-polar and cross-polar components for satellite transmitting antennas with fast roll-off in the main beam for Region 2
(From: Radio Regulations, App. 30)

(T_{eq}) and the associated value of transmission gain (gamma):

Not applicable to the Broadcasting-satellite service (sound).

2) Highest ratio of transmission gain (gamma) to equivalent satellite link noise temperature (T_{eq}):

Not applicable to the Broadcasting-satellite service (sound).

Satellite CD Radio, Inc.
Private Digital Satellite
Sound Broadcasting Application

Revised July 17, 1990

Appendix 2

FCC Form 430
Common Carrier and Satellite Radio
Licensee Qualification Report

FCC 430

FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

Approved by OMB 3060-0105 Expires 3/31/90

COMMON CARRIER AND SATELLITE RADIO LICENSEE QUALIFICATION REPORT

See reverse side for information regarding public burden statement.

INSTRUCTIONS

A. The "Filer" of this report is defined to include: (1) An applicant, where this report is submitted in connection with applications for common carrier and satellite radio authority as required for such applications; or (2) A licensee or permittee, where this report is required by the Commission's Rules to be submitted on an annual basis.

B. Submit an original and one copy (sign original only) to the Federal Communications Commission, Washington, DC 20554. If more than one radio service is listed in Item 6, submit an additional copy for each such additional service. If this report is being submitted in connection with an application for radio authority, attach it to that application.

C. Do not submit a fee with this report.

1. Business Name and Address (Number, Street, State and ZIP Code) of Filer's Principal Office:

Satellite CD Radio, Inc.
Techworld Plaza, Suite 750
Washington, D.C. 20001-8000

2. (Area Code) Telephone Number: (202) 408-0080

3. If this report supercedes a previously filed report, specify its date: 5/18/90

4. Filer is (check one): ☐ Individual ☐ Partnership ☒ Corporation ☐ Other (Specify):

5. Under the laws of what State (or othe jurisdiction) is the Filer organized? Delaware

6. List the common carrier and satellite radio services in which Filer has applied or is a current licensee or permittee:

Private Satellite Carrier

7(a) Has the Filer or any party to this application had any FCC station license or permit revoked or had any application for permit, license or renewal denied by this Commission? *If "YES", attach as Exhibit I a statement giving call sign and file number of license or permit revoked and relating circumstances.* ☐ Yes ☒ No

(b) Has any court finally adjudged the Filer, or any person directly or indirectly controlling the Filer, guilty of unlawfully monopolizing or attempting unlawfully to monopolize radio communication, directly or indirectly, through control of manufacture or sale of radio apparatus, exclusive traffic arrangement, or other means of unfair methods of competition? *If "YES", attach as Exhibit II a statement relating the facts.* ☐ Yes ☒ No

(c) Has the Filer, or any party to this application, or any person directly or indirectly controlling the Filer ever been convicted of a felony by any state or Federal Court? *If "YES", attach as Exhibit III a statement relating the facts.* ☐ Yes ☒ No

(d) Is the Filer, or any person directly or indirectly controlling the Filer, presently a party in any matter referred to items 7(b) and 7(c)? *If "YES", attach as Exhibit IV a statement relating the facts.* ☐ Yes ☒ No

8. Is the Filer, directly or indirectly, through stock ownership, contract or otherwise, currently interested in the ownership or control of any other radio stations licensed by this Commission? *If "YES", submit as Exhibit V the name of each such licensee and the licensee's relation to the Filer.* ☒ Yes ☐ No

See Exhibit V.

If Filer is an individual (sole proprietorship) or partnership, answer the following and Item 11:

9(a) Full Legal Name and Residential Address (Number, Street, State and ZIP Code) of Individual or Partners:

(b) Is individual or each member of a partnership a citizen of the United States? ☐ Yes ☐ No

(c) Is individual or any member of a partnership a representative of an alien or of a foreign government? ☐ Yes ☐ No

If Filer is a corporation, answer the following and Item 11:

10(a) Attach as Exhibit VI the names, addresses, and citizenship of those stockholders owning of record and/or voting 10 percent or more of the Filer's voting stock and the percentages so held. In the case of fiduciary control, indicate the beneficiary(ies) or class of beneficiaries.

See Exhibit VI.

(b) List below, or attach as Exhibit VII the names and addresses of the officers and directors of the Filer.

See Exhibit VII.

(c) Is the Filer directly or indirectly controlled by any other corporation? ☒ Yes ☐ No

If "YES", attach as Exhibit VIII a statement (including organizational diagrams where appropriate) which fully and completely identifies the nature and extent of control. Include the following: (1) the address and primary business of the controlling corporation and any intermediate subsidiaries; (2) the names, addresses, and citizenship of those stockholders holding 10 percent or more of the controlling corporation's voting stock; (3) the approximate percentage of total voting stock held by each such stockholder; and (4) the names and addresses fo the president and directors of the controlling corporation.

See Exhibit VIII.

(d) Is any officer or director of the Filer an alien? ☐ Yes ☒ No

(e) Is more than one-fifth of the capital stock of the Filer owned of record or voted by aliens or their representatives, or by a foreign government or representative(s) thereof, or by a corporation organized under the laws of a foreign country? ☐ Yes ☒ No

(f) Is the Filer directly or indirectly controlled: (1) by any other corporation of which any officer or more than one-fourth of the directors are aliens, or (2) by any foreign corporation or corporation of which more than one-fourth of the capital stock is owned or voted by aliens or their representatives, or by a foreign government or representatives thereof. ☐ Yes ☒ No

(g) If any answer to questions (d), (e) or (f) is "YES", attach as Exhibit IX a statement identifying the aliens or foreign entities, their nationality, their relationship to the Filer, and the percentage of stock they own or vote.

11. CERTIFICATION

This report constitutes a material part of any application which cross-references it, and all statements made in the attached exhibits are a material part thereof. The ownership information contained in this report does not constitute an application for, or Commission approval of, any transfer of control or assignment of radio facilities. The undersigned, individually and for the Filer, hereby certifies that the statements made herein are true, complete and correct to the best of Filer's knowledge and belief, and are made in good faith.

WILLFUL FALSE STATEMENTS MADE ON THIS APPLICATION ARE PUNISHABLE BY FINE AND IMPRISONMENT (U.S. Code, Title 18, Section 1001) and/or REVOCATION OF ANY STATION LICENSE OR CONSTRUCTION PERMIT (U.S. Code, Title 47, Section 312(a)(1)).	Date 7/17/90	Filer (Must correspond with that shown in Item 1) Satellite CD Radio, Inc.	Typed or Printed Name Peter Dolan
	Signature [signature]		Title President

NOTICE TO INDIVIDUALS REQUIRED BY THE PRIVACY ACT OF 1974 AND THE PAPERWORK REDUCTION ACT OF 1980

The solicitation of personal information requested in this form is to determine if you are qualified to become or remain a licensee in a common carrier or satellite radio service pursuant to the Communications Act of 1934, as amended. No authorization can be granted unless all information requested is provided. Your response is required to obtain the requested authorization or retain an authorization.

blic reporting burden for this collection of information is estimated to average 2 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Federal Communications Commission, Office of Managing Director, Washington, DC 20554, and to Office of Management and Budget, Paperwork Reduction Project (3060-0105), Washington, DC 20503.

Satellite CD Radio, Inc.
FCC Form 430
July 17, 1990

EXHIBIT V
OTHER RADIO STATION INTERESTS

100 percent of the common stock of Satellite CD Radio, Inc. will be owned by Era-Mar,Inc. Martin A. Rothblatt, who owns 100 percent of the stock of MARCOR which, in turn, owns 75 percent of the stock of Era-Mar, Inc., owns stock in Geostar Corporation, a licensee in the Radiodetermination Satellite Service.

EXHIBIT VI
STOCKHOLDERS OWNING OF RECORD AND/OR VOTING
10 PERCENT OR MORE OF THE FILER'S VOTING STOCK

Name and Address	Percentage of Common Stock Ownership	Percentage of Common Stock Voted
Era-Mar, Inc. Techworld Plaza 800 K Street, N.W. Suite 750 Washington, D.C. 20001	100%	100%

EXHIBIT VII
OFFICERS AND DIRECTORS OF SATELLITE CD RADIO, INC.

OFFICERS

Name and Title	Address
Martin A. Rothblatt Chief Executive Officer	MARCOR Techworld Plaza 800 K Street, N.W. Suite 750 Washington, D.C. 20001
Peter J. Dolan President & Chief Financial Officer	MARCOR Techworld Plaza 800 K Street, N.W. Suite 750 Washington, D.C. 20001
Kevin MacCarthy Secretary	Kevin MacCarthy Associates 444 Madison Avenue New York, N.Y. 10022
Thomas J. Dougherty, Jr. Assistant Secretary	Fletcher, Heald & Hildreth 1225 Connecticut Ave., N.W. Suite 400 Washington, D.C. 20036

DIRECTORS

Name	Address
Martin A. Rothblatt Chairman of the Board	MARCOR Techworld Plaza 800 K Street, N.W. Suite 750 Washington, D.C. 20001
Michael S. Alpert	Alpert & Associates 2000 L Street, N.W. Suite 702 Washington, D.C. 20036
Thomas J. Dougherty, Sr.	7308 Burdette Court Bethesda, MD 20817
Kevin MacCarthy	Kevin MacCarthy Associates 444 Madison Avenue New York, N.Y. 10022
Robert Mounty	301 East 62nd Street New York, N.Y. 10021
Yovette Mumford	System Builders, Inc. 1 Vande Graaff Drive Burlington, MA 01803
Sharad Tak	Tak Communications 1577 Spring Hill Road Vienna, VA 22180

EXHIBIT VIII

NATURE AND EXTENT OF CONTROL BY OTHER CORPORATIONS

100 percent of the stock of Satellite CD Radio, Inc. will be owned by Era-Mar, Inc., a Delaware corporation engaged primarily in the technology development business. The address of Era-Mar, Inc. is c/o MARCOR, Techworld Plaza, 800 K Street, N.W., Suite 750, Washington, D.C. 20001. Peter J. Dolan is the president and a director of Era-Mar, Inc. The other directors of Era-Mar, Inc. are Maurice Levy, Kevin MacCarthy and Martin A. Rothblatt, who serves as Chairman of the Board. The address of each director, except for Mr. MacCarthy, is c/o MARCOR at the address indicated above. Mr. MacCarthy's address is 444 Madison Avenue, New York, N.Y. 10022.

MARCOR, a District of Columbia corporation engaged primarily in the technology and market development business, will hold 75 percent of the stock of Era-Mar, Inc. The address of MARCOR is Techworld Plaza, 800 K Street, N.W., Suite 750, Washington, D.C. 20001. 100 percent of the stock of MARCOR is held by Martin A. Rothblatt, who is a U.S. citizen. His address is c/o MARCOR at the address indicated above. Martin A. Rothblatt is the president and a director of MARCOR. The other directors are Bina Rothblatt and Eleanor Leung. The address of each director is c/o MARCOR at the address indicated above.

New Era Corp., a Delaware corporation engaged primarily in the business of technology development, will hold 25 percent of the stock of Era-Mar, Inc. and warrants exercisable to purchase so many additional shares of the stock Era-Mar, Inc. as would equal 25 percent of the corporation's stock on a fully-diluted basis.

The address of New Era Corp. is c/o Kevin MacCarthy Associates, 444 Madison Avenue, New York, N.Y. 10022. 100 percent of the stock of New Era Corp. is held by Jean-Jacques Poutrel, who is a citizen of France. His address is c/o Ingenico, Compagnie Industrielle et Financiere d'Ingenierie, 9 Qual de Dion Bouton, 92800 Puteaux, France. Mr. Poutrel is also a director of New Era Corp. Kevin MacCarthy is the president and a director of New Era Corp. His address is 444 Madison Avenue, New York, N.Y. 10022.

Upon exercise of the warrants held by New Era Corp., it would hold 50 percent of the stock of Era-Mar, Inc, and MARCOR would hold the remaining 50 percent. However, the warrants, which will include standard investor protection provisions, will not be exercisable if to do so would result in aggregate stockholdings by non-U.S. persons in violation of the limitations of Section 310(b) of the Communications Act, should these limitations be determined to be applicable to the service to be offered by Satellite CD Radio, Inc.

Appendix 4

Supplement to Petition for Rulemaking.

BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of the Petition of SATELLITE CD RADIO, INC. For Amendment of Section 2.106 and Part 25 of the Commission's Rules To Establish a Satellite/ Terrestrial CD Quality Broadcasting Service	)))))))))	RM - 7400

SUPPLEMENT TO PETITION FOR RULEMAKING

SATELLITE CD RADIO, INC.

Peter Dolan
President

Techworld Plaza
800 K Street, N.W.
Suite 750
Washington, D.C. 20001-8000
(202) 408-0080

June 22, 1990

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BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of the Petition of SATELLITE CD RADIO, INC. For Amendment of Section 2.106 and Part 25 of the Commission's Rules To Establish a Satellite/ Terrestrial CD Quality Broadcasting Service	)	RM - 7400

SUPPLEMENT TO PETITION FOR RULEMAKING

Satellite CD Radio, Inc. (hereinafter "CD Radio, Inc.") hereby supplements the above-captioned Petition for Rulemaking which it filed on May 18, 1990 (hereinafter the "Petition"). In the Petition, CD Radio, Inc. sought the establishment of a new digital, CD-quality radio service in the bands from 1460-1530 MHz which would be provided in part by satellites (complemented by terrestrial repeaters) and in part by a new terrestrial radio service whose licensees would be current AM and FM broadcasters. This supplement clarifies and/or expands on the discussion of several aspects of CD Radio, Inc.'s proposal.1/

1/ The Commission placed CD Radio, Inc.'s Petition on Public Notice dated June 18, 1990 (Report No. 1817). The filing of this Supplement does not have any effect on the comment cycle established in that Public Notice. The only aspect of CD Radio, Inc.'s proposal being changed by this Supplement is the proposed design of vehicular receivers. In all other respects, this Supplement merely provides additional information to support statements in the original Petition. CD Radio, Inc. has served copies of this Supplement on all entities which have previously requested a copy of the Petition from CD Radio, Inc.

I. TERRESTRIAL REPEATERS AND TRANSMITTERS

At pages 8-10 of the Petition, CD Radio, Inc. describes the architecture of the proposed satellite system and how it would operate. CD Radio, Inc. notes that the system would include a large number of urban area terrestrial repeaters which would simulcast the satellite signal and thereby compensate for shadowing in urban areas. In connection with this discussion, CD Radio, Inc. wishes to clarify the distinction between "terrestrial repeaters" and "terrestrial transmitters" and to elaborate on the technical characteristics and service objectives of such equipment. Thus, the following should be added at page 10 after the first full paragraph (ending with "transmissions will be different"):

> "Terrestrial repeater" refers to the facilities and equipment by which the 66 programs broadcast via satellite are received on the ground, amplified, frequency shifted, and retransmitted at high power. In contrast, the term "terrestrial transmitter" refers to the facilities and equipment used by local broadcasters to deliver CD-quality, stereophonic local entertainment and information programming on the 34 terrestrial radio channels in the adjacent band. (See infra Section IIC.3, pp. 13-14, and Section V, pp. 28-29.) However, the equipment used for the terrestrial repeaters and the transmitters is virtually identical.
>
> The use of terrestrial repeaters is essential to ensuring the availability of an uncompromised, CD-quality stereo broadcasting service in heavily shadowed urban areas that would be otherwise extremely difficult to serve wholly by satellite. Similarly, terrestrial transmitters are essential because they increase the audio quality of currently available local radio programming.
>
> Together with the satellite, the terrestrial repeaters and terrestrial transmitters will make up an integrated, high-quality, radio broadcasting service that will provide 100 program channels in urban areas and 80 channels elsewhere throughout the United States.

Service Objectives. From the link calculations shown in Table 1 of the Technical Appendix to the CD Radio, Inc.'s applications, it may be shown that the nominal field strength delivered by satellite at the edge of the service areas is about 27 dBu(V/m). At this level, there is a link margin in excess of 6 dB to account for all additional losses. (These include blockage by buildings and vegetation and equipment implementation losses, etc.)

This same level of 27 dBu(V/m) has been chosen as the objective for the median field strength (the value exceeded 50% of the time) at the edge of the coverage area provided by either a terrestrial repeater or a terrestrial transmitter. That field strength will provide about the same level of performance at 50% of locations within the service area as the CD Radio satellite signal at the edge of its coverage area. An antenna height of 1.5 meters, typical of an automobile antenna installation, has been assumed. (The greater antenna heights typical of home installations would result in higher field strengths and even better performance.)

To estimate the required characteristics of the terrestrial transmitters and repeaters, CD Radio, Inc. has assumed that coverage is desired of an urban area out to a distance of 40 kilometers from its center.

The objective for field strength set forth here is a nominal value. Similarly, the e.i.r.p. to produce that field strength has been calculated assuming nominal conditions. The actual conditions encountered in specific installations may be considerably different from the assumptions used here. The actual terrain, the availability of suitable transmitting antenna locations, the density of vegetation and the height, location and construction of buildings, and, most important, the geographic coverage and quality of service sought by the terrestrial station operator are among the factors that can vary widely.

Repeater and Transmitter Characteristics. A terrestrial repeater is assumed to be sited in the middle of the urban area to be served, with a transmitting antenna at an effective height of approximately 200 meters. The transmitting antenna is assumed to be circularly polarized, to have an omnidirectional azimuthal pattern and to have a gain of approximately 6 dBic. Typical transmitting antennas having these characteristics include helix, crossed-dipole, slanted-dipole, and ring-panel types.2/

The radiated power required to produce a field strength of 27 dBu(V/m) at a distance of 40 kilometers is on the order of 32.2 dBW.3/ Assuming an antenna gain of 6 dBic and a feed line loss of 2.2 dB, the transmitter power would be about 700 watts.

Modulation Format. The modulation format of the signal transmitted by the terrestrial transmitters and repeaters will be identical to that used on the satellite broadcasting channel, that is, OQPSK, at 256 kb/s, with Dolby AC-2 encoding.

II. USE OF THE BAND BY AERONAUTICAL TELEMETRY

At pages 15-17 of the Petition, CD Radio, Inc. discusses the particular public interest benefits of the 1470-1530 MHz band as a primary allocation to digital satellite broadcasting. In this section, CD Radio, Inc. notes that the 1435-1530 MHz band is now allocated domestically for aeronautical telemetry operations and it explains why use of the band for digital satellite broadcasting would not have an adverse impact on aeronautical telemetry operations. CD Radio, Inc. wishes to clarify and expand on this discussion in the following ways.

2/ R.C. Johnson and H. Jasik, Antenna Engineering Handbook, Second Edition, McGraw-Hill Book Co., New York, ch. 28, 1984.

3/ This may be determined by reference to Figure 41 (d) of Y. Okumura, E. Ohmori, T. Kawana, and K. Fukuda, "Field Strength and Its Variability in VHF and UHF Land-Mobile Radio Service," Rev. Elec. Commun. Lab (Japan), Vol. 16, Sept.-Oct. 1968, pp. 825-873. Similar curves appear in CCIR Report 567-3. See Methods and Statistics for Estimating Field-Strength Values in the Land Mobile Services Using the Frequency Range 30 MHz to 1 GHz," CCIR Report 567-3, Vol. V, XVI Plenary Assembly, Dubrovnik, 1986, pp. 298-312.

1. Add the following at the end of the third paragraph on page 15 (which begins: "The band proposed..."):

> Most communications consist of telemetry links used during testing of aircraft or their major components.4/ Use of the band is coordinated by the Aerospace and Flight Test Radio Coordinating Committee (AFTRCC).5/

2. Delete from the middle of page 16 the sentence beginning "However, the use of frequency synthesizers. . ." and substitute the following:

> Because of the experimental nature of the service, most of the users of the band employ transmitters that can operate on many frequencies within the band. The use of frequency agile transmitters (e.g., those with frequency synthesizers) is becoming widespread.

3. Add the following on page 16 after the paragraph ending with "prevent interference with other users":

> Under the reallocation of spectrum proposed by CD Radio, Inc., which is described below in detail, there will be minimal disruption of existing users. Under the plan, only 4.2 MHz (less than 5% of the existing allocation to Mobile Aeronautical telemetering), would be precluded to it in all areas. Outside of urban areas, an additional (and different) 20 MHz in the band 1470-1530 MHz would be used for satellite transmissions in each of the three regional beams, but flight test activities already coordinated through AFTRCC could continue on a primary basis, and all

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4/ Aviation Services (Flight Test Telemetry), 56 Rad. Reg. 2d (P&F) 1413 (1985). Frequencies from 1435-1485 MHz are used for unmanned aircraft; frequencies from 1485-1530 MHz are used for manned aircraft and missiles.

5/ *See* Frequency Coordination in the 1435-1535 Mc/s Band, 15 F.C.C.2d 831 (1969).

other flight test transmissions would be authorized on a secondary basis.

Few flight test operations are conducted in urban areas. At the same time, satellite sound broadcasting transmissions may suffer blockage or multipath interference in 'urban canyons.' CD Radio, Inc. proposes to take advantage of these different geographic frequency requirements by using an additional 20 MHz in designated urban areas for terrestrial repeaters that will 'simulcast' the satellite transmissions. In this way, CD Radio, Inc.'s listeners in cities will continue to receive high-quality radio service without affecting flight test operations.

4. Add the following on page 16 after the first indented, single-spaced paragraph (which begins "Another band . . ."):

> Indeed, AFTRC itself recognized the relative paucity of use of this band by supporting the recent "carve-out" of 2310-2390 MHz for six specific frequencies for use by private launch operators.6/

5. Add the following on page 17 at the end of the last indented, single-spaced paragraph (which begins "The spectrum allocation . . ."):

> The next 6 MHz would be allocated to the terrestrial Broadcasting service in urban areas and to Mobile Aeronautical telemetering outside those urban areas. The next 4.2 MHz would be allocated to the terrestrial Broadcasting service for use in urban and non-urban areas. (That is the segment referred to above as the only one of the current 95 MHz wide allocation that would be foreclosed to the Mobile service.) The last, and highest 60 MHz would be allocated to satellite sound broadcasting on a primary basis, and to terrestrial broadcasting (for the 'simulcast' repeaters) in urban areas. Outside urban areas that 60 MHz allocation could also be used for Mobile Aeronautical telemetering on a secondary basis.
>
> An analysis of sharing between Broadcasting-Satellite Sound and Mobile Aeronautical Telemetering is attached hereto as Appendix 4.

6/ Commercial Space Launch Vehicles, 5 FCC Rcd 493 (1990).

III. FREQUENCY PLAN

At pages 26-29 of the Petition, CD Radio, Inc. discusses how the 1459.8-1530 MHz band would have to be reallocated in order to implement its proposed frequency plan. CD Radio, Inc. wishes to elaborate on this frequency plan by adding the following at the end of Section V on page 29:

> Detailed Frequency Plan. The detailed frequency assignment plan proposed for CD Radio, Inc.'s satellite transmissions and terrestrial repeaters is shown in Table 1.7/ The detailed frequency assignment plan in the adjoining band proposed to be reallocated to terrestrial broadcasting is shown in Table 2. Re-use of frequencies is depicted in Figure 3.
>
> Table 1 shows the division of the overall 60 MHz allocation to satellite sound broadcasting, into three frequency blocks, F1, F2 and F3.8/ Each of the 66 channels in each block will be associated with a specific 300 kHz bandwidth channel. As discussed below, and shown in Figure 3, in each region of the country, one of the blocks will be used for the satellite transmissions and the other blocks will be used for terrestrial repeaters. (Frequencies for terrestrial repeaters must be chosen so that there is no interference from the same frequency used for a satellite channel in the adjacent beam.) Each channel in a block, would be associated with a channel in the other two blocks. For example, the first (lowest frequency) channel in block F1 would be associated with the first channel in block F2 and the first channel in block F3; all the second channels would be associated, and so on through the blocks. Typically, the same program would be broadcast by satellite in another beam (or re-broadcast by a terrestrial

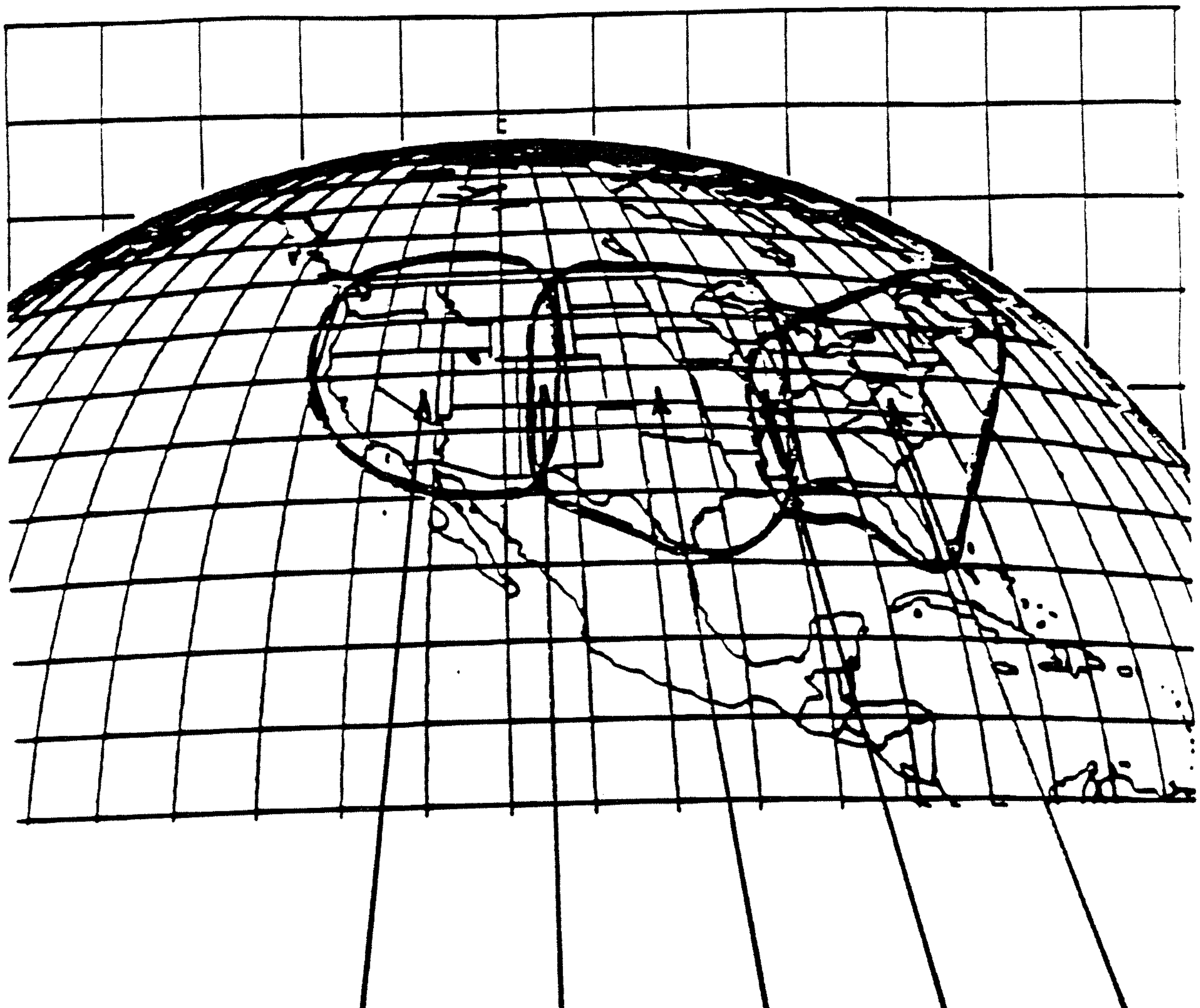
---

7/ Because of the addition of two tables included with this Supplement, Table 1 in Section VIII, immediately following page 42, is now "Table 3." In addition, in that Table, on the frequency scale of the "Proposed Allocation," the frequency "1465.8" is incorrect. The correct frequency is "1464.0." A revised Table 3 reflecting this correction is attached hereto.

8/ As shown in Figure 3, frequency blocks F1, F2 and F3, will be assigned to the Western, Central and Eastern Beams, respectively. Each of those 20 MHz wide blocks can provide 66, 256 kb/s program channels.

Figure 3

FREQUENCY USE AND REUSE THROUGHOUT THE UNITED STATES FOR SATELLITE AND TERRESTRIAL TRANSMISSIONS, BY BLOCK



SATELLITE:	F1	F1&F2	F2	F2&F3	F3
TERRESTRIAL REPEATERS:	F2&F3	F3	F1&F3	F1	F1&F2
MOBILE (AERO. TELEM.) IN NON-URBAN AREAS:	F2&F3	F3	F1&F3	F1	F1&F2

Note 1: Frequency Blocks F1, F2 and F3, and the channel assignments therein, are defined in Table 1.

Note 2: Additional channels are available for Mobile (Aeronautical Telemetering) in the bands 1435-1459.8 MHz and 1459.8-1470 MHz (see Table 2).

repeater). The purpose of that association is to insure continuous reception as a vehicle moves between urban and non-urban areas, or between one satellite beam coverage area and another.

Vehicular receivers would be designed to constantly compare the received signal strength of the channel being received with that of the two associated channels in the other blocks, and to select the strongest automatically. If a vehicle is moving from one satellite beam coverage area to another, the receiver will automatically switch to the same program being transmitted in the "associated channel" in the adjoining satellite service area. If the vehicle is moving between non-urban and urban areas, the receiver will select automatically on the basis of signal strength, either the satellite signal, or a channel being re- broadcast by the terrestrial repeater which carries the same program material. An overview of the vehicular receiver is attached as Appendix 5 hereto.

The CD Radio, Inc. frequency plan, depicted in Table 1, is based on a re-use factor of 3. That is, each of the satellite beams is assigned one-third of the total available satellite spectrum (i.e., 66 channels). Within each of the satellite beam areas, the remaining two-thirds of the satellite frequencies (i.e., 132 channels) are available for use by the terrestrial repeaters to fill in shadowed areas, except in geographic areas where the satellite beams overlap one another. In those overlap areas, only another one-third of the frequencies (i.e., 66 channels) is available for use by terrestrial repeaters on a noninterfering basis. In the much smaller overlap areas, 33 channels can be provided by the terrestrial repeaters.

In other words, if frequency block F2 is used in the Central beam, channels from block F1 could be used for terrestrial repeaters in the Central region except in its western parts where satellite signals from the Western beam (also in block 1) can be received. Similarly, channels from block 3 could be used for terrestrial transmitters in the Central region, except in its Eastern portions, where signals from the Eastern beam (also in block 3) can be received.

Similarly, Mobile aeronautical telemetering stations can use frequencies throughout that 60 MHz range that are not being used in the satellite beam covering that part of the country, and that are not being used by terrestrial repeaters in nearby urban areas.

IV. ADVANCE PUBLICATION INFORMATION

At page 30 of the Petition, CD Radio, Inc. emphasizes the importance of prompt Commission approval of this allocation proposal in order to maximize the chances of international recognition at the 1992 WARC. Toward this objective, a new Appendix 6 is attached hereto which contains standard ITU Advance Publication information for the CD Radio, Inc. system. The FCC should promptly forward this information to the IFRB to protect U.S. interests in the frequency bands concerned. Although CD Radio, Inc. recognizes that the 1470-1530 MHz downlink is not yet recognized by the ITU, the 30 GHz uplink is so recognized. The U.S. has an obligation to advance publish the 30 GHz uplink as early as possible within the five years before launch. Advance Publication of the 1470-1530 MHz downlink will increase worldwide exposure of this U.S. proposal, thereby enabling better opportunities for discussions of this issue at the 1992 WARC.9/

Respectfully submitted,

SATELLITE CD RADIO, INC.

By: ______________________
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President

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June 22, 1990

9/ Also attached to this Supplement is new Figure 4 which is a flow chart showing the participation options for local broadcasters under the CD Radio, Inc. proposal and the steps necessary to implement the proposed satellite system.

Figure 4

CD RADIO IMPLEMENTATION & PARTICIPATION OPTIONS
UNDER SATELLITE CD RADIO, INC. FCC PROPOSAL

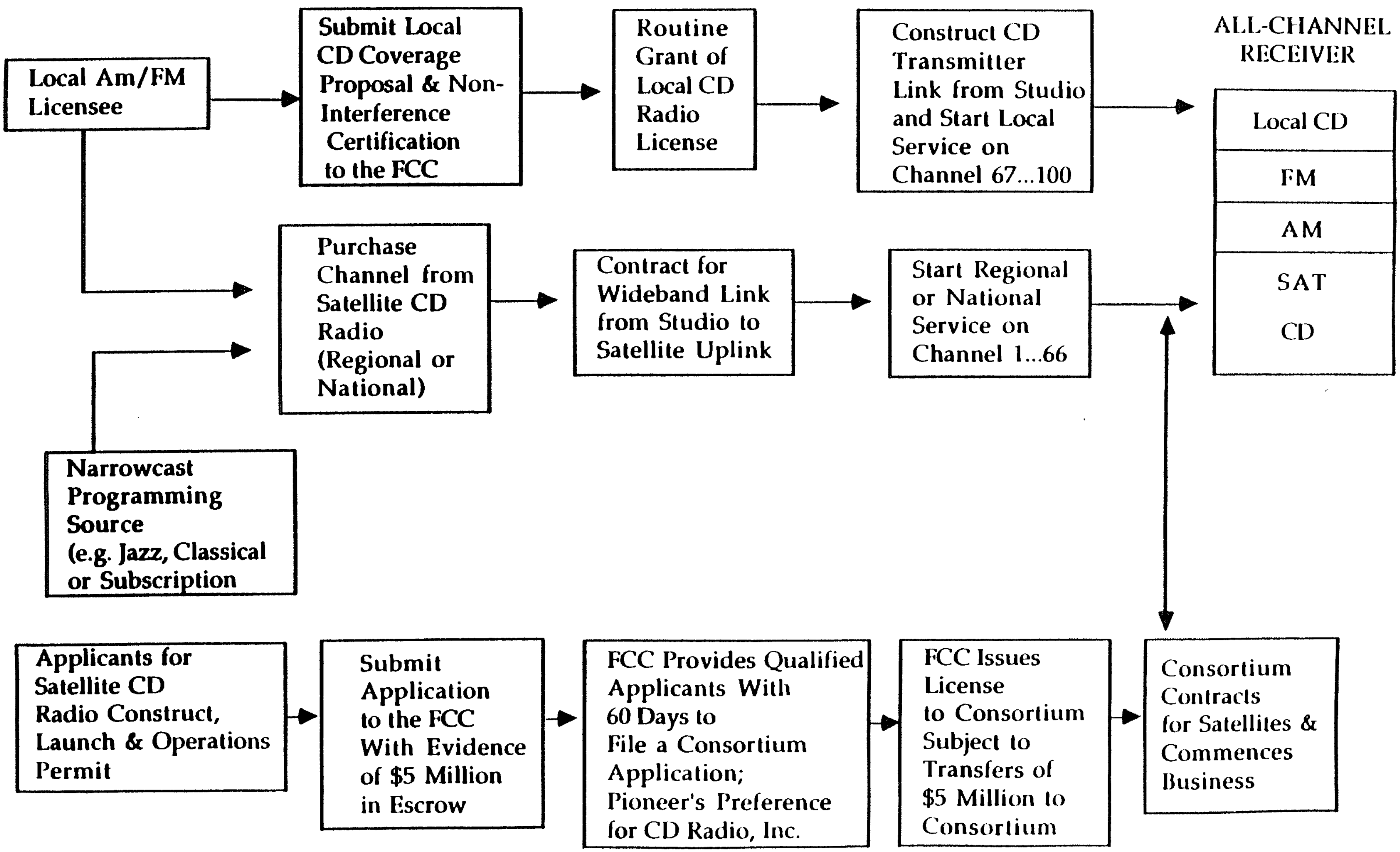

Table 1

Detailed Frequency Plan
For Satellite and Terrestrial Repeaters and
Mobile Aeronautical Telemetry
in the Band 1470.0-1530.0 MHz

Ch	Block F1	Block F2	Block F3
1	1470.0-1470.3	1490.0-1490.3	1510.0-1510.3
2	1470.3-1470.6	1490.3-1490.6	1510.3-1510.6
3	1470.6-1470.9	1490.6-1490.9	1510.6-1510.9
4	1470.9-1471.2	1490.9-1491.2	1510.9-1511.2
5	1471.2-1471.5	1491.2-1491.5	1511.2-1511.5
6	1471.5-1471.8	1491.5-1491.8	1511.5-1511.8
7	1471.8-1472.1	1491.8-1492.1	1511.8-1512.1
8	1472.1-1472.4	1492.1-1492.4	1512.1-1512.4
9	1472.4-1472.7	1492.4-1492.7	1512.4-1512.7
10	1472.7-1473.0	1492.7-1493.0	1512.7-1513.0
11	1473.0-1473.3	1493.0-1493.3	1513.0-1513.3
12	1473.3-1473.6	1493.3-1493.6	1513.3-1513.6
13	1473.6-1473.9	1493.6-1493.9	1513.6-1513.9
14	1473.9-1474.2	1493.9-1494.2	1513.9-1514.2
15	1474.2-1474.5	1494.2-1494.5	1514.2-1514.5
16	1474.5-1474.8	1494.5-1494.8	1514.5-1514.8
17	1474.8-1475.1	1494.8-1495.1	1514.8-1515.1
18	1475.1-1475.4	1495.1-1495.4	1515.1-1515.4
19	1475.4-1475.7	1495.4-1495.7	1515.4-1515.7
20	1475.7-1476.0	1495.7-1496.0	1515.7-1516.0
21	1476.0-1476.3	1496.0-1496.3	1516.0-1516.3
22	1476.3-1476.6	1496.3-1496.6	1516.3-1516.6
23	1476.6-1476.9	1496.6-1496.9	1516.6-1516.9
24	1476.9-1477.2	1496.9-1497.2	1516.9-1517.2
25	1477.2-1477.5	1497.2-1497.5	1517.2-1517.5
26	1477.5-1477.8	1497.5-1497.8	1517.5-1517.8
27	1477.8-1478.1	1497.8-1498.1	1517.8-1518.1
28	1478.1-1478.4	1498.1-1498.4	1518.1-1518.4
29	1478.4-1478.7	1498.4-1498.7	1518.4-1518.7
30	1478.7-1479.0	1498.7-1499.0	1518.7-1519.0
31	1479.0-1479.3	1499.0-1499.3	1519.0-1519.3
32	1479.3-1479.6	1499.3-1499.6	1519.3-1519.6
33	1479.6-1479.9	1499.6-1499.9	1519.6-1519.9

Table 1(Continued)

Detailed Frequency Plan
For Satellite and Terrestrial Repeaters and
Mobile Aeronautical Telemetry
in the Band 1470.0-1530.0 MHz

Ch	Block F1	Block F2	Block F3
34	1479.9-1480.2	1499.9-1500.2	1519.9-1520.2
35	1480.2-1480.5	1500.2-1500.5	1520.2-1520.5
36	1480.5-1480.8	1500.5-1500.8	1520.5-1520.8
37	1480.8-1481.1	1500.8-1501.1	1520.8-1521.1
38	1481.1-1481.4	1501.1-1401.4	1521.1-1521.4
39	1481.4-1481.7	1501.4-1501.7	1521.4-1521.7
40	1481.7-1482.0	1501.7-1502.0	1521.7-1522.0
41	1482.0-1482.3	1502.0-1502.3	1522.0-1522.3
42	1482.3-1482.6	1502.3-1502.6	1522.3-1522.6
43	1482.6-1482.9	1502.6-1502.9	1522.6-1522.9
44	1482.9-1483.2	1502.9-1503.2	1522.9-1523.2
45	1483.2-1483.5	1503.2-1503.5	1523.2-1523.5
46	1483.5-1483.8	1503.5-1503.8	1523.5-1523.8
47	1483.8-1484.1	1503.8-1504.1	1523.8-1524.1
48	1484.1-1484.4	1504.1-1504.4	1524.1-1524.4
49	1484.4-1484.7	1504.4-1504.7	1524.4-1524.7
50	1484.7-1485.0	1504.7-1505.0	1524.7-1525.0
51	1485.0-1485.3	1505.0-1505.3	1525.0-1525.3
52	1485.3-1485.6	1505.3-1505.6	1525.3-1525.6
53	1485.6-1485.9	1505.6-1505.9	1525.6-1525.9
54	1485.9-1486.2	1505.9-1506.2	1525.9-1526.2
55	1486.2-1486.5	1506.2-1506.5	1526.2-1526.5
56	1486.5-1486.8	1506.5-1506.8	1526.5-1526.8
57	1486.8-1487.1	1506.8-1507.1	1526.8-1527.1
58	1487.1-1487.4	1507.1-1507.4	1527.1-1527.4
59	1487.4-1487.7	1507.4-1507.7	1527.4-1527.7
60	1487.7-1488.0	1407.7-1508.0	1527.7-1528.0
61	1488.0-1488.3	1508.0-1508.3	1528.0-1528.3
62	1488.3-1488.6	1508.3-1508.6	1528.3-1528.6
63	1488.6-1488.9	1508.6-1508.9	1528.6-1528.9
64	1488.9-1489.2	1508.9-1509.2	1528.9-1529.2
65	1489.2-1489.5	1509.2-1509.5	1529.2-1529.5
66	1489.5-1489.8	1509.5-1509.8	1529.5-1529.8

Table 2

Detailed Frequency Plan
Terrestrial Broadcasting and Mobile Aeronautical
Telemetry in the Adjoining Band, 1459.8-1470.0 MHz

Broadcasting in Urban Areas and Mobile Aeronautical Telemety Elsewhere

Ch	Frequency
67	1459.8-1460.1
68	1460.1-1460.4
69	1460.4-1460.7
70	1460.7-1461.0
71	1461.0-1461.3
72	1461.3-1461.6
73	1461.6-1461.9
74	1461.9-1462.2
75	1462.2-1462.5
76	1462.5-1462.8
77	1462.8-1463.1
78	1463.1-1463.4
79	1463.4-1463.7
80	1463.7-1464.0
81	1464.0-1464.3
82	1464.3-1464.6
83	1464.6-1464.9
84	1464.9-1465.2
85	1465.2-1465.5
86	1465.5-1465.8

Broadcasting in Urban and Non-Urban Areas

Ch	Frequency
87	1465.8-1466.1
88	1466.1-1466.4
89	1466.4-1466.7
90	1466.7-1467.0
91	1467.0-1467.3
92	1467.3-1467.6
93	1467.6-1467.9
94	1467.9-1468.2
95	1468.2-1468.5
96	1468.5-1468.8
97	1468.8-1469.1
98	1469.1-1469.4
99	1469.4-1469.4
100	1469.7-1470.0

PRESENT ALLOCATION

MOBILE (Aeronautical telemetering)

1435 MHz — 1530 MHz

PROPOSED ALLOCATION

MOBILE (Aeronautical Telemetering)	NOTE 1 BROADCASTING	NOTE 1 BROADCASTING Mobile (Aeronautical telemetering)	NOTE 2 BROADCASTING-SATELLITE (SOUND) Broadcasting Mobile (Aeronautical telemetering)

1435 MHz — 1459.8 — 1464.0 — 1470.0 — 1530 MHz

NOTES:

1. In the band 1459.8-1470.0 MHz, the entire 10.2 MHz would be available for terrestrial broadcasting in major metropolitan areas. Outside those areas, 4.2 MHz of the band could be assigned only for terrestrial broadcasting, and 6.0 MHz could be assigned only for Mobile (Aeronautical telemetering). Terrestrial broadcasting would be limited to 34 channels carrying 256 kb/s transmissions within a 300 KHz bandwidth.

2. The band 1470-1530 MHz is divided into three sub-bands of 19.8 MHz each, for broadcasting-satellite use in Eastern, Central and Western parts of the United States, respectively. Broadcasting-satellite services are limited to 34 channels carrying 256 kb/s transmissions within a 300 KHz bandwidth. The two sub-bands not used in an area for satellite broadcasting, would be available for assignment to terrestrial repeaters of satellite transmissions in urban areas, and for Mobile (Aeronautical telemetering) elsewhere throughout the United States.

Table 3.

PRESENT AND PROPOSED DOMESTIC ALLOCATION FOR CD RADIO SERVICE

Appendix 4

Sharing Between Broadcasting-Satellite Sound and Mobile (Aeronautical Telemetering)

SHARING BETWEEN BROADCASTING-SATELLITE SOUND AND MOBILE (AERONAUTICAL TELEMETERING)

1. Introduction

This analysis considers sharing between the Broadcasting-satellite (sound) and Mobile (Aeronautical telemetering) services around 1500 MHz. Potential interference between the two services will be considered separately for the two directions of transmission. Interference to telemetry receivers from broadcasting- satellite transmitters, from the terrestrial repeaters rebroadcasting the satellite programs, and from the independent terrestrial broadcasting stations will be considered in Section 2. Interference from telemetry transmitters to portable, vehicular and home BSS receivers will be considered in Section 3.

Interference from the satellite to telemetry receivers is the most important direction of transmission to assess the feasibility of sharing between the two services. That is because the signal from the satellites will blanket the entire country: every telemetry receiver in the United States will be located within one of the satellite beams. On the other hand, the level of interference to telemetry receivers from the terrestrial repeaters and from the terrestrial broadcasting stations, and from telemetry transmitters to BSS receivers, will depend on the separation between them. Thus, sharing will be possible when there is sufficient separation between such stations.

The proposed re-allocation within the 95 MHz-wide band now allocated to Mobile aeronautical telemetry, leaves 25 MHz exclusive and untouched. That segment can continue to be used in areas where telemetry operations are too close to BSS receiver installations to permit co-channel sharing. Other segments of the 95 MHz-wide band can be used in rural areas where there will be no use of these frequencies by terrestrial broadcasting stations or by terrestrial repeaters that will re-broadcast satellite programming in urban areas.

Certain parameters of telemetry systems now operating in the band 1435 - 1530 MHz, have been obtained from the government master file ("GMF"), relevant portions of which were provided by NTIA in response to a request from Telecommunications Systems. A copy of that summary is attached. Other parameters have been derived or assumed, as noted below.

2. Interference to Receivers of Mobile Aeronautical Telemetry

2.1 Interference from Broadcasting-Satellite Transmitters

The increase in the noise threshold of a telemetry receiver caused by undesired signals from the broadcasting-satellites will be the measure of interference for this direction of transmission.

The calculations given below indicate that the receiver noise threshold will be increased by less than one-half a dB. Moreover, this slight increase in noise threshold will be noticed only when the telemetry transmitter is at maximum range from the receiver. At all lesser distances, the receiver will be operating with carrier-to-noise ratios above threshold.

Parameter	Value
Source	
Telemetry receiver sensitivity: (GMF)	-90 dBm
Carrier-to-noise at threshold: engineering	10 dB (Common practice for FM)
Bandwidth: (GMF)	500 kHz

Therefore, Rcvr. noise @ threshold: -90 dBm - 10 dB = -100 dBm
= -130 dBW

Satellite e.i.r.p. per channel: 46.1 dBW (CD Radio Application)

Path loss: -187.7 dB

Rcvr. sidelobe gain : 0 dB (Assumed)

Interfering power: 46.1 - 187.7 +0 = -141.6 dBW/250 kHz
= -138.6 dBW/500 kHz

Degradation of rcvr. threshold = [-138.6 dBW] + [-130 dBW]
= -0.4 dB

2.2 Interference from Terrestrial Repeaters and Broadcasting Stations

Interference to telemetry receivers from both terrestrial repeaters and terrestrial broadcasting stations will be considered together, because the characteristics of these terrestrial stations and, hence, their interference potential, will be similar. Major known characteristics of each are given below:

Mobile Aeronautical Telemetry

Receiver Sensitivity:	-120 dBW
Receiver Antenna Gain:	1 - 42 dBi
Modulation:	FM
Necessary Bandwidth:	500 kHz to 1 MHz
Transmitter Power:	3 - 17 dBW

Terrestrial Repeaters and Broadcasting Stations

Transmitter EIRP:	30 -40 dBW/channel
Modulation:	OQPSK
Necessary Bandwidth:	256 kHz/channel
Receiver Antenna Gain:	Mobile and portable: 5 dBi Home: 10 - 12 dBi
Service Area:	40 km circle around each transmitter

Typically, telemetry receivers will be less than 10 meters above surrounding terrain. Broadcasting repeaters and transmitters will be at elevations of 300 meters or less. Interference can be caused within line-of-sight, and by tropospheric propagation beyond the horizon. Coordination of frequency usage will be required in areas where telemetry operations are conducted.

2. Interference from Telemetry Transmitters to BSS (Sound) Receivers

Typically, portable and mobile BSS (Sound) receivers and their antennas (omnidirectional in azimuth) will be at elevations no more than a few meters above surrounding terrain. Antennas of home installations may be at somewhat higher elevations (in the case of multi-story dwellings, office buildings, etc.), but will typically have higher gain (10 -12 dB), and be more directive. Typically, such antennas will be oriented so that their main lobe will be in the direction of the local terrestrial transmitters and repeaters. Those will most often be located in or near the center of cities and other urban areas. In most situations, this relative orientation will provide additional discrimination against interference from airborne telemetry transmitters at flight test centers.

Interference can occur under some circumstances within line of sight, which can be 200 miles in the case of a telemetry transmitter on an aircraft at an altitude of 20,000 feet. Coordination of frequency usage will be required in areas where telemetry operations are conducted.

SUMMARY CHARACTERIZATION OF THE 1435-1530 MHz FREQUENCY BAND

Band MHz	Government Allocation	Non-Government Allocation	Major Government Use	Power (dBW)	Modulation Type and Necessary Bandwidth	Antenna Gain (dBi)		Receiver Sensitivity (dBW)
						TX	RX	
1435-1530 US78 722	MOBILE (Aeronautical telemetering)	MOBILE (Aeronautical telemetering)	Aeronautical Telemetry	33 to 47	Frequency Modulated; 500 kHz to 1 MHz	(1-16	(1-42	-90

Areas of Deployment: Aeronautical telemetry systems are operated by the military services and contractors at various test ranges and facilities nationwide.

Typical Operation: Telemetry is used by the military mainly during flight operations. The military's aeronautical mobile operations provide telemetry support for tests performed at military test ranges, and include ground checkout of telemetry packages prior to flight.

The following footnotes to the National Table of Allocations apply:

This footnote denotes a stipulation applicable to both the Government and non-Government.

US78 The frequencies between 1435 and 1535 MHz will be assigned for aeronautical telemetry and associated telecommand operations for flight testing of manned or unmanned aircraft and missiles, or their major components. Permissible usage includes telemetry associated with launching and reentry into the earth's atmosphere as well as any incidental orbiting prior to reentry of manned or unmanned objects undergoing flight tests. The following frequencies are shared with flight telemetering mobile stations: 1444.5, 1453.5, 1501.5, 1515.5, 1524.5 and 1525.5 MHz. In the band 1530-1535 MHz, the Maritime Mobile Satellite Service will be the only primary service after January 1, 1990.

This footnote comes from the Radio Regulations, Geneva 1982

722 In the bands 1400-1727 MHz, 101-120 GHz 197-220 GHz, passive research is being conducted by some countries in a program for the search for intentional emissions of extra-terrestrial origin.

Appendix 5

Overview of the Vehicular Receiver

Overview of the Vehicular Receiver

An artist concept of the vehicular receiver is shown in Figure 1. A block diagram of the vehicular receiver is shown in Figure 2. It is the CD radio portion of the combined AM/FM/CD radio proposed for vehicular installation. As shown in the figure, the receiver features the use of a single antenna, adaptive equalization, a deinterleaver, and a Viterbi decoder to recover the 256 kbps digital audio data stream for decoding by the Dolby AC-2 decoder. The output of the Dolby decoder includes two analog stereo channels which are fed to the stereo amplifier and then to the speakers.

The significant features of the receiver will be discussed in turn.

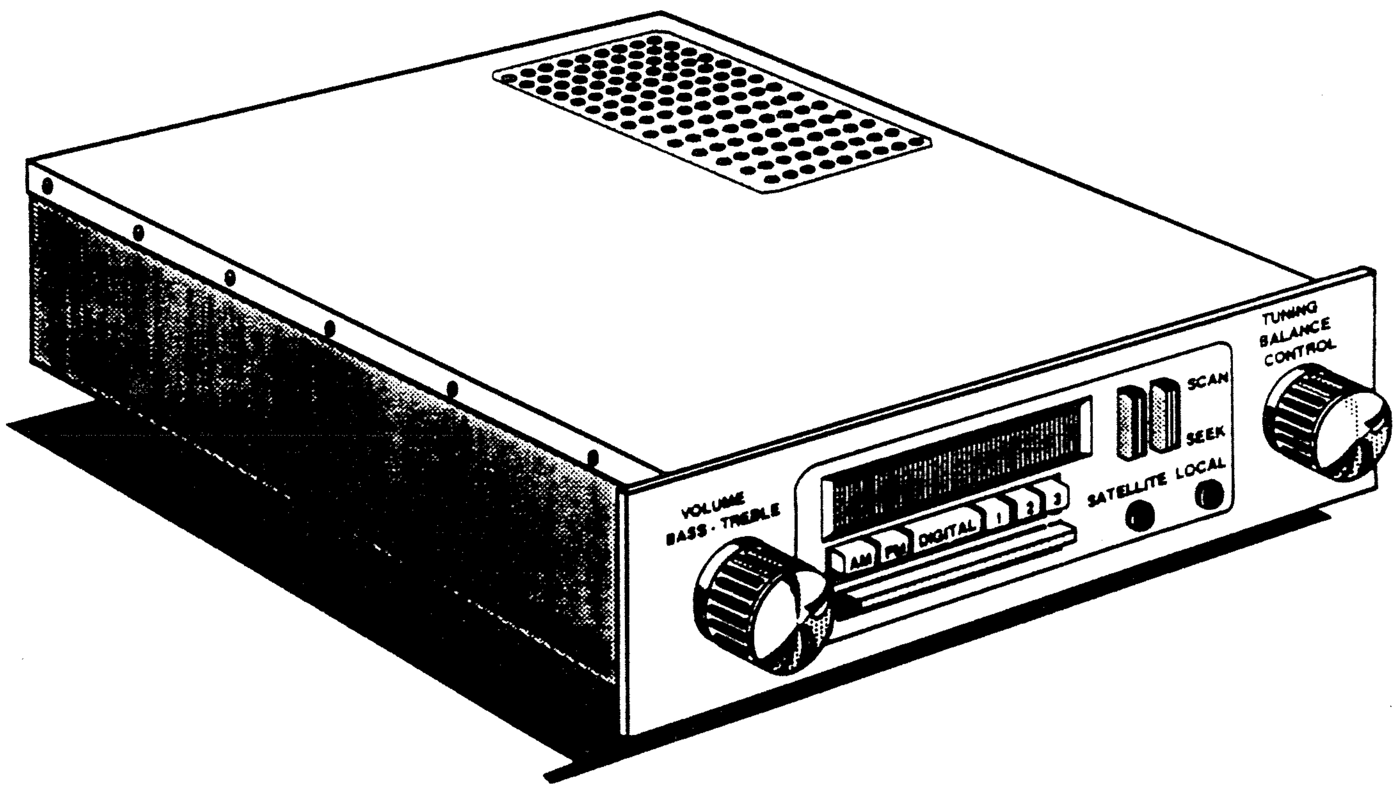

Figure 1: Artist concept of the CD Radio vehicular receiver.

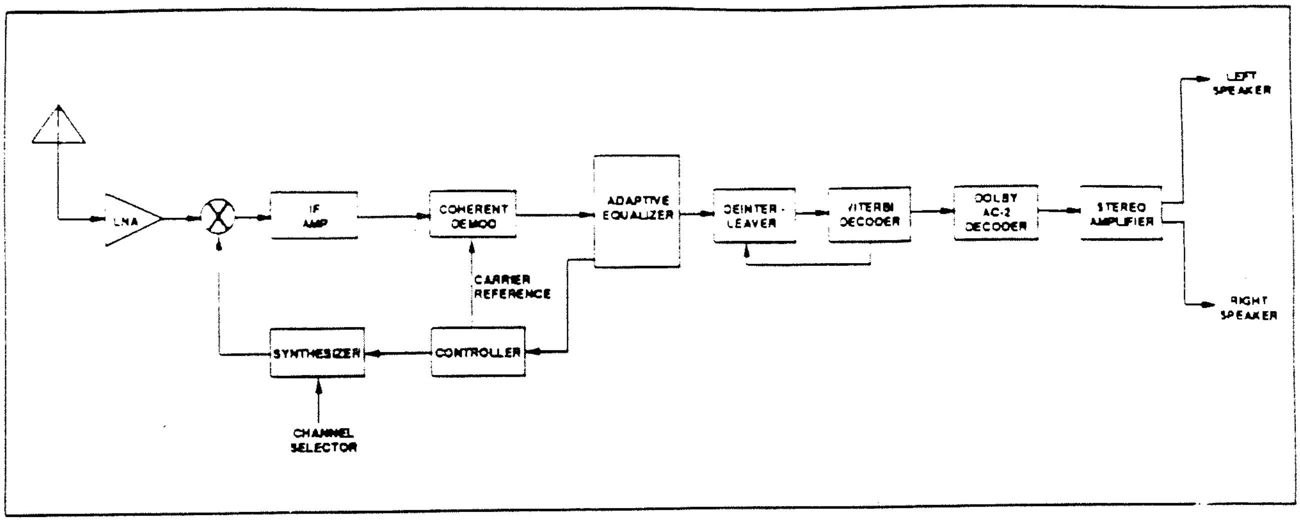

Figure 2: Block diagram of the vehicular receiver.

Receiving Antennas

Several antenna types are under consideration. It is desirable that the vehicular receiving antenna exhibit the following characteristics:

- circular polarization,
- omnidirectional azimuthal pattern,
- 5 dBic gain in the elevation plane between 30 degrees and 60 degrees above the local horizontal plane,
- 5% operating bandwidth,
- low wind profile, and,
- aesthetic package acceptable by the public.

The types of vehicular receiving antennas that are under consideration include:

- normal mode, quadrifilar helix,
- crossed-drooping dipole (inverted U and inverted V types),
- cavity-backed spiral, and,
- shallow-cavity, crossed slot.

Normal Mode, Quadrifilar Helix

A normal mode, quadrifilar helix antenna is shown in Figure 3. Each of the quadrifilar elements consists of a helical portion and two radial portions. The four top radials connect the helical portions to the feed region, while the bottom radials (not visible in the figure) are carried to the center where they are shorted together.

The radiation characteristics of this type antenna have been studied in detail by Kilgus [1]. The radiation characteristics are dependent on the number of turns, the diameter and the pitch of the helix. Figure 4 shows a pattern approximating that required by CD Radio. This pattern is realized with a 5-turn helix, wound on a 1.7 cm diameter rod. The length is on the order of 52 cm for an operating frequency of 1500 MHz.

While the directive gain and radiation pattern are suitable for the CD Radio application, the radiation efficiency tends to be low, the antenna is relatively large compared to a wavelength (performance in a multipath environment could be degraded), and, the radiation pattern is frequency sensitive.

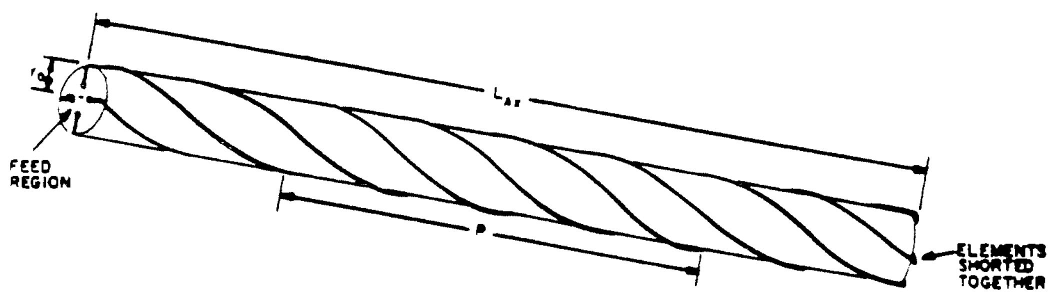

Figure 3: Normal mode, quadrifilar helix antenna [1].

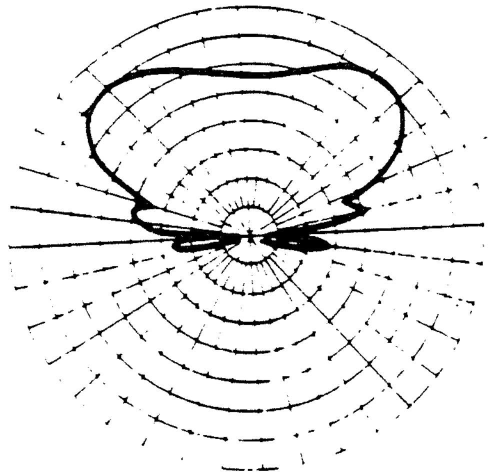

Figure 4: Radiation pattern for a normal mode, quadrifilar helix antenna [1].

Crossed-drooping Dipole (Inverted U and Inverted V types)

Two variations of the crossed-drooping dipole antenna are being considered -- the inverted U and the inverted V as shown in Figure 5. Computed patterns for the inverted U type antenna are shown in Figure 6 [2]. Reference to "Pattern B" in the figure indicates that the inverted U is capable of satisfying the gain-elevation angle requirements when operated over a square ground plane whose size is somewhat less than the roof of a car. The height of the antenna is on the order of a half-wavelength.

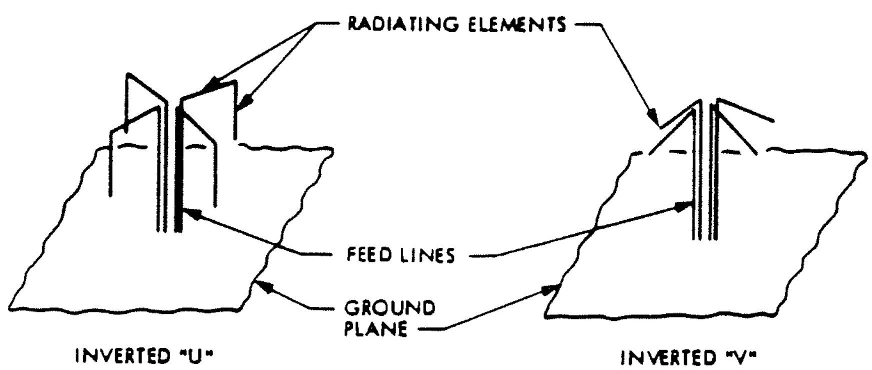

Figure 5: Variations of crossed-drooping dipole [2].

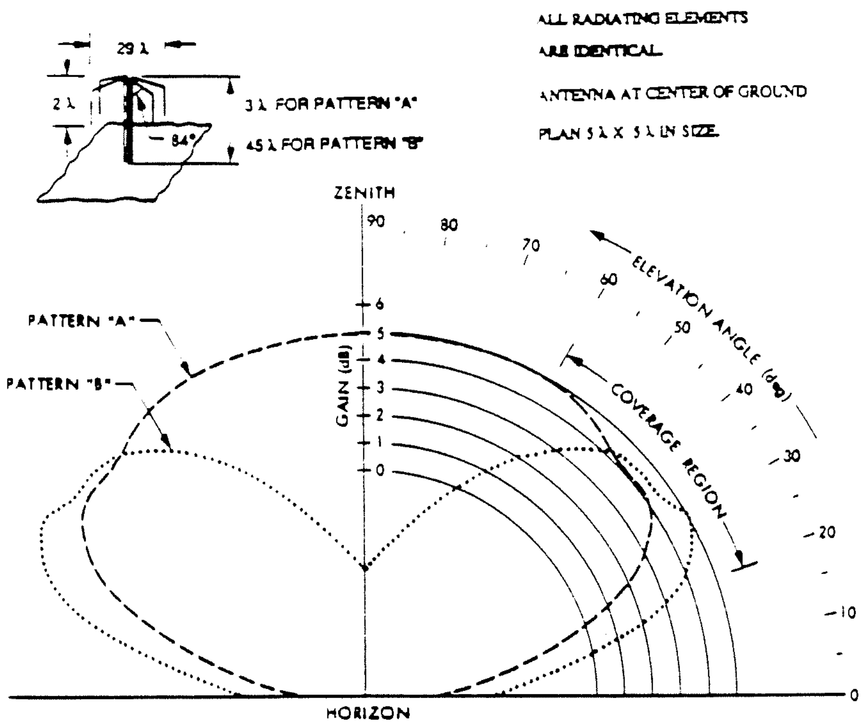

Figure 6: Computed performance of inverted U antenna [2].

Cavity-backed Spiral

A cavity-backed spiral antenna is an inherently broadband antenna that radiates circularly polarized waves in the direction normal to the plane containing the spiral. The optimum depth of the cavity for maximum gain is one-quarter wavelength, whereas the diameter of the cavity is in excess of one-half wavelength. The maximum gain is on the order of 4 dBic in the direction normal to the plane of the spiral [3]. The direction of maximum gain towards zenith is a disadvantage for this type antenna.

Shallow-cavity, Crossed Slot

The shallow-cavity, crossed slot antenna is one of the more promising antennas that is being considered. It is the complement of the crossed dipole antenna (see [4]). The radiation is circularly polarized and is broadside to the plane of slots.

Figure 7 shows several views of the antenna. The view at (a) shows the cavity and the feed posts, while (b) schematically shows the antenna and feed line. The maximum gain of the antenna is on the order of 5 dBic. The dimensions of a typical element designed for operation at 1500 MHz are [5]:

Cavity edge	13 cm
Cavity thickness	1.6 cm
Slot length	18.3 cm

These dimensions may be made smaller with the use of dielectrically loaded cavities.

The lack of a need for a separate ground plane is an advantage of this type antenna.

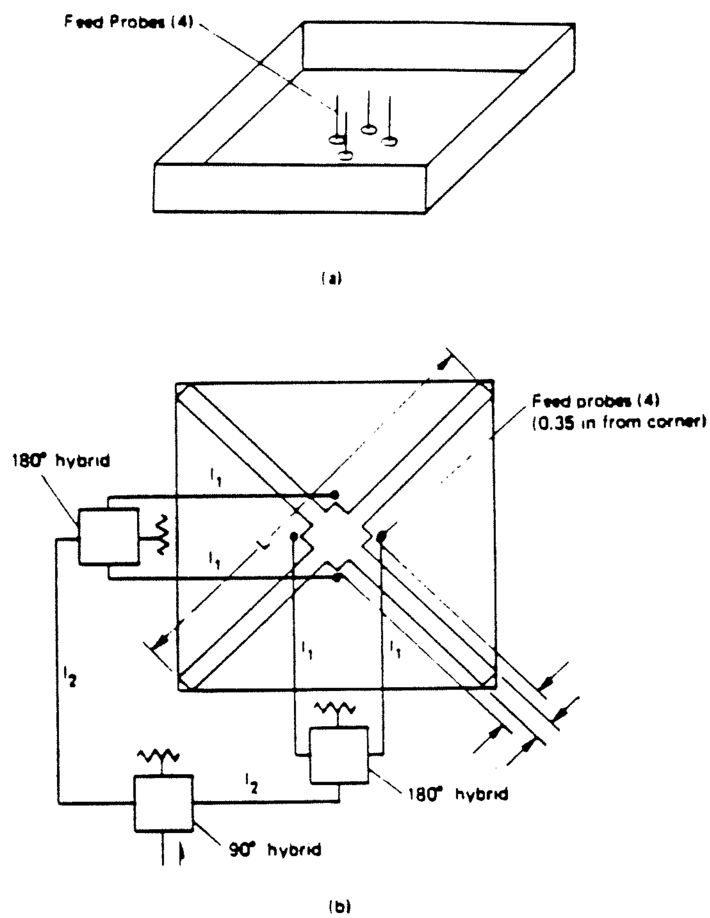

Figure 7: Shallow-cavity, crossed slot antenna.

Receiver RF/IF/Demodulator Sections

As shown in Figure 2, the receiver section consists of a low-noise amplifier (LNA), a mixer-downconverter, an IF amplifier, and a coherent product demodulator. A frequency synthesizer is used to manually select (via a front panel control) the desired CD radio channel. The actual frequency that the synthesizer is set to is determined by the controller. When the maximum signal is received on the satellite frequency, the synthesizer is set to receive that channel frequency by the controller. When the maximum signal is received on the terrestrial channel, the synthesizer is set to receive that channel frequency by the controller. The synthesizer will also be capable of being set from the front panel to receive any of the additional channels that will be available to local terrestrial broadcasters.

The controller also provides an estimate derived from the adaptive equalizer of the received carrier frequency and phase to coherently demodulate the received signal [6].

Adaptive Equalizer

A block diagram of an adaptive equalizer being considered for the CD radio application is shown in Figure 8. This particular one is a 32 tap, fractionally-spaced equalizer that uses the least-mean-square error algorithm [7]. The adaptive equalizer performs adaptive channel equalization, phase tracking and bit synchronization. Unique acquisition and tracking techniques are incorporated into the design to overcome the distortions caused by the multipath fading environment. It is a design that has been demonstrated by Stanford Telecom [6]. The output of the adaptive equalizer is an optimal estimate of the convolutionally encoded serial digital signal.

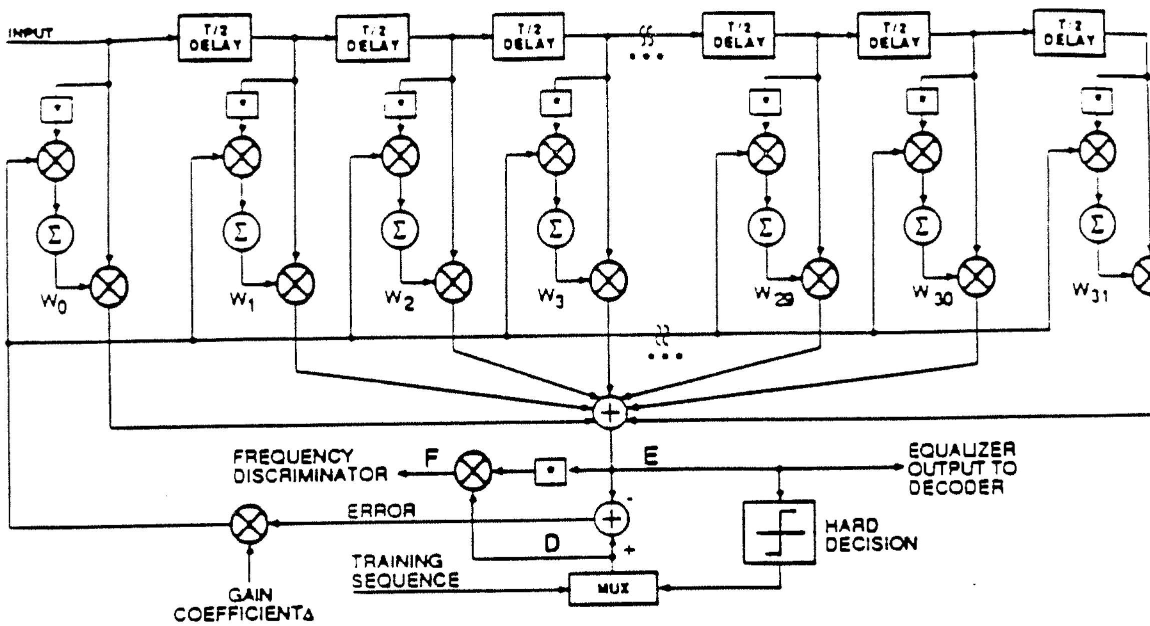

Figure 8: Functional diagram of one section of the adaptive equalizer [6].

Deinterleaver

A deinterleaver consisting of conventional computer memory is driven by the output of the adaptive equalizer. The reason for using an interleaver/deinterleaver is to mitigate the effects of fading on the performance of the vehicular receivers when operating in signal fading environments [8]. The synchronization of the deinterleaver may be accomplished using a technique described in [8]. The technique involves the modulo 2 addition of a synchronization sequence (e.g., a maximal length sequence) with the serial data stream at the transmitter and the removal of the sequence by modulo 2 addition of the serial data stream with the local estimate of the phase of the synchronization sequence at the receiver. When the deinterleaver is not in synchronization, the bit error ratio at the output of the Viterbi decoder will be about 0.5; a condition that is easily detected by the Viterbi decoder. The out-of-sync condition is fed back to the deinterleaver as shown in Figure 2 where it is used to enable or continue the search procedure.

Viterbi Decoder

A block diagram of the Viterbi maximum likelihood decoder available commercially from Stanford Telecom is shown in Figure 9. The decoder extracts the serial data from the channel-corrupted received signal using an efficient algorithm as described in [9].

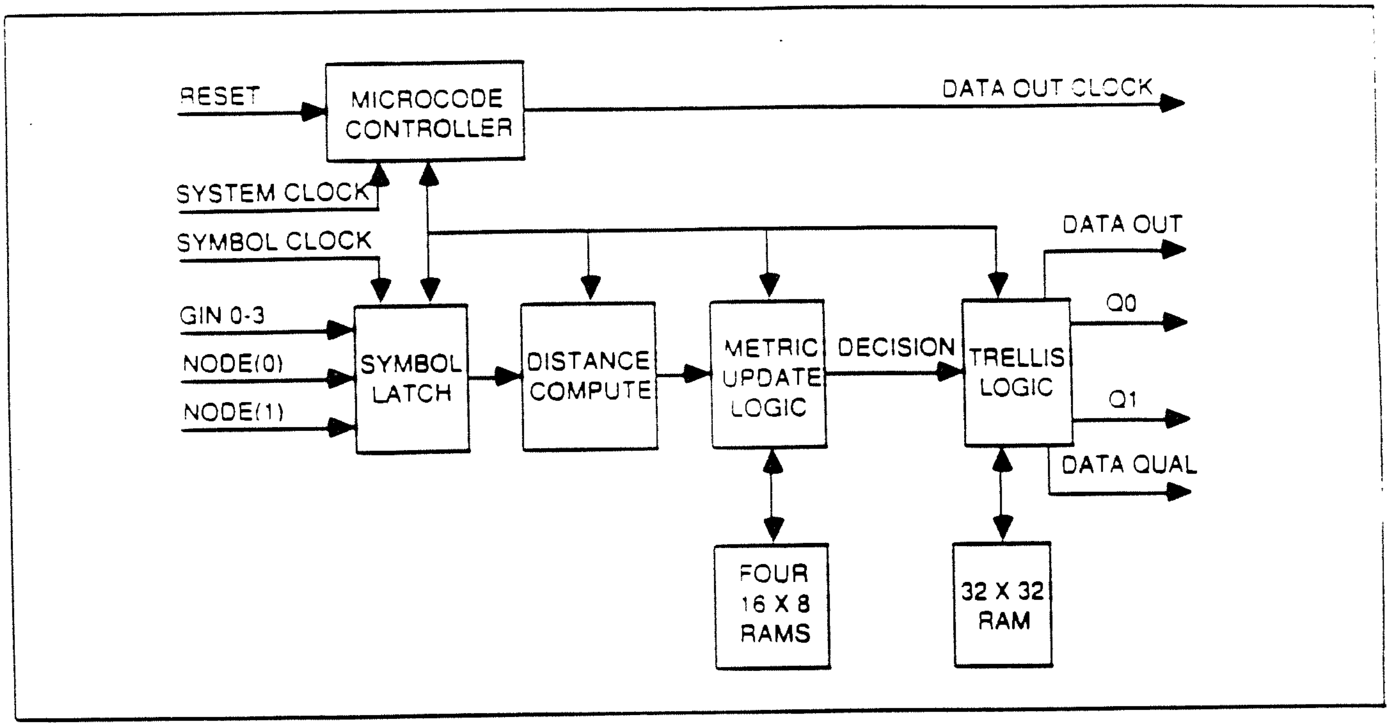

Figure 9: Functional diagram of the Viterbi decoder.

Dolby AC-2 Decoder

A block diagram of the Dolby AC-2 two-channel decoder is shown in Figure 10. It accepts the serial data at a rate of 256 kbps, establishes frame synchronization with the encoded data, and unpacks the formatted data blocks. Any necessary error correction is performed (it is noted that Reed-Solomon coding is used to protect critical sub-band data from random errors) prior to decoding the audio information and outputting the serial PCM data stream to the digital-to-analog (D/A) conversion circuits. In the absence of frame synchronization or during high channel BER, the processor provides a control signal to externally mute the audio. Encoder overload status and auxiliary channel data are similarly decoded and routed to appropriate hardware [10].

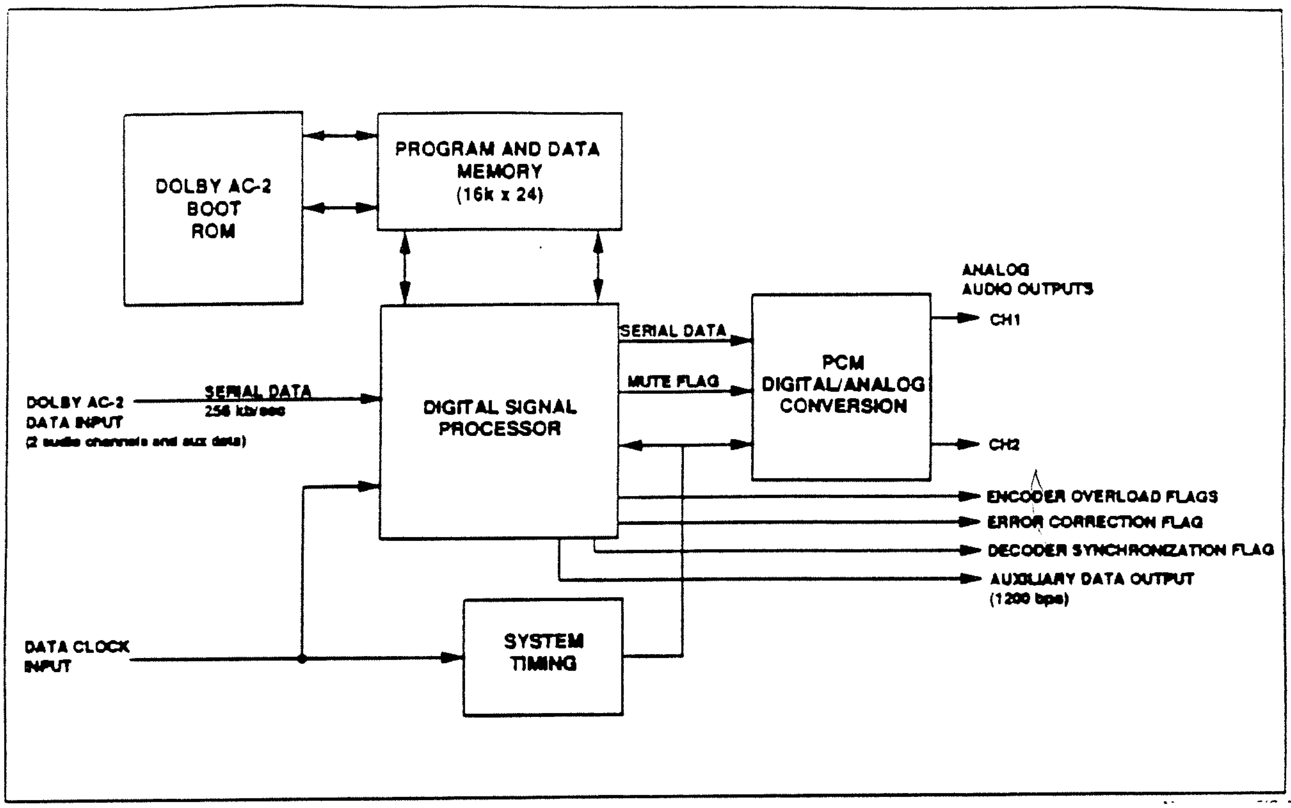

Figure 10: Block diagram of the Dolby AC-2 two-channel decoder.

Stereo Amplifier

The stereo amplifier will be of conventional design and is not expected to be a significant performance driver.

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[9] G.C. Clark, Jr. and J.B. Cain, Error-Correction Coding for Digital Communications, Plenum Press, New York and London, ch. 6, 1981.

[10] G. Davidson, L. Fielder, and M. Antill, "High-Quality Audio Transform Coding at 128 kbits/s," Proceedings of the IEEE International Acoustics, Speech, and Signal Processing Conference, Albuquerque, NM, April 1990.

Appendix 6

Information for Advance Publication Under RR 1042
Satellites of CD Radio, Inc.

INFORMATION FOR ADVANCE PUBLICATION UNDER RR 1042
SATELLITES OF CD RADIO, INC.

Section B. General Characteristics

Item 1 Identity of the satellite network

USASAT ___ and USASAT ___ [to be supplied by FCC]

Item 2 Date of bringing into use

1 January, 1994

Period of validity of frequency assignments to the space station

12.5 years

Item 3 Administration or group of administrations submitting the advance information

UNITED STATES OF AMERICA
Federal Communications commission
WASHINGTON, D.C. 20554
FEDCOMCOM, WASHINGTON, D.C.

Item 4 Orbital information relating to the space station

		USASAT [X]	USASAT [Y]
a)	Nominal geographical long.:	103°W	121°W
	Longitudinal tolerance:	+/- 0.1°	
	Inclination excursion:	+/- 5.0°	
1)	Visible arc:	42 - 165°W	60 - 183°W
2)	Service arc:	101 - 139°W	

3) Reason that arc defined in 2) above, is less than arc defined in 1) above:

Network design is based on 30° minimum elevation angle to both satellites at all stations in the service area.

Section C Characteristics of the Satellite Network in the Earth to Space Direction

Item 1 Earth to Space service area

Contiguous United States

Item 2 Class of stations and nature of service

TC, TD, CV, EC, ED

Item 3 Frequency range

27,500 - 29,500 MHz

Item 4 Power characteristics of the transmitted wave

a) Maximum spectral power density

+ 7.0 dBW/Hz

b) Typical radiation pattern (relative to isotropic):

G = 55.0 dB

Antenna sidelobes conform to CCIR Rec. 465-2

Item 5 Characteristics of space station receiving antenna

a) Antenna gain contour estimates, see Figure 1

Item 6 Noise temperature of the receiving space station

1,660 K (telecommand only)

Section D Characteristics of the Satellite Network in the Space to Earth Direction

Item 1 Space to Earth service area

Contiguous United States

Item 2 Class of station and nature of service

EB, EC, EK, ER, CV, TC, TK, TR

Item 3 Frequency range

1,470 - 1,530 MHz

Item 4 Power characteristics of the transmission

a) Maximum spectral power density

- 7.9 dBW/Hz

Item 5 Characteristics of space station transmitting antenna

a) Antenna gain contour estimates, see Figure 2.

Item 6 Characteristics of receiving earth stations

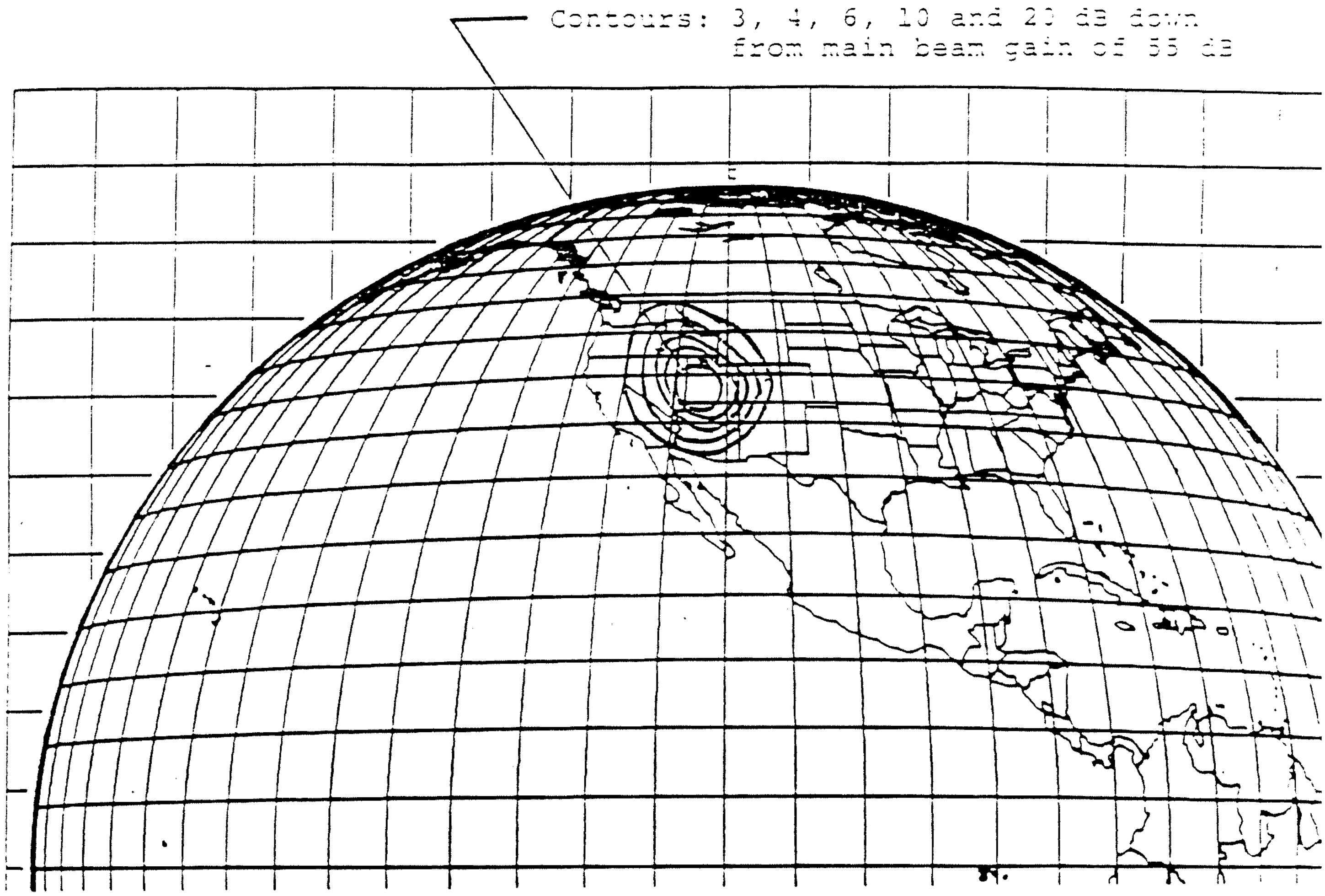
a) Lowest total receiving system noise temperature:

200 K (Tracking and telemetry)

1) Lowest equivalent satellite link noise temperature

Figure 1.

Space Station Receiving Antenna
Gain Contour Estimates



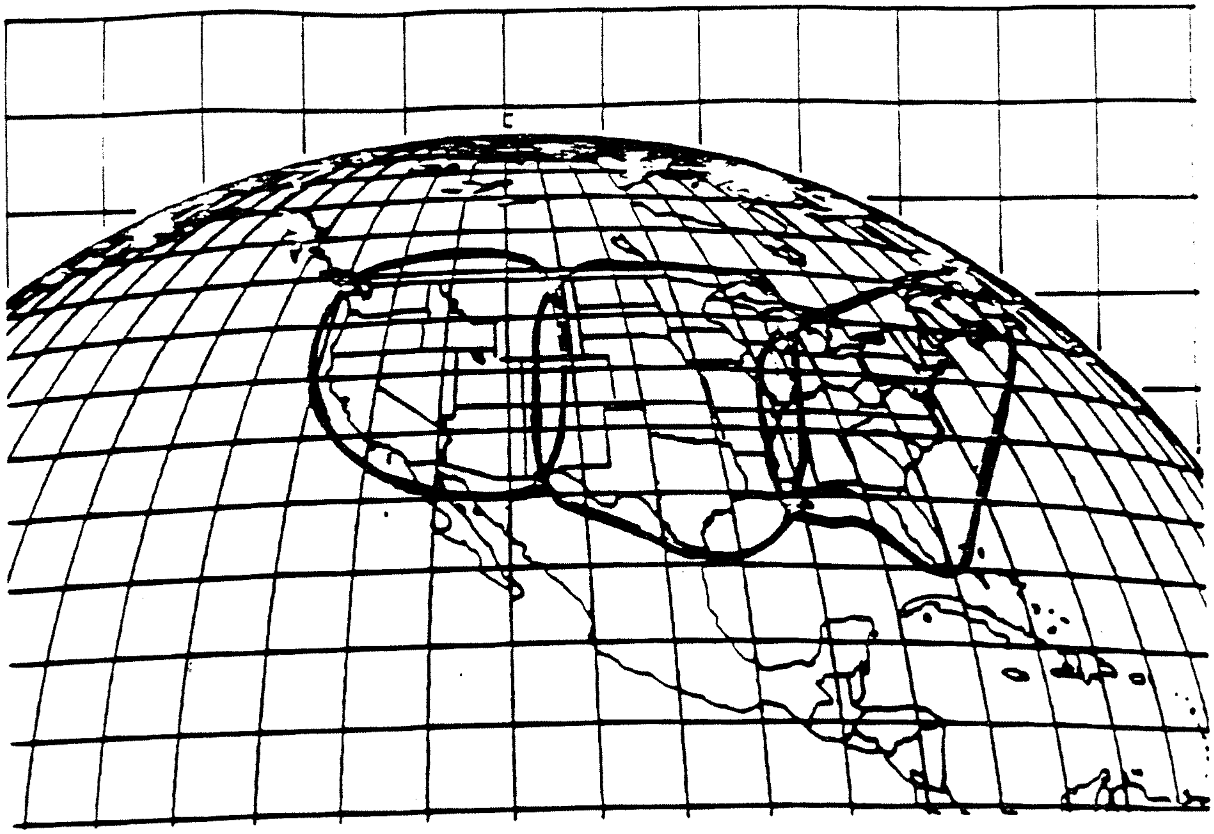
(T_{eq}) and the associated value of transmission gain (gamma):

Not applicable to the Broadcasting-satellite service (sound).

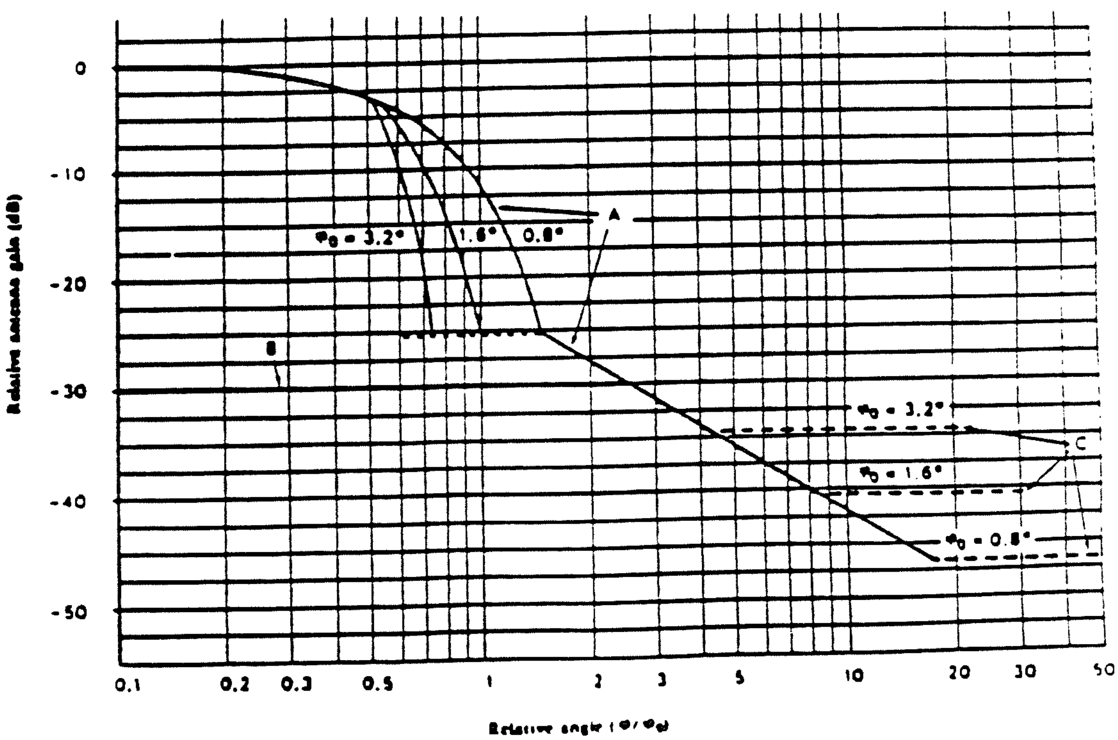
2) Highest ratio of transmission gain (gamma) to equivalent satellite link noise temperature (T_{eq}):

Not applicable to the Broadcasting-satellite service (sound).

Figure 2
Space Station Transmitting Antenna
Gain Contour Estimates



Contours shown are 3 dB below main beam gain. Outside those contours, gain will decrease in accord with fast roll-off reference pattern shown below.



Reference patterns for co-polar and cross-polar components for satellite transmitting antennas with fast roll-off in the main beam for Region 2
(From: Radio Regulations, App. 30)

TELECOMMUNICATIONS SYSTEMS

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CERTIFICATION OF PERSON RESPONSIBLE
FOR PREPARING ENGINEERING INFORMATION
SUBMITTED IN THIS APPLICATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familiar with Parts 2, 25 and 73 and 87 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this application, and that it is complete and accurate to the best of my knowledge.

by: *Richard G. Gould*
Richard G. Gould
Registered Professional Engineer

dated: *May 17, 1990*