Comments FCC 05-94/ET 05-182

This listing of commenters does not include the Engineering comments submitted by Hammett and Edison on behalf of EchoStar Satellite L.L.C. The comment filings are separate due to the fact that they were submitted in a format that prevents their inclusion in this integrated electronic document.

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Technical Standards for Determining	)	ET Docket No. 05-182
Eligibility for Satellite-Delivered Network Signals	)	
Pursuant to the Satellite Home Viewer	)	
Extension and Reauthorization Act of 2004	)	

COMMENTS OF THE ABC, CBS, AND NBC TELEVISION AFFILIATE ASSOCIATIONS

Kurt A. Wimmer
COVINGTON & BURLING
1201 Pennsylvania Avenue, N.W. (20004)
Post Office Box 7566
Washington, D.C. 20044-7566
Telephone: (202) 662-6000
Facsimile: (202) 662-6291

Counsel for the CBS Television Network Affiliates Association and for the NBC Television Affiliates Association

Wade H. Hargrove
Mark J. Prak
David Kushner
BROOKS, PIERCE, MCLENDON, HUMPHREY & LEONARD, L.L.P.
Wachovia Capitol Center, Suite 1600
150 Fayetteville Street Mall (27601)
Post Office Box 1800
Raleigh, North Carolina 27602
Telephone: (919) 839-0300
Facsimile: (919) 839-0304

Counsel for the ABC Television Affiliates Association

June 17, 2005

Table of Contents

Summary

SHVERA requires the Commission to report to Congress on a variety of factors that may ultimately affect whether a household is deemed to be "unserved" by a digital television signal as that term is defined in 17 U.S.C. § 119(d)(10). While SHVERA specifies certain particular considerations the Commission is to study, as the *Notice* recognizes, the Commission's inquiry must be predicated upon the fundamental nature of the "unserved household" limitation set forth in the Copyright Act. That fundamental nature is a compulsory license operating in derogation of the property rights of copyright holders which should, accordingly, always be conservatively construed in favor of the local broadcast station.

In its *SHVA Order*, and in keeping with the narrow purpose of the distant signal compulsory license, the Commission properly allowed the principle of localism and several important corollaries to guide its decision to recommend to Congress the Individual Location Longley-Rice ("ILLR") predictive model in the form that it did. *First*, the Commission respected the fact that SHVA reflected "Congress' intent to protect the role of local broadcasters in providing free, over-the-air television to American families." *Second*, the Commission sought to formulate an approach whose effect would neither "increase the number of unserved households that already exist, nor . . . reduce the size of local stations' markets by subtracting viewers who are able to receive their signal." *Third*, the Commission properly observed that "when served households are deemed eligible for satellite-delivered broadcast network service, network affiliates are harmed and the SHVA's intent is also thwarted." *Fourth*, and finally, the Commission recognized that a "predictive model that includes truly served households in an unserved category, even temporarily, creates . . . undesired effects." These same principles should continue to guide the Commission in the instant proceeding.

The Commission should also be mindful that SHVERA is not merely a continuation of the Section 119 *status quo ante*. Rather, SHVERA, building upon the local-into-local Section 122 compulsory license enacted in SHVIA, begins to *phase out* the Section 119 distant compulsory license. Although the definition of "unserved household" has not been substantively changed, the class of viewers to whom satellite carriers may retransmit distant duplicating network signals has been considerably narrowed through the principle of "if local, no distant." The new, fundamental limitation imposed by SHVERA is the *ineligibility* for distant network signals of satellite subscribers who are able to obtain access to the local network signals of local broadcast stations via local-into-local service offered pursuant to the Section 122 license. This principle applies as fully to digital signals as it does to analog signals.

In fact, the primary category of satellite subscribers for whom site testing is even statutorily authorized (and, hence, for whom this proceeding is even relevant) is narrower still: Where a satellite carrier does not offer local-into-local digital service but does offer local-into-local analog service, if the satellite subscriber is *served* over the air by the local station's analog signal, then such a subscriber *may* be eligible for distant digital service provided a site test measurement, under certain further conditions as to market, date, and DTV build-out status and conducted pursuant to the current test methodology set forth in Section 73.686(d), demonstrates that the household cannot receive a digital signal of signal intensity that exceeds the DTV signal intensity standards set forth in Section 73.622(e)(1).

Accordingly, what is left, then, for the Commission in this proceeding, like the Section 119 license itself, is narrow, requiring a conservative approach to respect the limited nature of the compulsory license and to preserve the integrity of the localism principle. Although SHVERA lists six specific items that the Commission is to study in this proceeding, logically these items may be reclassified into three separate, but ultimately interrelated, concerns: (1) the appropriateness of the DTV planning factors which resulted in the digital signal intensity standards set forth in Section 73.622(e)(1); (2) the appropriateness of the objective analog signal site test methodology in Section 73.686(d) in the digital signal context; and (3) the advisability of developing a predictive model for future use.

Fundamental to digital television is the Commission's decision to predicate the coverage area of the new DTV service upon each station's existing NTSC Grade B service area. The Commission carefully crafted its approach to "foster the transition to DTV, while simultaneously preserving viewers' access to off-the-air TV service and the ability of stations to reach the audiences they now serve." Maintaining viewer "access to the stations that they can now receive over-the-air" was a critical component of the DTV replication scheme. Thus, the value of over-the-air service to both viewers and broadcasters was fundamental to the Commission's actions. Obviously, the Commission would not have predicated DTV—for which broadcasters have invested many millions of dollars—on planning factors intended to replicate existing television service if those factors were not, in fact, adequate or up to the task.

As the *Notice* correctly states—and critical to the Commission's entire DTV plan to replicate NTSC Grade B service areas—"[*t*]*hese criteria presume that households will exert similar efforts to receive DTV broadcast stations as they have always been expected to exert to receive NTSC analog TV signals*." As the extensive discussion herein of each of these planning factors demonstrates, the Commission's existing noise-limited field strength thresholds for DTV service are more than adequate for real-world reception of local digital broadcast signals.

In fact, the discussion of the adequacy of the DTV planning factors, the specifications and characteristics of currently available consumer equipment, and the Commission's intentions and expectations in promulgating the DTV planning factors all point ineluctably to the following answers to queries raised in the *Notice*:

- The receiving antenna must be mounted outside on the roof or adjacent to the house. Moreover, the antenna must be oriented to the desired signal, and if the desired stations are not located in the same direction, then the antenna must be orientable in the direction of the desired signal(s). An excellent outdoor antenna receiving system can be installed for approximately $100, including an eight-way bowtie-with-screen antenna and a rotor with remote control.

- The Commission should continue to recommend that the current signal strength thresholds for noise-limited digital service should be used to define the availability of a DTV signal for determining whether a household is eligible to receive distant digital signals from satellite services. Real-world equipment, including fifth generation receivers, demonstrates that the Commission's current signal strength thresholds are more than adequate to receive a high-quality digital picture.

- Variation in DTV set prices should play no role in determining whether a household is unserved by an adequate DTV network signal. The evidence shows that there is very little penetration (no more than 1%) of early generation DTV receivers in television households. Most households have or will acquire DTV sets with integrated tuners incorporating the latest generational chip design (fifth generation or later), including equalizers demonstrating superior multipath handling performance capabilities.

- Multipath should not be taken into account in determining whether a household is served by an adequate digital signal. Fifth generation receivers incorporate equalizers that are remarkably good at handling very early pre-ghosts and very late post-ghosts (on the order of 50 microseconds each). But, more fundamentally, multipath is not a matter of signal strength, which is the objective means by which a digital "unserved household" should be determined. The effects of multipath, however, can be greatly, if not wholly, mitigated by the use of the latest generation receiver; by the use of an outdoor antenna raised to 30 feet which will place the antenna above many of the principal multipath reflectors; and by the use of highly directional antennas with high front-to-back ratios, properly oriented to the strongest desired signal.

Although the Commission's testing procedure for cluster measurements of signal strength at household locations in Section 73.686(d) was developed specifically for analog signals, it is generally workable for digital signals once several slight modifications are made to measure the signal strength of digital signals: *First*, a directional gain antenna should be utilized instead of a half-wave dipole. *Second*, the field strength of a digital signal should be determined by measuring the integrated average power over the 6 MHz bandwidth. *Third*, the tester should use a spectrum analyzer tuned to the center of the channel, sweep across a variety of small intermediate frequency bandwidths, and integrate the total power across the 6 MHz bandwidth.

With these slight modifications, the testing methodology in Section 73.686(d) will permit the objective testing of the signal strength of digital signals. But this is true only if the remaining elements of the testing methodology are not altered. Most notably, the site test must measure signal strength *outdoors*, at the specified rooftop heights (20 feet for one-story residences, 30 feet for all others), and with the testing antenna properly oriented. Finally, the test methodology must remain objective. There is neither any basis nor any warrant for the Commission to consider altering any aspect of the test methodology that would add any element of subjectivity to the test.

Network Affiliates believe that the Commission should develop and recommend a predictive model for digital signals, but only for future, and not immediate, use. By "future use," Network Affiliates mean *after* the digital transition is *complete*. Before the end of the transition, too much is unknown, the process would be too complicated, and the resulting viewer confusion could be rampant. For example, not all stations have made elections for their final digital channel, and the spectrum repacking process is far from complete. Importantly, digital service for low power stations and translators has not yet been authorized. Because a household is considered "served" if it receives a signal from any station, be it full power, satellite, or translator, affiliated with the network in issue, it is not possible to predict whether a household can receive a digital signal if the station that could be delivering the signal has not yet been authorized to broadcast in digital or the station has not yet had a reasonable opportunity to construct digital facilities. Waiting for the completion of the digital transition will not materially prejudice the distant signal license, especially when weighed against the countervailing harms to local affiliates if a predictive model is implemented prematurely.

It would be appropriate for the Commission to recommend the ILLR model for digital signal prediction purposes at the end of the DTV transition—with one exception. The ILLR model as currently structured in OET 72 *over-provides* for clutter at UHF frequencies, and, in the digital context, these UHF clutter loss values make the model less accurate, rather than more accurate. In the case of digital signal predictions, the clutter considerations already inherent in the basic, semi-empirical Longley-Rice model provide a more accurate predictive model than the additional UHF clutter loss values added into the ILLR model in OET 72. The National Association of Broadcasters ("NAB") is providing extensive data (more than 2000 individual site predictions with associated measured field strengths) in its comments in this proceeding providing empirical support for this slight modification to the ILLR model.

For the reasons contained herein, Network Affiliates respectfully request that the Commission recommend to Congress (1) that the digital signal strength thresholds set forth in Section 73.622(e)(1) remain the same for purposes of determining whether a household is "unserved" by a digital signal pursuant to 17 U.S.C. § 119(d)(10); (2) that the testing methodology set forth in Section 73.686(d) be modified slightly so that the procedure may be correctly used for digital signal site tests; and (3) that Congress prescribe a slightly modified ILLR model (without UHF clutter loss values) to be used after the digital television transition is complete to presumptively determine the eligibility of a household to receive a duplicating distant digital network signal.

* * *

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Technical Standards for Determining	)	ET Docket No. 05-182
Eligibility for Satellite-Delivered Network Signals	)	
Pursuant to the Satellite Home Viewer	)	
Extension and Reauthorization Act of 2004	)	

COMMENTS OF THE ABC, CBS, AND NBC TELEVISION AFFILIATE ASSOCIATIONS

The ABC Television Affiliates Association, the CBS Television Network Affiliates Association, and the NBC Television Affiliates Association (collectively, the "Network Affiliates"), by their attorneys, hereby comment upon the *Notice of Inquiry* ("*Notice*"), FCC 05-94, released on May 3, 2005, in the above-referenced proceeding.[1]

I. In Addressing SHVERA's Statutory Study Considerations, the Commission Should Be Guided by the Fundamental Nature of the Section 119 Compulsory License

The Satellite Home Viewer Extension and Reauthorization Act of 2004 ("SHVERA")[2] requires the Commission to report to Congress on a variety of factors that may ultimately affect whether a household is deemed to be "unserved" by a digital television signal as that term is defined in the Copyright Act pursuant to 17 U.S.C. § 119(d)(10). While SHVERA specifies certain particular considerations the Commission is to study, as the *Notice* recognizes, the Commission's

[1] The Network Affiliates collectively represent approximately 600 local television stations affiliated with the ABC, CBS, and NBC Television Networks.

[2] Pub. L. No. 108-447, Div. J, Tit. IX (2004), at § 204(b) (codified at 47 U.S.C. § 339(c)(1)).

inquiry must be predicated upon the fundamental nature of the "unserved household" limitation set forth in the Copyright Act. That fundamental nature is a compulsory license operating in derogation of the property rights of copyright holders which should, accordingly, always be conservatively construed in favor of the local broadcast station.

The Section 119 "unserved household" provision permitting the limited importation of a distant duplicating network signal in a narrow set of circumstances has been an element of copyright law since the original Satellite Home Viewer Act ("SHVA") in 1988. In the Copyright Act, Congress, pursuant to its constitutional authority in the Copyright Clause, Art. I, § 8, cl. 8, has granted an exclusive, albeit time-limited, right in original works of authorship fixed in a tangible medium of expression.[3] A copyright, therefore, is a constitutionally- and congressionally-sanctioned property right. One of the principal exclusive rights subsisting in copyright is the right to choose whether and how one's copyrighted works can be distributed to others.[4]

SHVA (as did the Satellite Home Viewer Improvement Act of 1999 ("SHVIA") and now SHVERA) granted a limited and conditional compulsory copyright license to satellite carriers to enable them to distribute distant network signals to a narrow class of viewers—a class of viewers that has shrunk even further under SHVERA, as explained below. This compulsory license is an express limitation on the distribution rights of creators of original works of expression, and, thus, is in derogation of the normally broad power to exercise control over one's copyrighted works.[5] The

---

[3] *See* 17 U.S.C. § 102(a).

[4] *See* 17 U.S.C. § 106(3).

[5] *See* U.S. Copyright Office, *A Review of the Copyright Licensing Regimes Covering Retransmissions of Broadcast Signals* (Aug. 1, 1997) ("*Copyright Office Report*"), at 13 ("A compulsory license mechanism is in derogation of the rights of authors and copyright owners."
(continued...)

compulsory license permits satellite carriers to retransmit copyrighted material without having to obtain the express permission of the owner. Compulsory licenses are not favored in the law and, therefore, are narrowly construed. As stated by the Fifth Circuit, because a "compulsory license provision is a limited exception to the copyright holder's exclusive right to decide who shall make use of his [copyrighted work] . . . it must be construed narrowly, lest the exception destroy, rather than prove, the rule."[6]

Each of the satellite laws has had a dual purpose: (1) to enable households located beyond the reach of a local affiliate, primarily in rural areas,[7] to obtain access to broadcast network

---

(...continued)
(internal quotation marks and citation omitted)).

[6] *Fame Publ'g Co. v. Alabama Custom Tape, Inc.*, 507 F.2d 667, 670 (5th Cir.), *cert. denied*, 423 U.S. 841 (1975).

[7] Reviewing the legislative history of the original SHVA and its 1994 renewal demonstrates that the original intent of Section 119 was to enable satellite carriers, through a compulsory license mechanism, to provide broadcast network service to *rural* areas:

> [The bill] will benefit *rural America*, where significant numbers of farm families are inadequately served by broadcast stations licensed by the Federal Communications Commission.

H.R. REP. NO. 100-887, pt. 1, at 15 (1988) (emphasis added).

> The extension of the SHVA "ensure[s] that *rural home satellite dish consumers* will be able to continue to receive retransmitted broadcast programming. This is essential because in many rural areas satellite technologies represent the only way that *rural families* can receive the kind of information and entertainment programming that many urban Americans take for granted."

140 CONG. REC. E1770 (daily ed. Aug. 19, 1994) (statement of Rep. Long) (emphases added).

> The extension of the SHVA is needed "to ensure that *rural consumers* will continue to receive television programming."

(continued...)

programming by satellite and (2) to protect the integrity of the copyrights that make possible the existing free, over-the-air national network/local affiliate broadcast distribution system.[8]

Section 119, therefore, has always represented a careful balance between the public interest, on the one hand, in allowing households located beyond the reach of a local network station to secure access to broadcast network programming and, on the other hand, in preserving "localism" by protecting the copyrights each local network station has for the broadcast of its network programming in its local market. Each of these laws was designed to protect the exclusivity of the copyright held by each affiliate for exhibition in its market of its network programming.[9] At the heart of these laws is an acknowledgment by Congress of the national interest in preserving "local" broadcast service by protecting the longstanding, free, universally-available, over-the-air national network/local affiliate television distribution system—a system Congress acknowledged "has served the country well."[10]

---

[7](...continued)
140 CONG. REC. H9268, H9270 (daily ed. Sept. 20, 1994) (statement of Rep. Hughes) (emphasis added).

This same basis has been expressed in the legislative history of SHVERA:

> Its [the Section 119 license] primary purpose is to ensure that those residing in *rural* areas or in areas where terrain makes it impossible to receive an acceptable over-the-air signal from their television stations can receive a "*life-line*" network television service from a satellite provider.

H.R. REP. NO. 108-660, at 10 (2004) (emphases added).

[8] *See* H.R. REP. NO. 100-887, pt. 1, at 8 (1988); H.R. REP. NO. 108-660, at 11 (2004).

[9] *See* H.R. REP. No. 100-887, pt. 2, at 19-20 (1988); H.R. REP. NO. 100-887, pt. 1, at 14 (1988).

[10] H.R. REP. NO. 100-887, pt. 2, at 20 (1988); H.R. REP. NO. 108-660, at 11 (2004).

Localism is a bedrock principle of the nation's broadcast television system. "[T]he Commission historically has followed a policy of 'localism' as a sound means of promoting the statutory goal of efficient public service."[11] Indeed, the Commission has acknowledged that "our commercial television system is based upon the distribution of programs to the public through a multiplicity of local station outlets. [W]e have not turned to an alternative system of signal and program distribution, based upon a handful of 'super stations.'"[12]

In initiating its first SHVA proceeding, in CS Docket No. 98-201, the Commission recognized the central role that the core policy of localism plays in the Section 119 regime:

> The network station compulsory licenses created by the Satellite Home Viewer Act are limited because Congress recognized the importance that the network-affiliate relationship plays in delivering free, over-the-air broadcasts to American families, and because of the value of localism in broadcasting. Localism, a principle underlying the broadcast service since the Radio Act of 1927, serves the public interest by making available to local citizens information of interest to the local community (e.g., local news, information on local weather, and information on community events). Congress was concerned that without copyright protection, the economic viability of local stations, specifically those affiliated with national broadcast networks, might be jeopardized, thus undermining one important source of local information.[13]

In the resulting *SHVA Order*, the Commission allowed the principle of localism and several important corollaries to guide its decision to recommend to Congress the Individual Location

---

[11] *National Ass'n of Broadcasters v. FCC*, 740 F. 2d 1190, 1198 (D.C. Cir. 1984).

[12] *Restrictions on Use of Microwave Relay Facilities to Carry Television Signals to Community Antenna Television Systems*, First Report and Order, FCC 65-335, 4 Rad. Reg. 2d (P & F) 1725 (1965), ¶ 47.

[13] *Satellite Delivery of Network Signals to Unserved Households for Purposes of the Satellite Home Viewer Act*, Notice of Proposed Rule Making, FCC 98-302, 14 Comm. Reg. (P & F) 2163 (1998).

Longley-Rice ("ILLR") predictive model in the form that it did. *First*, the Commission respected the fact that the "Satellite Home Viewer Act limits the compulsory copyright license to 'unserved' households, reflecting Congress' intent to protect the role of local broadcasters in providing free, over-the-air television to American families."[14] *Second*, the Commission sought to formulate an approach throughout the *SHVA Order* whose effect would neither "increase the number of unserved households that already exist, nor . . . reduce the size of local stations' markets by subtracting viewers who are able to receive their signal."[15] *Third*, the Commission properly observed that "when served households are deemed eligible for satellite-delivered broadcast network service, network affiliates are harmed and the SHVA's intent is also thwarted."[16] *Fourth*, and finally, the Commission recognized that a "predictive model that includes truly served households in an unserved category, even temporarily, creates . . . undesired effects."[17] These principles must continue to guide the Commission in the instant proceeding.

While SHVIA in 1999 added new sections to the existing SHVA, most notably the Section 122 local-into-local compulsory license for satellite carriers,[18] the Section 119 distant compulsory license provision was reenacted basically unchanged. The Conference Report accompanying passage of SHVIA noted that "the Section 119 regime is largely being extended in

---

[14] *Satellite Delivery of Network Signals to Unserved Households for Purposes of the Satellite Home Viewer Act*, Report and Order, 14 FCC Rcd 2654 (1999) ("*SHVA Order*"), at ¶ 11.

[15] *SHVA Order* at ¶ 8.

[16] *SHVA Order* at ¶ 65.

[17] *SHVA Order* at ¶ 77.

[18] *See* 17 U.S.C. § 122.

its current form."[19]

As the SHVIA Conference Report states:

> [T]he specific goal of the Section 119 license is to allow for a *life-line network television service* to those homes which cannot receive the local network television stations. Hence, the unserved household limitation that has been in the license since its inception.[20]

When Congress passed SHVIA, it specifically reiterated its intention to promote the concept of localism. As the Conference Report accompanying SHVIA further states:

> [T]he Conference Committee reasserts the importance of protecting and fostering the system of television networks as they relate to the concept of localism. It is well recognized that television broadcast stations provide valuable programming tailored to local needs, such as news, weather, special announcements and information related to local activities. *To that end the Committee has structured the copyright licensing regime for satellite to encourage and promote retransmissions by satellite of local television broadcast stations to subscribers who reside in local markets of those stations.*[21]

Congress continued to recognize that allowing satellite carriers to retransmit distant network programming into a local affiliate's market is a violation of a local station's exclusive copyright privileges. The SHVIA Conference Report observes that "allowing the importation of distant or out-of-market network stations in derogation of the local station's exclusive right—bought and paid for in market negotiated arrangements—to show the works in question, undermines those arrangements."[22] Congress, therefore, intended that the scope of this extraordinary privilege continue

---

[19] Conference Report on H.R. 1554, Intellectual Property and Communications Omnibus Reform Act of 1999, 145 CONG. REC. H11793 (daily ed. Nov. 9, 1999) (hereinafter "SHVIA Conference Report").

[20] SHVIA Conference Report, 145 CONG. REC. H11792-H11793 (emphasis added).

[21] SHVIA Conference Report, 145 CONG. REC. H11792 (emphasis added).

[22] SHVIA Conference Report, 145 CONG. REC. H11792.

to be extremely narrow. As the SHVIA Conference Report further recognized:

> [P]erhaps most importantly, the Conference Committee is aware that in creating compulsory licenses, it is acting in derogation of the exclusive property rights granted by the Copyright Act to copyright holders, and that it therefore *needs to act as narrowly as possible* to minimize the effects of the government's intrusion on the broader market in which the affected property rights and industries operate.[23]

Against this consistent historical backdrop, Congress in SHVERA, in another full explication of these same underlying principles, continued to express its recognition of the need to minimize the abrogation of the rights of local broadcast stations:

> The abrogation of copyright owners' exclusive rights and the elimination of transaction costs for satellite carriers are valuable accommodations that benefit the DBS industry. The terms and conditions of § 119, therefore, are crafted to represent a careful balance between the interests of satellite carriers who seek to deliver distant broadcast programming to subscribers in a manner that is similar to that offered by cable operators, and the need to provide copyright owners of the retransmitted broadcast programming fair compensation for the use of their works.
>
> [. . .]
>
> An element of the § 119 license since inception, the unserved household limitation has been a central tenet of congressional policy on distant signal carriage. Its primary purpose is to ensure that those residing in rural areas or in areas where terrain makes it impossible to receive an acceptable over-the-air signal from their television stations can receive a "life-line" network television service from a satellite provider.
>
> Where a satellite provider can retransmit a local station's exclusive network programming but chooses to substitute identical programming from a distant network affiliate of the same network instead, the satellite carrier undermines the value of the license negotiated by the local broadcast station as well as the continued viability of the network-local affiliate relationship. . . .
>
> The Committee has consistently considered market-negotiated exclusive arrangements that govern the public performance of broadcast programming in a given geographic area to be preferable to statutory mandates. Accordingly, a second purpose of the unserved

[23] SHVIA Conference Report, 145 CONG. REC. H11792 (emphasis added).

95949.1

> household limitation is to confine the abrogation of interests borne by copyright holders and local network broadcasters to only those circumstances that are absolutely necessary to provide the "life-line" service.[24]

But SHVERA is not merely a continuation of the Section 119 *status quo ante*. Rather, SHVERA, building upon the local-into-local Section 122 compulsory license enacted in SHVIA, begins to *phase out* the Section 119 distant compulsory license. Although the definition of "unserved household" has not been substantively changed, the class of viewers to whom satellite carriers may retransmit distant duplicating network signals has been considerably narrowed through the principle of "if local, no distant." Thus, Section 103 of SHVERA, codified in 17 U.S.C. § 119(a)(4), creates a new limitation on the applicability of the distant signal license, greatly restricting its applicability where local-into-local retransmissions are available. Section 204 of SHVERA, codified in 47 U.S.C. § 339(a)(2), creates a Communications Act analogue to the Copyright Act amendment. The new, fundamental limitation imposed by SHVERA is the *ineligibility* for distant network signals of satellite subscribers who are able to obtain access to the local network signals of local broadcast stations via local-into-local service offered pursuant to the Section 122 license. This principle applies as fully to digital signals as it does to analog signals.[25] The relationship between localism and the congressional policy preference for local-into-local service was expressed by Congressman Buyer as follows:

> The act imposes a variety of limits designed to protect free, local, over-the-air broadcasting. . . . Put another way, local-to-local service is the right way, and—except when there is no other choice—distant network stations are the wrong way, to deliver broadcast programming by satellite. Local-to-local fosters localism and helps

---

[24] H.R. REP. NO. 108-660, at 9-11 (2004).

[25] *See* 17 U.S.C. § 119(a)(4)(D); 47 U.S.C. § 339(a)(2)(D).

> keep free, over-the-air television available to everyone, while delivery of distant network stations to households that can receive their own local stations (whether over the air or via local-to-local service) has just the opposite effect.[26]

Currently, DIRECTV offers local-into-local analog service in 133 markets covering 92.53% of the nation's television households.[27] EchoStar offers local-into-local analog service in 157 markets covering 95.25% of television households.[28] Accordingly, the number of households that cannot receive local network stations *either* over the air *or* via local-into-local satellite service is truly minuscule. In addition, DIRECTV has announced its intention to provide local-into-local *digital* service by the end of 2005 in 30-40 of the largest markets in the country, providing local HD service to as many as 60% of television households just as the Commission's report to Congress is due[29]; local HD service to the rest of the country is expected by the end of 2007. When Congress enacted SHVERA with its substantially narrowed Section 119 compulsory license, it acted with

---

[26] 150 CONG. REC. H8221-H8222 (Oct. 6, 2004) (statement of Rep. Buyer).

[27] *See DIRECTV Local Channels available at* <http://www.directv.com/DTVAPP/see/LocalChannels_markets.dsp> (visited June 1, 2005).

[28] *See Dish Network Local Channels available at* <http://www.dishnetwork.com/content/programming/locals/index.asp> (visited June 1, 2005).

[29] *See* Mark Seavey, *DirecTV Expects to Have Local HD Available in 30-40 Markets*, COMMUNICATIONS DAILY (June 2, 2005) (citing DIRECTV CEO Chase Carey); *see also DIRECTV's Spaceway F1 Satellite Launches New Era in High-Definition Programming; Next Generation Satellite Will Initiate Historic Expansion of DIRECTV Programming* (Apr. 26, 2005) *available at* <http://phx.corporate-ir.net/phoenix.zhtml?c=127160&p=irol-newsArticle&ID=700828&highlight=> (visited June 1, 2005) (stating that the Spaceway F1 satellite will provide local HD service to 32.8% of television households) ; *DIRECTV Spaceway F2 Satellite will Expand Local Digital/HD Services for DIRECTV Customers; Satellite shipped to French Guiana* (May 25, 2005) *available at* <http://phx.corporate-ir.net/phoenix.zhtml?c=127160&p=irol-newsArticle&ID=713981&highlight=> (visited June 1, 2005) (stating that the Spaceway F2 satellite, and its twin, the Spaceway F1, "will provide the needed capacity to roll out local digital and HD in at least 24 markets this year, representing more than 45 percent of U.S. TV households"). According to Nielsen Media Research, the top 30 markets contain 53.4% of U.S. television households and the top 40 markets contain 60.8% of U.S. television households.

knowledge of this extensive local-into-local service.[30]

Against this background of a long history of minimizing the abrogation of the rights of copyright holders and of preserving and promoting localism, through both over-the-air and local-into-local satellite service, Congress enacted a very special and particularly limited regime for the satellite delivery of duplicating distant *digital* network signals. *First*, in any market where a satellite carrier offers local-into-local digital signals, any subscriber who did not purchase a distant digital signal of the relevant network prior to the commencement of local-into-local digital service would be ineligible for distant digital service. By the end of 2005, as many as 60% of television households subscribing to DIRECTV's service will be able to obtain local-into-local digital service and thus will be ineligible for distant digital service.

Second, in any market where satellite carriers do not offer either local-into-local digital service or local-into-local analog service, only subscribers living in an *analog* white area will be eligible for distant digital service (provided the relevant local affiliate has obtained a special testing waiver pursuant to 47 U.S.C. § 339(a)(2)(D)(viii)(VI) for just such a circumstance). As seen above, less than 5% of television households for EchoStar and less than 8% of television households for DIRECTV are even located in such markets, and the number of satellite subscribers who also live in an analog white area in those markets is virtually *de minimis*. In fact, the number of households who cannot receive local network stations by *any* means can only be counted in the thousands, not in the hundreds of thousands, and certainly not in the millions.

Third, in a market where a satellite carrier does not offer local-into-local digital service but

---

[30] *See* 150 CONG. REC. H8222 (Oct. 6, 2004) (statement of Rep. Buyer) (citing local-into-local service figures and acknowledging DIRECTV's announcement of its plans for local HD service).

does offer local-into-local analog service, if a satellite subscriber lives in an analog white area *and* purchases the local analog signal of the relevant network, then that subscriber is eligible for a distant digital signal. Although not ideal for the local network station since DTV coverage can exceed analog coverage, because the Commission intended that a station's digital facility only replicate its analog coverage area, Congress made the policy determination that such a subscriber unserved by the over-the-air analog signal would likely be unserved by the over-the-air digital signal. Moreover, Congress required that the subscriber "buy-through" the local-into-local analog service in order to obtain the distant digital service so that its local signal would still be received by the satellite subscriber.

Fourth, and the primary category of relevance to this proceeding, in a market where a satellite carrier does not offer local-into-local digital service but does offer local-into-local analog service (as in the third category, *supra*), if the satellite subscriber is *served* over the air by the local station's analog signal, then such a subscriber *may* be eligible for distant digital service provided a site test measurement, under certain further conditions as to market, date, and DTV build-out status and conducted pursuant to the current test methodology set forth in Section 73.686(d) of the Commission's rules, demonstrates that the household cannot receive a digital signal of signal intensity that exceeds the DTV signal intensity standards set forth in Section 73.622(e)(1) of the Commission's rules.

As enacted, the digital "unserved household" scheme is virtually self-executing. SHVERA specifies the circumstances under which a subscriber may be eligible for a distant digital signal; specifies conditions under which a household site test may occur, including the beginning dates on which testing can begin for certain markets; specifies the initial objective test methodology; and specifies the DTV signal intensity standard the site measurement must exceed. Notably absent from this digital "unserved household" scheme as enacted is a predictive model. That is, eligibility for distant digital service for subscribers falling into the fourth category delineated above can *only* be determined by a household site test. Given the "if local, no distant" principle, given the local-into-local analog service "buy-through" requirement, and given the reliance on an *analog* white area determination in many circumstances, Congress obviously intended that actual household site tests for digital signal intensity be few and far between in order to protect the investments of local stations in the DTV transition.

What is left, then, for the Commission in this proceeding, like the Section 119 license itself, is narrow, requiring a conservative approach to respect the limited nature of the compulsory license and to preserve the integrity of the localism principle. Although SHVERA lists six specific items that the Commission is to study in this proceeding, logically these items may be reclassified into three separate, but ultimately interrelated, concerns: (1) the appropriateness of the DTV planning factors which resulted in the digital signal intensity standards set forth in Section 73.622(e)(1); (2) the appropriateness of the objective analog signal site test methodology in Section 73.686(d) in the digital signal context; and (3) the advisability of developing a predictive model for future use. In addressing these issues, the starting point must always be a clear recognition that Congress has already made the policy determination to protect the exclusive arrangement the local network affiliate has made with its network partner and that distant service should only be available as a "life-line" for those subscribers for whom it is *impossible* to receive a local digital signal.

II. The DTV Planning Factors Established Appropriate Signal Strength Thresholds for Reception of Real-World Digital Broadcast Signals

In its DTV proceeding, the Commission decided to predicate the coverage area of the new DTV service upon each station's existing NTSC Grade B service area. The Commission's goals were two-fold: first, to provide DTV coverage comparable to a station's current coverage area and, second, to provide the best correspondence between the size and shape of the proposed DTV channel's coverage area and the station's existing coverage.[31] The Commission carefully crafted this approach to "foster the transition to DTV, while simultaneously preserving viewers' access to off-the-air TV service and the ability of stations to reach the audiences they now serve."[32] Maintaining viewer "access to the stations that they can now receive over-the-air" was a critical component of the DTV replication scheme.[33] Thus, the value of over-the-air service to both viewers and broadcasters was fundamental to the Commission's actions. Obviously, the Commission would not have predicated DTV—for which broadcasters have invested many millions of dollars—on planning factors intended to replicate existing television service if those factors were not, in fact, adequate or up to the task.

DTV service areas are defined in terms of the geographic area within which a station's noise-limited field strength is expected to exceed a pre-determined field strength level at 50% of the locations 90% of the time, i.e., F(50,90). That pre-determined field strength depends on the broadcast band and is derived from the DTV planning factors intended, as stated above, to replicate NTSC service areas. The DTV noise-limited field strength standards are 28 dBu for the low VHF band, 36 dBu for the high VHF band, and 41 dBu for the UHF band,[34] which have been rounded up to the nearest whole number. The relationship between the planning factors and the requisite noise-

---

[31] *See Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service*, Sixth Report and Order, 12 FCC Rcd 14588 (1997) ("*Sixth DTV Report and Order*"), ¶ 12.

[32] *Sixth DTV Report and Order* at ¶ 14.

[33] *Sixth DTV Report and Order* at ¶ 29.

[34] *See* 47 C.F.R. § 73.622(e)(1).

limited field strength is shown in Table 1.[35]

DTV Planning Factors *Table 1*

Parameter	Channels 2 to 6	Channels 7 to 13	Channels 14 to 69
Thermal Noise	(106.2)	(106.2)	(106.2)
Dipole Factor	111.8	120.8	130.8
System Noise Figure	10	10	7
Downlead Line Loss	1	2	4
Receiving Antenna Gain	(4)	(6)	(10)
Carrier-to-Noise Ratio	15.2	15.2	15.2
Median Field Intensity	27.8 dBu	35.8 dBu	40.8 dBu

As the *Notice* correctly states—and critical to the Commission's entire DTV plan to replicate NTSC Grade B service areas—"[*t*]*hese criteria presume that households will exert similar efforts to receive DTV broadcast stations as they have always been expected to exert to receive NTSC analog TV signals*."[36] As the discussion below of each of these planning factors demonstrates, the Commission's existing noise-limited field strength thresholds for DTV service are more than adequate for real-world reception of local digital broadcast signals.[37]

Thermal Noise. Thermal noise is a function of the laws of physics. It has not and will not change. The Commission's planning factor for thermal noise is appropriate as is.

---

[35] *See Sixth DTV Report and Order* at Appendix A & Appendix B; OET Bulletin No. 69, *Longley-Rice Methodology for Evaluating TV Coverage and Interference* (revised Feb. 6, 2004) ("OET 69"), at Table 3.

[36] *Notice* at ¶ 6 (emphasis added).

[37] *See generally* Engineering Statement of Jules Cohen, P.E. ("Cohen Engineering Statement"), at 1-5 (attached hereto as an Appendix).

Dipole Factor. The dipole factor is also a function of the laws of physics. However, the dipole factor is dependent upon frequency, and in the DTV planning factors the Commission utilized the geometric mean frequency of a UHF band extending from 470 MHz to 806 MHz (Channels 14 to 69). But the DTV transition is not just about migrating to digital broadcasting, it is also about reallocating Channels 52 to 69 (698 MHz to 806 MHz) to other services. Because the core DTV channels extend only to Channel 51—and the only channels for which digital site testing will ever occur are located in the core—the dipole factor should be recalculated on the basis of the geometric mean frequency of the UHF band extending from 470 MHz to 698 MHz (Channels 14 to 51). The geometric mean frequency of the core UHF band is 573 MHz, which results in a dipole factor of −130.2 dB.

Carrier-to-Noise Ratio. The carrier-to-noise ratio of 15.2 dB (15.19 dB) for DTV is derived from measurements of the Grand Alliance system conducted by the Technical Subgroup of the Advisory Committee on Advanced Television Service.[38] Thus, the carrier-to-noise ratio is empirically derived and represents the minimum ratio of signal strength to noise adequate for a digital receiver to decode the data and produce a digital picture.

Downlead Line Loss. The Commission has long recommended the use of RG-6 coaxial cable for television reception installations.[39] RG-6 coaxial cable is a shielded cable for which

---

[38] *See Sixth DTV Report and Order* at Appendix A; Advisory Committee on Advanced Television Service, *Final Technical Report* (Oct. 31, 1995), at Table 5.1.

[39] *See* Philip B. Gieseler *et al.*, *Comparability for UHF Television: Final Report* (Office of Plans and Policy Sept. 1980) ("*UHF Comparability Final Report*"), at 69 (stating that "RG-6 coax offers very good performance" and that "an RG-6 system is a good value because the coaxial systems offer even less performance variability than shielded twin-lead; and coax is much easier to manipulate than shielded twin-lead, and, therefore, presents fewer installation problems").

"wetness and metal proximity ma[k]e no change in the attenuation characteristics."[40] As the Commission recently reported to Congress following SHVIA: "[T]here is no serious question that RG-6 is clearly the preferred and recommended choice that consumers residing near the Grade B contours of TV stations would typically employ . . . ."[41]

RG-6 coax cable is commonly available. Based on current specifications for such readily available RG-6, attenuation for 50 feet is as follows[42]:

Low VHF	0.75 dB to 0.93 dB
High VHF	1.31 dB to 1.44 dB
UHF	2.20 dB to 2.76 dB

where the range provides the loss from the lowest to the highest channel in each band. Based on these current data, it is plain that transmission line loss occurring in 50 feet of recommended RG-6 coaxial cable is, for low VHF, less than 1 dB; for high VHF, less than 2 dB; and for UHF, less than 3 dB. Therefore, the Commission's DTV planning factor for downlead line loss is a little conservative.[43]

Receiving Antenna Gain. SHVERA requires the Commission to examine a number of

---

40 *UHF Comparability Final Report* at 60. *See also* Improvements to UHF Television Reception, *Report and Order*, 90 F.C.C.2d 1121 (1982), ¶ 50 (noting that RG-6 is a good quality cable).

41 *Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Improvement Act*, Report, 15 FCC Rcd 24321 (2000), at ¶ 28.

42 *See* Channel Master Coaxial Cable and Wire *available at* <http://www.channelmaster.com/Pages/TVS/Cable.htm> (providing cable attenuation values at various frequencies for Channel Master's RG-6 Coaxial Cable—Pro Install Series). The UHF band was considered only through Channel 51 (mid-frequency 695 MHz).

43 *Cf. Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Improvement Act*, Report, 15 FCC Rcd 24321 (2000), at ¶ 28 (stating that the "transmission loss planning factor values for Grade B provide a conservative margin for this type [RG-6] of coaxial cable").

considerations concerning antennas. In order to do so, it is necessary to determine whether the basis for the receiving antenna gain assumed in the DTV planning factors is reasonable. Television receiving antennas have, of course, been a component of a home television receiving installation for more than 50 years, and existing consumer antennas are capable of receiving both analog and digital television signals.

The Commission itself has recommended that consumers use "[s]eparate UHF and VHF outdoor antennas" because separate antennas will "provide better performance on UHF than can a combination UHF/VHF antenna, at little or no extra cost."[44] Therefore, in determining appropriate gain figures, what is relevant are the results of analyses of separate VHF and UHF antennas.

The Commission and its staff have recognized that the best UHF antenna, considering both performance and value, is an eight-bay bowtie-with-screen antenna.[45] An FCC-sponsored study in 1980 determined that the average gain for such an antenna is 13.4 dB.[46] In fact, the Electronics Technicians Association—the group that actually installs and works in the field with antennas on a day-to-day basis—stated in its Comments in CS Docket No. 98-201 that the eight-bay and four-bay bowtie-with-screen antennas "are *the* conventional UHF antennas for fringe rural areas."[47] Antennas

---

[44] *Improvements to UHF Television Reception*, Report and Order, 90 F.C.C.2d 1121 (1982), ¶ 50; *see also UHF Comparability Final Report* at xiii, 52, 83.

[45] *See Improvements to UHF Television Reception*, Report and Order, 90 F.C.C.2d 1121(1982), ¶¶ 47-51 & Appendix B; *UHF Comparability Final Report* at xiii, 50 n.8, 51, 83.

[46] *See Improvements to UHF Television Reception*, Report and Order, 90 F.C.C.2d 1121(1982), at Appendix B; *UHF Comparability Final Report* at 51; W.R. Free *et al.*, *Final Report, Program to Improve UHF Television Reception*, Project No. FCC-0315 (Georgia Inst. of Tech., Eng'g Experiment Station, Sept. 1980) ("*UHF Antenna Report*").

[47] Comments of the Electronics Technicians Association, International, Inc. (hereinafter "Electronics Technicians Association" and "Electronics Technicians Association Comments") in CS Docket No. 98-201, at 23 (emphasis added).

with higher average UHF gains are available, although they are slightly more expensive. For example, one parabolic UHF antenna possessed an average gain of 14.6 dB.[48] The UHF Comparability Task Force used an average UHF antenna gain of 14.3 dB in one part of its analysis.[49] Each of these gain figures is well in excess of the 10 dB gain assumed in the DTV planning factors for UHF.

Pursuant to the *Notice*'s request for information on currently available antennas,[50] the Network Affiliates have compiled data from several leading manufacturers of consumer television antennas which are attached hereto as Exhibit 1. As can be seen from these data, Channel Master offers an eight-bay bowtie-with-screen UHF antenna, Model No. 4228, with an average gain of 12.0 dB. Winegard offers a UHF antenna designed for deep fringe areas, the Model PR-9032, with a gain of 15.6 dB. Antennas Direct also offers a long-range UHF antenna, Model 91XG, with a gain of 16.7 dB.[51] In short, there is no question that the Commission's DTV planning factor for UHF antenna gain, 10 dB, is very conservative and can easily be achieved with readily available consumer UHF antennas.

The most recent study of VHF antennas of which the Network Affiliates are aware was conducted by the Institute for Telecommunications Sciences ("ITS"), an arm of the Department of Commerce, in 1979. That study indicates that the average gain in the low VHF band is 4.43 dB and

---

[48] *See Improvements to UHF Television Reception*, Report and Order, 90 F.C.C.2d 1121 (1982), at Appendix B (citing *UHF Antenna Report*).

[49] *See UHF Comparability Final Report* at 76 (Table 3-10) (citing *UHF Antenna Report*).

[50] *See Notice* at ¶ 11.

[51] *See* Exhibit 1. The Channel Master 4228 retails for $38.99 from Solid Signal (solidsignal.com). Winegard's PR-9032 retails for $34.99 from Solid Signal. Antenna Direct's Model 91XG sells for $79 (antennasdirect.com).

in the high VHF band is 8.34 dB.[52] These gains exceed the relevant DTV planning factor gains for the VHF bands.

Currently, Antennacraft manufactures a VHF antenna, Model CS1100, with an average gain in the low VHF band of 6.9 dB and an average gain in the high VHF band of 9.6 dB. Channel Master offers a VHF antenna, Model No. 3610, with an average gain in the low VHF band of 5.8 dB and an average gain in the high VHF band of 11.4 dB. Winegard offers a VHF antenna, Model HD4053P, with a gain between 5.9 dB and 6.6 dB in the low VHF band and a gain between 9.6 dB and 11.1 dB in the high VHF band.[53] Again, there is no question that the Commission's DTV planning factors for low VHF gain, 4 dB, and for high VHF gain, 6 dB, are also very conservative and can easily be achieved with readily available consumer VHF antennas.

Although combination VHF/UHF antennas do not generally perform as well as separate VHF and UHF antennas, there are consumer models available that still handily exceed the assumed gains in the DTV planning factors. For example, Winegard's Model HD7084P has gains of from 6.2 dB to 7.6 dB in the low VHF band, from 10.8 to 12.0 in the high VHF band, and from 11.8 dB to 14.6 dB in the UHF band. Antennacraft's Model HD1850 has an average gain of 6.2 dB in the low VHF band, 10.7 dB in the high VHF band, and 10.0 in the UHF band.[54] Even Channel Master's

---

[52] *See* R.G. FitzGerrell *et al.*, *Television Receiving Antenna System Component Measurements*, Report No. 79-22 (NTIA June 1979) (cited in Philip B. Gieseler *et al.*, *Comparability for UHF Television: A Preliminary Analysis* (Office of Plans and Policy Sept. 1979), at 45 (Table 3-1)).

[53] *See* Exhibit 1. The Antennacraft CS1100 has a list price of $96.08 (antennacraft-tpd.com). Winegard's HD4053P retails for $119.99 from Solid Signal (solidsignal.com). Pricing information on Channel Master's 3610 is not available.

[54] *See* Exhibit 1. The Winegard HD7084P retails for $127.99 from Solid Signal (solidsignal.com). Antennacraft's HD1850 has a list price of $174.97 (antennacraft-tpd.com).

eight-bay bowtie-with-screen UHF antenna, Model No. 4228, has been measured by an independent engineer, Kerry Cozad of Dielectric Communications, to possess an average gain of approximately 3.0 dB in the low VHF band, approximately 9.0 dB in the high VHF band, and approximately 15.0 dB in the UHF band (which exceeds the manufacturer's own specifications).[55]

Such high-gain antennas are not appropriate for all receiving locations. Where signal strength is already adequate, or nearly adequate, such a high-gain antenna could overload the receiver. For circumstances such as these, antenna manufacturers produce smaller antennas with less gain. But even if the gain of such an antenna is less than the gain assumed in the planning factors, that does not mean the planning factors are defective. At such locations, the ambient signal strength will already exceed the thresholds established by the planning factors. The Consumer Electronics Association ("CEA"), in conjunction with Decisionmark, has created a website, AntennaWeb.org, that is designed to assist consumers in selecting an appropriate outdoor receiving antenna. It is evident from the website that CEA does not recommend a large high-gain antenna for all locations and all circumstances. In fact, CEA has introduced an antenna labeling program with six different categories, ranging from small, medium, and large antennas that are either directional or multi-directional, and the AntennaWeb.org website recommends an antenna from one or more of these categories depending on the consumer's location in relation to the location, distance, and predicted signal strength of various desired television station signals.

Although it is not an element affecting the digital signal intensity standards, the Commission did assume that the receiving antenna would have a directional gain pattern in order to discriminate

---

[55] *See* Kerry W. Cozad, *Measured Performance Parameters for Receive Antennas Used in DTV Reception* (text available from the author at kerry.cozad@dielectric.spx.com).
Once again, the Channel Master 4228 retails for only $38.99 from Solid Signal (solidsignal.com).

against off-axis undesired stations and, therefore, ameliorate interference. In fact, the ATSC recommends the use of a directional gain antenna to enhance *receiver* performance with respect to multipath: "[A]n antenna with a directional pattern that gives only a few dB reduction in a specific multipath reflection can dramatically improve the equalizer's performance. Such modest directional performance can be achieved with antennas of consumer-friendly size, especially at UHF."[56] Accordingly, an element of the DTV planning factors is the front-to-back ratio of the receiving antenna, which the Commission assumed to be 10 dB for low VHF, 12 dB for high VHF, and 14 dB for UHF. (Incidentally, these front-to-back ratios greatly exceed those assumed for analog television reception, which was 6 dB across all bands.)[57]

It is common for readily available consumer antennas to meet or exceed these assumed front-to-back ratios. Thus, of the antennas mentioned in the text above for which data are available, the front-to-back ratio of Channel Master's eight-bay bowtie-with-screen UHF antenna, Model No. 4228, exceeds 19 dB at all UHF frequencies and is 24 dB at Channel 43. These front-to-back ratios far exceed the 14 dB assumed in the DTV planning factors. Similarly, the front-to-back ratio of Winegard's UHF Model PR-9032 is 14 dB at Channel 14 and 20 dB at both Channel 32 and Channel 50, which meets or substantially exceeds the assumed front-to-back ratio for the UHF band.[58]

Consumer VHF antennas appear to easily exceed the assumed front-to-back ratios for the low VHF and high VHF bands. Thus, Antennacraft's previously mentioned VHF antenna, Model

---

[56] *ATSC Recommended Practice: Receiver Performance Guidelines*, Doc. A/74 (June 18, 2004), at 24.

[57] *See* OET 69 at Table 6.

[58] *See* Exhibit 1.

CS1100, has a front-to-back ratio of 19.4 dB in the low VHF band and 17.6 dB in the high VHF band. The front-to-back ratio of Winegard's VHF Model HD4053P is 17 dB or greater across both the low VHF and high VHF bands.[59]

It appears that VHF/UHF combination antennas also greatly exceed the Commission's assumed front-to-back ratios for the low VHF and high VHF bands and just meet the assumed front-to-back ratio for the UHF band. For instance, the front-to-back ratio of Winegard's VHF/UHF combination antenna, Model HD7084P, is 20 dB or greater in the low VHF band, 15 dB or greater in the high VHF band, and is 11 dB at Channel 14 and 20 dB at both Channel 32 and Channel 50. The front-to-back ratio of Antennacraft's VHF/UHF combination antenna, Model HD1850, is 20.2 dB in the low VHF band, 17.3 dB in the high VHF band, and 13.7 dB in the UHF band.[60]

In addition to the specific numerical values of antenna gain and front-to-back ratio, the DTV planning factors, more generally, are, as stated in OET 69, "assumed to characterize the equipment, including antenna systems, used for home reception."[61] As the instant *Notice* aptly summarizes it: "These criteria presume that households will exert similar efforts to receive DTV broadcast stations as they have always been expected to exert to receive NTSC analog TV signals."[62] In the past, the Commission has always assumed that homeowners would employ an outdoor, directional gain antenna for over-the-air reception of television signals. Because of the directional nature of the receiving antenna, a typical installation also utilizes a rotor so that the antenna may be properly oriented. In addition, in fringe areas where signal strength is known to be weak, the typical home

---

[59] *See* Exhibit 1.

[60] *See* Exhibit 1.

[61] OET 69 at 3.

[62] *Notice* at ¶ 6.

installation uses a low-noise amplifier ("LNA"), also known as a pre-amplifier.

As the Commission has previously explained in the analog context but whose basic principles apply equally in the digital context:

> A radio frequency (RF) preamplifier is a device that is utilized in a receiving antenna system to increase the RF power of the desired signal delivered to the receiver. In a television receiving system, a preamplifier can improve overall system performance by both compensating for the decrease in signal strength (attenuation) caused by the transmission line and components, and by lowering the amount of noise, or snow, the receiving antenna system contributes to the displayed image. The degree to which the preamplifier affects the transmission line attenuation and system noise depends on its own gain and the amount of noise internally generated by the preamplifier (which to a certain extent are a function of its cost) and where in the receiving antenna system the preamplifier is installed. If the preamplifier is located at the antenna, the overall amount of noise in the picture will be established by the noise characteristic of the preamplifier, because its gain can then compensate for most, if not all, of the signal attenuation due to the transmission line and components. . . . When mounted at the terminals of an outdoor antenna, a preamplifier can provide its maximum degree of picture quality improvement.[63]

The UHF Comparability Task Force itself noted that "[p]reamplifiers have historically been utilized in 'fringe' reception areas."[64] The Electronics Technicians Association—again, the group that installs antennas—stated in its comments in CS Docket No. 98-201 that, in its home county in rural Indiana, "*virtually all* rooftop antenna systems include a pre-amplifier."[65] And the ATSC has also recommended LNAs for digital reception: "Many reception problems can be mitigated by use

[63] *UHF Comparability Final Report* at 73-74.

[64] *Id.* at 78.

[65] Electronics Technicians Association Comments, CS Docket No. 98-201, at 6 (emphasis added).

of a mast-mounted low-noise amplifier (LNA). Currently, several manufacturers sell LNAs."[66]

The gain achievable with an LNA is more than sufficient to ensure the adequacy of the digital signal intensity standards in fringe areas.[67] For example, the pre-amplifier the UHF Comparability Task Force used in one study, which was chosen because of its good performance characteristics and relatively low price, possessed a gain of 16 dB and an internal noise figure of 3.7 dB, for an aggregate advantage of 12.3 dB.[68] The Electronics Technicians Association stated in CS Docket No. 98-201 that typical gains with current pre-amplifiers are 17 dB to 24 dB.[69]

Current offerings of LNAs from several manufacturers are compiled in Exhibit 2. For instance, Winegard currently offers 16 different LNAs with gains ranging from 17 dB to 29 dB. One of their LNAs, Model AP-8275, provides an average gain of 29 dB for VHF and 28 dB for UHF with an internal noise figure of only 2.9 dB and 2.8 dB in those respective bands.[70] Channel Master offers an LNA, Model 7777, with an average gain of 23 dB for VHF and 26 dB for UHF with an internal noise figure of 2.8 dB for VHF and only 2.0 dB for UHF.[71] Antennacraft offers an LNA with adjustable gain to prevent receiver overload. This model, Model 10G212, provides an average gain

---

[66] *ATSC Technology Group Report: DTV Signal Reception and Processing Considerations*, Doc. T3-600r4 (Sept. 18, 2003), at 37.

[67] *Cf. Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Improvement Act*, Report, 15 FCC Rcd 24321 (2000), at ¶ 32 (stating that, "where needed, the combination of a smaller low gain antenna and an inexpensive low noise amplifier at the antenna terminals can easily provide an effective gain equal to the planning factor values").

[68] *See UHF Comparability Final Report* at 75 n.18, 76 (Table 3-10 n.3).

[69] *See* Electronics Technicians Association Comments, CS Docket No. 98-201, at 14-15.

[70] *See* Exhibit 2. Winegard's AP-8275 LNA retails for $77.99 from Solid Signal (solidsignal.com).

[71] The Channel Master 7777 LNA retails for $56.99 from Solid Signal (solidsignal.com).

of 30 dB for both VHF and UHF with a noise figure of less than 4.0 dB for VHF and less than 3.5 dB for UHF. This model's list price is only $33.63 (antennacraft-tpd.com).[72]

Specialty LNAs are also available from manufacturers such as Blonder Tongue and Advanced Receiver Research. Advanced Receiver Research manufactures single channel LNAs with exceptionally low noise figures. For example, single channel low VHF LNAs are available with a gain of 24 dB and a noise figure of only 0.5 dB. Advanced Receiver Research also manufactures a broadband UHF LNA with narrow tune capability with a gain of 15 dB and a noise figure of 0.6 dB.[73] Blonder Tongue not only makes single channel LNAs, but it makes broadband LNAs with exceptionally high gain figures. For instance, Blonder Tongue's Vaulter III Plus model provides a gain of 31 dB in the VHF band and a gain of 38 dB in the UHF band with a noise figure of 4.5 dB across all bands.[74]

In addition to LNAs, the Commission has always expected and recognized that

> persons living in areas located in the outer reaches of the service areas of broadcast stations (for example, at the edge of a predicted Grade B contour) can, and generally do, take relatively simple measures such as installation of an improved roof-top antenna and careful location and orientation of that antenna to enhance their off-the-air reception.[75]

In fact, the Commission expressly advised that "[a]ntennas should be installed by 'probing' for the best receiving location; signal strength can vary significantly over a very short distance; thus, the

---

[72] *See* Exhibit 2.

[73] *See* Exhibit 2. Prices for these specialty LNAs from Advanced Receiver Research are not available online, but comparable models for other applications appear to list for approximately $80 and up (advancedreceiver.com).

[74] *See* Exhibit 2. The Blonder Tongue Vaulter III Plus LNA retails for $99.99 from Solid Signal (solidsignal.com).

[75] *Cable Communications Policy Act Rules*, Second Report and Order, FCC 88-128, 64 Rad. Reg. 2d (P & F) 1276 (1988), ¶ 18.

antenna should be installed at the location that provides good picture quality for the channels desired."[76]

As the Electronics Technicians Association showed in CS Docket No. 98-201, the majority of home antenna systems in Putnam County, Indiana, a location representative of the outer reaches of the service areas of broadcast stations, contain a rotor (in addition to an LNA)—and this is true, as the Electronics Technicians Association further remarked, even though homeowners in Putnam County can receive network programming from each of the four major networks from affiliates all located in Indianapolis.[77]

In fact, as the Electronics Technicians Association correctly pointed out:

> Rotors are as important in many areas as steering wheels are in automobiles. Because a household needs to reverse the antenna to get a signal 180 degrees from another should not be an excuse to pay $600 over ten years to receive the signal via satellite instead of installing the proper antenna system.[78]
>
> Rotors are economical ($60-$75) and they do not require constant rotation. . . . To circumvent the intent of the SHVA because the homeowner prefers to not invest in a rotor where needed[] is not right.[79]

Channel Master, Antennacraft, and Radio Shack each sell rotors for home antenna installations. Some of these rotors are available with a remote control so the viewer can properly orient the antenna from the couch. A sample of such rotors is compiled in Exhibit 3. Prices for rotors range from $68.99 for the Channel Master with remote control (available from Solid Signal

---

[76] Improvements to UHF Television Reception, *Report and Order*, 90 F.C.C.2d 1121 (1982), ¶ 50.

[77] Electronics Technicians Association Comments, CS Docket No. 98-201, at 6.

[78] *Id.* at 21

[79] *Id.* at 24.

(solidsignal.com)) to a list price of $94.88 for the Antennacraft (antennacraft-tpd.com), with the Radio Shack rotor priced in the middle (radioshack.com).

System Noise Figure. It is difficult to obtain data from receiver manufacturers on the specifications, including noise figure, of DTV receivers, and, thus, it is difficult to verify that the assumed noise figures in the DTV planning factors are accurate. However, it has long been recognized that the *system* noise figure is essentially determined by the noise figure of an LNA if the system incorporates such an amplifier, which, as shown above, is standard for fringe reception areas.[80] In fact, not long after the original Grade B planning factors were established for analog broadcasting, it was recognized that the system noise figure could be reduced by as much as 6 dB if an LNA were incorporated into the reception system.[81]

When an LNA is combined with a DTV receiver in a system, the noise figure (NF) of the system is given by the following[82]:

$$NF_{system} = 10 \log_{10} [NF_{LNA} + (NF_{receiver} - 1)/Gain_{LNA}]$$

Thus, when the noise figures of readily available consumer LNAs are considered, it is plain that system noise figures on the order of 3 to 4 dB, far below the assumed system noise figures of 10 dB,

---

[80] *See UHF Comparability Final Report* at 73 ("If the preamplifier is located at the antenna, the overall amount of noise in the picture will be established by the noise characteristic of the preamplifier . . . .").

[81] *See* Robert A. O'Connor, *Understanding Television's Grade A and Grade B Service Contours*, BC-14 IEEE TRANS. ON BROADCASTING 137, 142 (Dec. 1968) ("[M]ost receivers now have noise figures considerably better than indicated. This is particularly true in the outlying areas where the use of low-noise, moderate-gain antenna-mounted preamplifiers can reduce these figures by as much as 6 dB.").

[82] *See Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Improvement Act*, Report, 15 FCC Rcd 24321 (2000), at ¶ 32 n.115.

10 dB, and 7 dB for the low VHF, high VHF, and UHF bands, respectively, are easily achievable in conventional home reception installations. There is, accordingly, no question that the Commission's DTV planning factor for system noise figure can be considered conservative when viewed in the context of a complete reception system.

Miscellaneous Considerations. Several other considerations are relevant to the adequacy of the Commission's DTV planning factors for real-world reception of DTV signals. Perhaps most importantly, in the early stages of the DTV transition, multipath was known to be more difficult for digital reception than it is for analog reception. In fact, the International Telecommunications Union specifically incorporated an additional cushion into the carrier-to-noise ratio it assumed for its ATSC DTV planning criteria to account for typical multipath reception impairment, making the cushioned C/N ratio 19.5 dB.[83] Fifth generation DTV receivers, which are now commercially available in integrated sets from manufacturers such as LG and Zenith, have made substantial improvements in equalizer architecture and can now handle 50 microsecond pre-ghosts and 50 microsecond post-ghosts.[84] As one recent report summarizes the current state-of-the-art:

> Because of the "all or nothing" nature of digital reception, digital TV must provide excellent reception even where analog reception is poor, in order to facilitate the transition for the large number of receivers that use over-the-air reception. *This is beyond the requirements originally proposed at the inception of digital television, but it is*

---

[83] *See, e.g.*, International Telecommunications Union, *Draft Revision of Recommendation ITU-R BT.1368-4*, Document 6/BL/32-E (Mar. 22, 2005), at Table 13 and note 1 to table.

[84] *See* Tim Laud *et al.*, *Performance of 5th Generation 8-VSB Receivers*, 50 IEEE TRANS. ON CONSUMER ELECS. 1076 (Nov. 2004); Communications Research Centre Canada, *Results of the Laboratory Evaluation of Zenith 5th Generation VSB Television Receiver for Terrestrial Broadcasting* (Sept. 2003).

being met by 5th generation designs.[85]

Because multipath is not a function of signal strength *per se* and because current fifth generation receivers can handle multipath even in generally poor reception conditions, the Commission's DTV planning factors do not need to be adjusted to account for multipath the way in which the ITU recommended.

In addition, because so few earlier generation DTV receivers are owned by consumers—estimated at no more than 1% penetration[86]—it is clear that virtually all household sets

---

[85] *Performance of 5th Generation 8-VSB Receivers* at 1080 (emphasis added).

[86] It is difficult to obtain complete DTV receiver penetration information. In January 2004, in the *Tenth Annual Video Competition Report*, the Commission observed (i) that "[w]hile over 1000 stations are providing a DTV signal, many consumers within those service areas are unable to view the DTV format either because they do not have DTV receivers or because they are subscribers to a MVPD that does not carry the DTV signal," and (ii) that "[f]rom their introduction in August 1998 through the second quarter of 2003, over six million HDTV-capable sets have been sold, but only 700,000 of these [i.e., 11.67%] have been purchased with a built-in tuner or add-on decoder box required for receiving an HDTV broadcast." *Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming*, Tenth Annual Report, FCC 04-5 (released Jan. 28, 2004), ¶ 96 n.433 & ¶ 103. Updating that data through December 2003, as reported by the Consumer Electronics Association, indicates that approximately 8.88 million DTV units were sold from 1998 through December 2003. *See Holiday Sales Boost DTV Numbers for October and November* (Dec. 18, 2003), *available at* http://www.ce.org/press_room/press_release_detail.asp?id=10375 (stating that the "total number of DTV products sold since introduction in the fourth quarter of 1998 is now 8.24 million units"); *2003 a Banner Year for DTV; Unit Sales Top Four Million* (Jan. 12, 2004), *available at* http://www.ce.org/press_room/press_release_detail.asp?id=10396 (stating that "December 2003 sales totaled 640,443"). That number, of course, represents DTV-*capable* units and necessarily includes sales of units to restaurants, sports bars, and other public venues vis-à-vis private households; the number of DTV *receivers* in actual homes, as the Commission has observed, is far less. Considering that there were more than 108 million television households in the 2003-2004 television season, according to Nielsen Media Research, it is clear that DTV receiver penetration did not reach even 1% by the end of 2003 ((($700,000 \div 6,000,000) \times 8,880,443) \div 108,410,160 = 0.96\%$). Network Affiliates recognize that this calculation does not include sales figures for 2004, but CEA appears not to have separately reported those figures for DTV receivers, and the Commission's *Eleventh Annual Video Competition Report* makes no mention of them either. *Cf. Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming*, Eleventh Annual Report, FCC 05-13 (released Feb. 4, 2005), ¶ 87 (similar figures (continued...)

do or will contain late generation receiver chips, especially given the effective dates of the Commission's tuner mandates. Indeed, given SHVERA's time table to implement the digital signal site testing regime, it is likely that sixth generation receivers with additional improvements will be commercially available by then. This obviates the need for the Commission to consider whether to artificially boost the digital signal strength thresholds to account for multipath.

It is also worth comparing several of the other assumptions made by the ITU in its ATSC digital planning criteria with those assumed by the Commission. For example, the ITU assumed an antenna gain of 8.2 dB for low VHF, 10.2 dB for high VHF, and 12.2 for UHF.[87] Each of these exceed the antenna gains assumed by the Commission in the DTV planning factors, but, as the Network Affiliates' survey of commercially available antennas demonstrates, each of the ITU's antenna gain assumptions are readily achievable by real-world antennas available for purchase today. In addition, the ITU assumed transmission line loss of 1.1 dB for low VHF, 1.9 dB for high VHF, and 3.3 dB for UHF.[88] The VHF line loss values are virtually identical to those assumed by the Commission, while the UHF line loss value is less. As the specifications for RG-6 coax cable indicate, even the ITU's assumptions remain slightly conservative. Finally, for receiver noise figure, the ITU assumed 5 dB for both low VHF and high VHF and 10 dB for UHF.[89] These assumed noise

[86](...continued)
as in *Tenth Annual Video Competition Report* not provided). DTV receiver penetration did undoubtedly increase in 2004, but the imbedded base of DTV receivers is still low, and, more importantly, any DTV receivers sold in 2004 would have contained later generation chips (fourth or fifth generation), which only underscores the point that there are very few early generation DTV receivers in consumers' hands.

[87] *See Draft Revision of Recommendation ITU-R BT.1368-4* at Table 13.

[88] *See Draft Revision of Recommendation ITU-R BT.1368-4* at Table 13.

[89] *See Draft Revision of Recommendation ITU-R BT.1368-4* at Table 13.

figures for VHF are substantially less than—indeed, they are half—what the Commission assumed, while the ITU's UHF noise figure is higher. In any event, each of these noise figures is higher than the system noise figure would be if it incorporated an LNA. The ITU makes additional assumptions that the Commission did not (including incorporating an LNA and an antenna balun, among others), but the end result is signal strength levels generally in line with the Commission's own, 35 dBu for low VHF, 33 dBu for high VHF, and 39 dBu for UHF. What the ITU's independent results do is corroborate that the Commission's 1997 DTV planning factors led to signal strength thresholds that are realistic for real-world reception conditions for a typical receiving installation located near the edge of coverage and for a viewer taking reasonable steps, including an outdoor antenna oriented or orientable to the desired signal and an appropriate receiver, to receive DTV service.

* * *

Based on the above survey of considerations affecting the Commission's DTV planning factors, it is possible to adjust the DTV planning factors to account for what is possible under current real-world *reception* conditions—not NTSC replication conditions. Such adjustments would recognize the minor alteration in the dipole factor for UHF, a slight reduction in downlead line loss for UHF, slightly better receiving antenna gains from readily available outdoor antennas, lesser noise figures in all bands through use of an LNA (without even accounting for the additional gain to the receiving installation from the amplification provided by the LNA), and the ability of fifth generation DTV receivers to perform well when confronted with substantial pre- and post-ghosts. The results of these minor adjustments are shown in Table 2.

***Adjusted* DTV Planning Factors** *Table 2*

Parameter	Channels 2 to 6	Channels 7 to 13	Channels 14 to 69
Thermal Noise	(106.2)	(106.2)	(106.2)
Dipole Factor	111.8	120.8	130.2
System Noise Figure	4	4	4
Downlead Line Loss	1	2	3
Receiving Antenna Gain	(6)	(10)	(12)
Carrier-to-Noise Ratio	15.2	15.2	15.2
Median Field Intensity	19.8 dBu	25.8 dBu	34.2 dBu

Network Affiliates do not recommend that the Commission actually propose to Congress these adjusted planning factors as the basis for digital signal strength thresholds for site testing purposes. Rather, what these adjusted planning factors show is that the current planning factors, in a proper receive installation, have plenty of "headroom"—a "safety margin," as the Commission has termed it[90]—to ensure that quality DTV reception is achievable precisely where the Commission expected it to be—in the replicated NTSC coverage area where 50% of the viewers would be able to receive acceptable service 90% of the time. In fact, that "headroom" or "safety margin" ensures that substantially more than 50% of the viewers are able to receive acceptable service 90% of the time or, equivalently, that 50% of the viewers are able to receive acceptable service substantially in excess of 90% of the time.[91] This level of coverage is more than the Commission ever anticipated in adopting the DTV planning factors, and it clearly demonstrates that the Commission need not

[90] *Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Improvement Act*, Report, 15 FCC Rcd 24321 (2000), at ¶ 68.

[91] In addition, the "headroom" may be thought of as providing a margin of safety for any "slippage" in the receive system, such as, for example, a minor loss of signal strength due to an impedance mismatch.

recommend artificially boosting the planning factors for SHVERA purposes, which would be contrary to the limited purpose of SHVERA's ever narrower distant signal license.

The discussion of the adequacy of the DTV planning factors, the specifications and characteristics of currently available consumer equipment, and the Commission's intentions and expectations in promulgating the DTV planning factors, together with Congress's long history of minimizing the abrogation of the rights of copyright holders and of preserving and promoting localism and the network-affiliate distribution system and with the nature of the particularly limited—and now even narrower—regime for the satellite delivery of duplicating distant digital network signals, all appropriately drive consideration of the inquiries required by SHVERA and set forth in the *Notice*. All of these considerations point ineluctably to the following conclusions:

First, the receiving antenna must be mounted outside on the roof or adjacent to the house. Moreover, the antenna must be oriented to the desired signal, and if the desired stations are not located in the same direction, then the antenna must be orientable in the direction of the desired signal(s).[92] In addition to all of the above considerations which point to this natural conclusion, it is worth observing that satellite receive antennas are mounted outside and are oriented to the satellite. It would be inappropriate to essentially penalize a local television station for a consumer who was only willing to install an indoor antenna or an antenna that was not capable of being oriented to the desired signal, especially when the consumer is willing to take additional, necessary steps to obtain adequate satellite reception. Consequently, there is no need for the Commission to consider modifying the inherent assumptions regarding DTV antenna receiving systems in the DTV

---

[92] *See Notice* at ¶ 9.

planning factors.[93] An excellent antenna receiving system can be installed at relatively low cost. For example, the Channel Master Model 4228 eight-way bowtie-with-screen antenna, which even has adequate gain at VHF frequencies, costs only $39, and it can be paired with the Channel Master rotor with remote control for $69, for a complete system price of only $108. If additional gain were necessary or there were a desire or need to lower the system noise figure, the Antennacraft Model 10G212 LNA with adjustable gain can be added to the receive installation for an additional $33.63.

Second, the Commission should continue to recommend that the current signal strength thresholds for noise-limited digital service should be used to define the availability of a DTV signal for determining whether a household is eligible to receive distant digital signals from satellite services.[94] As stated above, real-world equipment, including fifth generation receivers, demonstrates that the Commission's current signal strength thresholds are more than adequate to receive a high-quality digital picture. There is no basis to artificially boost the current signal strength thresholds. And there is certainly no basis to retreat from a signal strength standard altogether when that can only jeopardize localism and the network-affiliate distribution system while running counter to the extremely narrow compulsory license that remains in SHVERA for satellite delivery of duplicating distant network signals.

Third, variation in DTV set prices should play no role in determining whether a household is unserved by an adequate DTV network signal.[95] The evidence shows that there is very little penetration (no more than 1%) of early generation DTV receivers in television households. Most

---

[93] *See Notice* at ¶ 11.

[94] *See Notice* at ¶ 14.

[95] *See Notice* at ¶ 16.

households have or will acquire DTV sets with integrated tuners incorporating the latest generational chip design (fifth generation or later), including equalizers demonstrating superior multipath handling performance capabilities. With digital tuners manufactured in mass quantities to satisfy the Commission's tuner mandate, the cost of an integrated DTV set is not particularly dependent on the cost of the generation of chip design (say, fourth generation versus fifth generation). Instead, DTV set prices are largely dependent on features, such as ATSC format capabilities (enhanced definition versus high definition, particularly in smaller-sized models), screen size, screen technology (CRT, plasma, LCD, DLP), screen resolution, contrast ratio, and integration of other functions, such as digital video recorders ("DVRs"). For example, a survey of the Sharp Aquos and LG websites revealed no difference in the type of ATSC tuner included in integrated DTV sets within each manufacturer's product lines. It would make a mockery of the principle of localism, and of the objective standards Congress has always imposed on the "unserved household" definition, to permit a satellite carrier to deliver a duplicating distant network signal to a household merely because the household had purchased, probably unknowingly, an inferior quality DTV set. The current analog "unserved household" definition is not dependent on whether a household buys a $59 13-inch television set or a $400 27-inch television set. There is no reasonable, defensible basis to make such a distinction in the digital context. Moreover, there is no workable basis to incorporate a receiver quality factor into a site testing regime, given the many dozens, if not hundreds, of consumer DTV sets available for purchase in the market. Finally, as the *Notice* appears to recognize,[96] any limitations in fifth generation receiver design are likely to be highly mitigated by using higher performance antennas with high front-to-back ratios and auxiliary devices such as rotors and LNAs.

---

[96] *See Notice* at ¶ 17.

Fourth, multipath should not be taken into account in determining whether a household is served by an adequate digital signal.[97] As shown above, fifth generation receivers incorporate equalizers that are remarkably good at handling very early pre-ghosts and very late post-ghosts (on the order of 50 microseconds each). But, more fundamentally, multipath is not a matter of signal strength, which is the objective means by which a digital "unserved household" should be determined. The effects of multipath, however, can be greatly, if not wholly, mitigated by the use of the latest generation receiver; by the use of an outdoor antenna raised to 30 feet which will place the antenna far above the principal multipath reflectors, including moving vehicles such as cars, trucks, and buses, as well as neighboring houses; and by the use of highly directional antennas with high front-to-back ratios, properly oriented to the strongest desired signal. As the ATSC has observed: "[A]n antenna with a directional pattern that gives only a few dB reduction in a specific multipath reflection can *dramatically* improve the equalizer's performance. Such modest directional performance can be achieved with antennas of consumer-friendly size, especially at UHF."[98] In addition, the Commission refused to include multipath within the distant analog signal eligibility standard,[99] and there is no principled basis to include multipath in the distant digital signal eligibility standard since there still remains no objective means to predict or evaluate multipath at any particular location or to evaluate the impact of multipath on local television service generally.

In sum, the only way to respect the Commission's own history of implementing the DTV

---

[97] *See Notice* at ¶ 20.

[98] *ATSC Recommended Practice: Receiver Performance Guidelines*, Doc. A/74 (June 18, 2004), at 24 (emphasis added).

[99] *See Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Improvement Act*, Report, 15 FCC Rcd 24321 (2000), at ¶ 59.

service, to respect the narrow and limited purpose of the distant signal compulsory license, and to respect the bedrock principle of localism in television service is for the Commission to recommend to Congress that its existing signal strength thresholds remain the objective standards by which the eligibility of a household for duplicating distant digital signal service should be determined.

III. The Commission's Objective Test Methodology for Analog Signals Is Generally Sound but Must Be Modified Slightly to Test Objectively the Signal Strength of Digital Broadcast Signals

Section 73.686(d) of the Commission's rules sets forth the testing procedure for cluster measurements of signal strength at household locations. This methodology was developed specifically for analog signals, but it is generally workable for digital signals once several slight modifications are made to measure the signal strength of digital signals.[100]

First, a directional gain antenna should be utilized instead of a half-wave dipole. Since the objective of the site test is to determine whether adequate signal strength exists to deliver high-quality DTV reception, use of a directional gain antenna that can be oriented to the strongest desired signal and that can ameliorate any difficulties that could be caused by multipath at the site would represent a better engineering practice than use of a half-wave dipole in these circumstances.

Second, there is no visual carrier for digital signals, so the requirement in Section 73.686(d)(2)(i) to measure the visual carrier makes no sense in the digital context. The *Notice*'s suggestion to substitute the pilot signal for the visual carrier is not feasible.[101] The Commission defines digital signals by their integrated average power over the 6 MHz bandwidth. It is this integrated average power that should be measured to determine the field strength. Because

---

[100] *See* Cohen Engineering Statement at 6-7.

[101] *See Notice* at ¶ 13.

the 6 MHz bandwidth of the digital channel will contain many sharp peaks and valleys and because the pilot signal, which is already down 3 dB, could fall within a valley, there is little likelihood that measurement of the pilot signal will tell one anything useful about the actual signal strength of the digital signal. Again, the field strength of a digital signal should be determined by measuring the integrated average power over the 6 MHz bandwidth.

Third, a typical analog field strength meter cannot be used to measure digital signal strength since its bandwidth is too narrow. Instead, the tester should use a spectrum analyzer tuned to the center of the channel, sweep across a variety of small intermediate frequency bandwidths, and integrate the total power across the 6 MHz bandwidth.

With these slight modifications, the testing methodology in Section 73.686(d) will permit the objective testing of the signal strength of digital signals. But this is true only if the remaining elements of the testing methodology are not altered. Most notably, the site test must measure signal strength *outdoors*, at the specified rooftop heights (20 feet for one-story residences, 30 feet for all others), and with the testing antenna properly oriented.[102] The Commission should not consider developing specific procedures for measuring signal strength indoors.[103] As explained extensively above, DTV service was designed to provide a service that would replicate existing Grade B analog service, and that existing Grade B analog service was always predicated upon providing satisfactory service to 30-foot outdoor antennas, properly oriented, located at households near the fringe of the station's service area. Local service will simply be eviscerated if the Commission were to recommend measuring signal strength indoors or establishing an indoor standard that the entire DTV

[102] *See* 47 C.F.R. § 73.686(d)(2)(iii), (iv).

[103] *See Notice* at ¶ 13.

service was never intended to be able to meet.

Of course, the test methodology must remain objective. There is neither any basis nor any warrant for the Commission to consider altering any aspect of the test methodology that would add any element of subjectivity to the test. As one third party has explained it:

> [S]ubjective tests are only applicable for development purposes. They do not lend themselves to operational monitoring, production line testing, trouble shooting or repeatable measurements required for equipment specifications. Subjective testing is too complex and provides too much variability in results, making clear the need for an objective testing method of picture quality.[104]

Finally, *what* is to be measured is as important as *how* it is to be measured. And there are numerous circumstances in which what is to be measured is not digital signal strength but analog signal strength. As noted above, in a market, for example, where a satellite carrier does not offer local-into-local digital service but does offer local-into-local analog service, if the satellite subscriber is served over the air by the local station's analog signal, then such a subscriber may be eligible for distant digital service depending on the results of a site test measurement in conjunction with certain further conditions as to market, date, and DTV build-out status. Digital signal strength is to be measured at the site test only for those stations for which the SHVERA trigger events in 47 U.S.C. § 339(a)(2)(D)(vii) are satisfied. For all other stations, the site test must continue to measure *analog* signal strength, even though it is eligibility for a distant *digital* duplicating network signal that is in issue.

This principle is best demonstrated by an example. In local Market L, which is a top 100 market, the local ABC affiliate is Station X. Station X has received a tentative DTV service channel

---

[104] Tektronix White Paper, *A Guide to Maintaining Video Quality of Service for Digital Television Programs* (Feb. 2000), at 3.

designation that is the same as its current DTV channel in the core. Station X also operates two translators T1 and T2. In an adjacent market, Market A1, which is a top 100 market, the local ABC affiliate is Station Y. Although Market A1 is a top 100 market, Station Y has received a testing waiver pursuant to 47 U.S.C. § 339(a)(2)(D)(viii) because Station Y has a side-mounted digital antenna that causes it to experience a substantial decrease in its digital signal coverage area. In another adjacent market, Market A2, which is not a top 100 market, the local ABC affiliate is Station Z. If, on July 1, 2006, a satellite subscriber located in Market L seeks to have a site test conducted to determine the subscriber's eligibility for a distant digital duplicating ABC signal, then the site test must measure the following: (1) the *digital* signal strength of Station X (because the SHVERA trigger events are satisfied for Station X, *see* 47 U.S.C. § 339(a)(2)(D)(vii)(I)(aa)), (2) the *analog* signal strength of translator stations T1 and T2 (because the trigger events for translator stations are not yet satisfied, *see* 47 U.S.C. § 339(a)(2)(D)(vii)(II)), (3) the *analog* signal strength of Station Y (because Station Y obtained a digital testing waiver for a valid reason, *see* 47 U.S.C. § 339(a)(2)(D)(viii)(IV)), and (4) the *analog* signal strength of Station Z (because the trigger events for stations that are not in the top 100 markets are not yet satisfied, *see* 47 U.S.C. § 339(a)(2)(D)(vii)(I)(bb)). Only if the location of the subscriber's household cannot receive the requisite signal strength (be it digital or analog, as stated) from *any* of these stations would the subscriber be deemed eligible to receive a distant digital signal. Therefore, even if the subscriber's location is unable to receive the requisite signal strength of Station X's digital signal, if the location can receive the requisite signal strength of Translator T1 *or* Translator T2's analog signal *or* the requisite signal strength of Station Y's analog signal *or* the requisite signal strength of Station Z's analog signal, then the subscriber is *not* eligible for a distant digital ABC signal. (It should be remembered that the subscriber in this case is not left without life-line network service. Before the testing could even occur in this example, SHVERA requires the subscriber to be receiving local Station X's ABC programming as part of the satellite carrier's local stations package offered under the Section 122 local-into-local compulsory license.)

A testing regime implemented as described herein best comports with SHVERA and Congress's long-standing policy goals to protect and preserve localism and to retain the extremely limited character of the distant signal compulsory license.

IV. The Longley-Rice Model Is an Appropriate Predictive Model to Recommend to Congress for Future, But Not Immediate, Use

SHVERA, unlike SHVIA, does not contain a requirement that the Commission promulgate a predictive model to presumptively determine whether an individual location can receive a digital signal of a certain threshold intensity.[105] Although Congress considered requiring the development of a predictive model for digital signals,[106] in the end it did not enact such a scheme. SHVERA, therefore, contains only a requirement for objective site testing to determine the adequacy of digital signal strength, and such testing can only occur after certain future trigger dates. The Commission, accordingly, has no authority to promulgate and implement a predictive model for digital signals.[107]

SHVERA, instead, directs the Commission only to "consider whether to develop a predictive methodology for determining whether a household is unserved by an adequate digital signal under

---

[105] *Compare* 47 U.S.C. § 339(c)(1) (enacted in SHVERA) *with id.*, § 339(c)(3) (enacted in SHVIA).

[106] *See* S. REP. NO. 108-427, at 8-9 (2004).

[107] *See INS v. Cardoza-Fonseca*, 480 U.S. 421, 442-43 (1987) (stating that "[f]ew principles of statutory construction are more compelling than the proposition that Congress does not intend *sub silentio* to enact statutory language that it has earlier discarded in favor of other language" (internal quotation marks and citations omitted)).

section 119(d)(10) of Title 17."[108] Network Affiliates believe that the Commission should develop and recommend a predictive model for digital signals, but only for future, and not immediate, use. By "future use," Network Affiliates mean *after* the digital transition is *complete*. Before the end of the transition, too much is unknown, the process would be too complicated, and the resulting viewer confusion could be rampant.

For example, not all stations have made elections for their final digital channel, and the spectrum repacking process is far from complete. Importantly, digital service for low power stations and translators has not yet been authorized. Because a household is considered "served" if it receives a signal from any station, be it full power, satellite, or translator, affiliated with the network in issue,[109] it is not possible to predict whether a household can receive a digital signal if the station that could be delivering the signal has not yet been authorized to broadcast in digital or the station has not yet had a reasonable opportunity to construct digital facilities. Local network affiliates, particularly those in western states that rely heavily on translators, should not be penalized by having their viewers siphoned away to distant duplicating stations solely because they are unable to provide a digital signal through no fault of their own. This is the antithesis of preserving and promoting localism and the network-affiliate distribution system as well as giving an expansive capability to a compulsory license intended to be, and that by law must be, narrowly construed.[110]

---

[108] 47 U.S.C. § 339(c)(1)(B)(iv).

[109] *See* 17 U.S.C. § 119(d)(2), (3), (10).

[110] Theoretically, it would be possible to predict whether a location is served by a *digital* signal of any station that does not have a Commission-sanctioned reason for not broadcasting in full power on its final DTV channel and, if not, to then predict whether that location is served by an *analog* signal of any station that does have such a Commission-sanctioned reason, but this process quickly becomes too complicated, too unworkable, and too subject to rampant confusion. Moreover,
(continued...)

Consequently, Network Affiliates urge the Commission to recommend that no predictive model be implemented until the digital transition is complete. Waiting for the completion of the digital transition will not materially prejudice the distant signal license for a number of reasons. For instance, the delay will be minimal since the transition should be complete not long after SHVERA's testing scheme is fully triggered, and, of course, a site test would always be available in such circumstances. In addition, given SHVERA's "if local, no distant" policy, the need for a predictive model as well as for site testing should be rapidly diminishing over time as satellite carriers introduce local-into-local digital service into markets. Moreover, waiting for the completion of the digital transition also appears to have been Congress's intent.[111] Finally, the distant signal license existed for many years under SHVA without a predictive model, and it can do the same in the digital context, although the time frame is expected to be much less. When the relative harms are weighed, it is plain that the harm to local affiliates by permitting a predictive model to presume lack of service before the end of the digital transition is too great to be implemented prematurely.

After the completion of the digital transition, it would be appropriate to utilize a predictive model for digital signals, and Network Affiliates urge the Commission to recommend the Longley-Rice model for use in this Section 119(d)(10) context. Not only is DTV coverage predicated upon the Longley-Rice model, as set forth in OET 69, but both the broadcast and satellite

---

[110](...continued)
such a hybrid process does not appear to be what Congress intended the Commission to consider and recommend.

[111] *See* H.R. REP. NO. 108-634, at 19-20 (2004) (stating that SHVERA requires the Commission to recommend "a methodology for determining whether a particular consumer would be unserved over the air by the digital signal of a specific network as transmitted by a broadcast station *after* the broadcasters in that consumer's market have ceased to broadcast in analog because of implementation of section 309(j)(14) of the Communications Act" (emphasis added)).

industries have five years of experience with the modified Individual Location Longley-Rice ("ILLR") model described in OET Bulletin No. 72 ("OET 72").[112] Furthermore, Congress intended for the Commission to base its recommended predictive methodology on the ILLR model.[113]

It would be appropriate for the Commission to recommend the ILLR model for digital signal prediction purposes—with one exception. The ILLR model as currently structured in OET 72 over-provides for clutter at UHF frequencies, and, in the digital context, these UHF clutter loss values make the model less accurate, rather than more accurate.[114]

Predictive models such as Longley-Rice already account for clutter factors such as buildings and vegetation inasmuch as they are empirically-based. As the Longley-Rice Manual explains, the model combines certain theoretical treatments

> using empirical relations derived as fits to measured data. This combination of elementary theory with experimental data makes it a *semi-empirical* model . . . .
>
> *The data used in developing the empirical relations have clearly influenced the model itself.* It should then be noted that these data were obtained from measurements made with fairly clear foregrounds at both terminals. In general, ground cover was sparse, but some of the measurements were made in areas with moderate forestation. *The model, therefore, includes effects of foliage, but only to the fixed degree that they were present in the data used.*[115]

The fact that Longley-Rice is semi-empirical and incorporates the then-existing clutter in the model

---

[112] OET Bulletin No. 72, *The ILLR Computer Program* (July 2, 2002).

[113] *See* H.R. REP. NO. 108-634, at 20 (2004) ("The Committee intends the FCC to base its methodology on the FCC's existing technical specifications for digital television service and the individual location Longley-Rice algorithm.").

[114] *See* Cohen Engineering Statement at 5-6.

[115] G.A. Hufford *et al.*, *A Guide to the Use of the ITS Irregular Terrain Model in the Area Prediction Mode*, NTIA Report 82-100 (U.S. Dep't of Commerce Apr. 1982) ("Longley-Rice Manual"), at 12 (emphases added); *see also id.* at 22.

is well-recognized in the scientific and technical community.[116]

In creating the ILLR model, the Commission was careful to include additional clutter, above and beyond that already accounted for in the semi-empirical model itself, only where it made the model more accurate. Thus, the Commission determined that any clutter loss values greater than 0 dB would make the model less accurate in the low VHF and high VHF bands for analog signal predictions. With respect to the analog UHF band, the Commission proposed modest clutter loss values for certain land use categories (between 3 dB and 6 dB for the lower half of the UHF band and between 5 dB and 8 dB in the upper half of the UHF band). The Commission determined that these UHF clutter factors, when analyzed with real-world data for over-predictions and under-predictions, made the model the most accurate.[117]

In the case of digital signal predictions, the clutter considerations already inherent in the basic Longley-Rice model provide a more accurate predictive model than the additional UHF clutter loss values added into the ILLR model in OET 72. The National Association of Broadcasters ("NAB") is providing extensive data (more than 2000 individual site predictions with associated measured

---

[116] *See, e.g.*, R. Grosskopf, *Comparison of Different Methods for the Prediction of the Field Strength in the VHF Range*, 35 IEEE TRANS. ON ANTENNAS & PROPAGATION 852 (July 1987), 852 (stating that in the Longley-Rice model "empirically gained quantities influence the field strength prediction"); M.L. Meeks, *VHF Propagation over Hilly, Forested Terrain*, 31 IEEE TRANS. ON ANTENNAS & PROPAGATION 483 (May 1983), 488 (recognizing the semi-empirical nature of the Longley-Rice model and the fact that if affects the model's prediction of propagation loss); M.M. Weiner, *Use of the Longley-Rice and Johnson-Gierhart Tropospheric Radio Propagation Programs: 0.02-20 GHz*, 4 IEEE J. ON SELECTED AREAS IN COMMUNICATIONS 297 (Mar. 1986), 297 (stating that Longley-Rice is a "statistical/semi-empirical model[] of tropospheric radio propagation"); *id.* at 299 (stating that it is necessary to take account of vegetation only in the immediate vicinity of the receiving antenna because "knife-edge diffraction by vegetation distant from the antennas is usually included in the semi-empirical methods used for estimating the excess propagation loss").

[117] *See Establishment of an Improved Model for Predicting the Broadcast Television Field Strength Received at Individual Locations*, First Report and Order, 15 FCC Rcd 12118 (2000), at ¶¶ 13-15 & Appendix A, Table 3.

field strengths) in its comments in this proceeding providing empirical support for this new modification to the ILLR model. NAB shows, using the same basic form of analysis that the Commission undertook in creating the ILLR model, that the best balance of over-predictions and under-predictions—and, hence, the most accurate predictive model—is provided by the Longley-Rice model without the OET 72 UHF clutter loss values.

In sum, Network Affiliates urge the Commission to recommend to Congress that it prescribe the Longley-Rice predictive model, without the OET 72 UHF clutter loss values, for use after the digital transition is complete in presumptively determining whether an individual location can receive a digital signal of the requisite threshold intensity.

Conclusion

For the foregoing reasons, Network Affiliates respectfully request that the Commission recommend to Congress (1) that the digital signal strength thresholds set forth in Section 73.622(e)(1) remain the same for purposes of determining whether a household is "unserved" by a digital signal pursuant to 17 U.S.C. § 119(d)(10); (2) that the testing methodology set forth in Section 73.686(d) be modified slightly, as explained herein, so that the procedure may be used for digital signal site tests; and (3) that Congress prescribe a slightly modified ILLR model, as explained herein, to be used after the digital television transition is complete to presumptively determine the eligibility of a household to receive a duplicating distant digital network signal.

Respectfully submitted,

ABC, CBS, AND NBC
TELEVISION AFFILIATE ASSOCIATIONS

/s/
Kurt A. Wimmer
COVINGTON & BURLING
1201 Pennsylvania Avenue, N.W. (20004)
Post Office Box 7566
Washington, D.C. 20044-7566
Telephone: (202) 662-6000
Facsimile: (202) 662-6291

Counsel for the CBS Television Network Affiliates Association and for the NBC Television Affiliates Association

/s/
Wade H. Hargrove
Mark J. Prak
David Kushner
BROOKS, PIERCE, MCLENDON, HUMPHREY & LEONARD, L.L.P.
Wachovia Capitol Center, Suite 1600
150 Fayetteville Street Mall (27601)
Post Office Box 1800
Raleigh, North Carolina 27602
Telephone: (919) 839-0300
Facsimile: (919) 839-0304

Counsel for the ABC Television Affiliates Association

June 17, 2005

Appendix

Engineering Statement of Jules Cohen, P.E.

ENGINEERING STATEMENT IN SUPPORT OF COMMENTS
FCC NOTICE OF INQUIRY, ET DOCKET NO. 05-182

This engineering statement, prepared on behalf of Network Affiliates, is in support of comments responding to the Commission's Notice of Inquiry In the Matter of Technical Standards for Determining Eligibility For Satellite-Delivered Network Signals Pursuant To the Satellite Home Viewer Extension and Reauthorization Act, ET Docket No. 05-182, released May 3, 2005. The statement is directed, particularly, to the equipment employed to intercept the desired digital signal and the effect of that equipment on Planning Factors. Included also are comments on field testing of the availability of an adequate digital signal from a local terrestrial television broadcast station.

As a threshold matter, the criteria employed to determine eligibility for satellite-delivery of network signals should include an assumption that the receiving point apparatus includes equipment appropriate for the location of the household. Generally, that implies that distant locations use outdoor antennas of reasonably high gain, preferably supplemented by a mast-mounted low noise amplifier. Although at distances relatively close to the transmitter site indoor antennas may suffice for a satisfactory viewing experience, some locations may be so obstructed by terrain, either natural or man-made, that they require equipment generally considered necessary only for distant locations. Additionally, in each instance, the antenna should be assumed to be oriented toward the strongest signal arriving from the desired station. At times, that strongest signal may not be on the direct bearing to the transmitting station but may be from a nearby water tower or large surface reflecting the desired signal.

Receiving Antennas

Outdoor antennas for fringe area reception are available from numerous sources. Web site listings can be found for such manufacturers as Andrew Channel Master, Antennas Direct, Winegard and AntennaCraft as well as for numerous retail outlets carrying the antennas of these manufacturers and others. Manufacturers' specified antenna gains vary from averages of 5 to 7 dB for low band VHF, mostly about 10 dB for high VHF and 12 dB or more for UHF. Half-power beam widths are in the order of 70 degrees for low VHF, 35 degrees for high VHF and 35 to 40 degrees for UHF. List prices for individual VHF and UHF or all-band high gain outdoor antennas are in the order of $100 to $165 with lower prices found at the times of special sales.

A useful collection of measured patterns of receiving antennas from a source independent of receiving antenna manufacturers is a paper delivered by Mr. Kerry W. Cozad at the 54th Annual IEEE Broadcast Symposium on October 14, 2004. An even more extensive description of Mr. Cozad's work is found in a paper he delivered at the 2005 National Translator Convention on May 15, 2005.

Rotators

Where television transmitting sites are located at a variety of bearings from the receiving location an antenna rotator is required. Rotators capable of handling the outdoor antennas are available from Radio Shack, Channel Master and others at a cost of about $75 plus about $15 for 100 feet of control cable, permitting adjustment to the optimum orientation from a location at the receiver. Manufacturers provide manuals to guide the householder on the installation of antennas and rotators so that the cost of hiring an installer can be avoided if desired.

Low-Noise Amplifiers

Mast-mounted low noise amplifiers, at reasonable costs of 60 to 90 dollars, are readily available from equipment suppliers, either via the internet or retail outlets. They perform the useful function of assuring high quality digital television reception at marginal locations. A feature of their use is the substantial improvement of the system noise figure over that provided by the television receiver alone.

System noise figure is equal to the sum of the amplifier noise figure plus the noise figure of the receiver divided by the amplifier gain (all in linear terms). Manufacturers' published noise figures run from 2.5 to about 4.0 dB, with gains varying from 11 to 29 dB. A conservative choice of parameters to illustrate the advantage of using a pre-amplifier at the antenna would be: amplifier noise figure 5 dB (3.16), amplifier gain 20 dB (100), and receiver noise figure of 12 dB (15.85). The resulting system noise figure is 3.32, or 5.2 dB. Considering that the system noise factors used by the Commission for DTV reception are 10 dB for VHF and 7 dB for UHF, a system noise figure of approximately 5 dB can be seen to provide an extra margin to minimize the impact of system mismatches.

Planning Factors

Planning factors currently in use by the Commission, as shown in Table 3 of OET Bulletin No. 69, *Longley-Rice Methodology for Evaluating TV Coverage and Interference*, February 06, 2004, is shown in the table on the following page:

PlanningFactor	Symbol	Low VHF	High VHF	UHF
Geometric mean frequency (MHz)	F	69	194	615
Dipole factor (dBm-dBu)	K_d	-111.8	-120.8	-130.8
Dipole factor adjustment	K_a	none	none	see below
Thermal noise (dBm)	N_t	-106.2	-106.2	-106.2
Antenna gain (dBd)	G	4	6	10
Downlead line loss	L	1	2	4
System noise figure (dB)	N_s	10	10	7
Required Carrier to Noise ratio (dB)	C/N	15	15	15

Bulletin 69 states as follows:

"The adjustment, K_a = 20 log[615/(channel mid-frequency in MHz)], is added to K_d to account for the fact that field strength requirements are greater for UHF channels above the geometric mean frequency of the UHF band and smaller for UHF channels below that frequency. The geometric mean frequency, 615 MHz, is approximately the mid-frequency of channel 38."

From the foregoing discussion of equipment available, and employed by television viewers, factors such as antenna gain and system noise figure are well within the capabilities of receiving systems. As to downlead losses, they too are conservatively stated in the current planning figures. Losses for 50 feet of RG-6 coaxial cable, the downlead recommended for television use, are shown by Channel Master to be: 0.75 to 0.93 dB for low VHF, 1.31 to 1.44 dB for high VHF, and 2.20 to 2.76 dB for UHF.

Since UHF digital television broadcasting will be limited to channels 14 to 51 (470 to 698 MHz) after the transition, the geometric mean frequency of 615 MHz, based on the use of channels 14 to 69 (470 to 806 MHz), no longer applies in the digital world. The appropriate geometric mean frequency for the new channel alignment is 573 MHz and the dipole factor becomes -130.2. However, in light of an absence for need to change other quantities in the table, the planning factor table is not proposed to be changed.

Prediction of Service

Use of the objective determination of field strength above a suitable threshold level is urged strongly as the criterion of whether or not a particular location has available service from a local terrestrial digital broadcast station. The availability at reasonable cost of sophisticated receiving equipment capable of delivering to the receiver strong signals with suitable carrier-to-noise ratios, coupled with the demonstrated improvements in receiver technology, leaves little doubt that, given sufficient signal strength, the viewer will have excellent digital reception. Multipath degradation that affected early receiver designs has been conquered to a substantial degree. Further improvements have been promised and can be expected to be delivered as the demand for product grows.

A method is already available for making those needed predictions of field strength at particular locations—ILLR. The Commission describes the use of the *Individual Location Longley-Rice (ILLR) Computer Program* in OET Bulletin Number 72 of July 2, 2002. That program has been proved to be reliable through comparison with several thousand measurements of received signal strength. No need exists for a new program with one exception. The clutter loss adjustments for UHF channels should be eliminated. Built into the Longley-Rice Model for the prediction of field strength over irregular terrain are empirical factors based on actual field strength measurements. Addition of a clutter factor adjustment compounds field strength losses and serves to reduce rather than increase reliability of the prediction.

In rare instances where a party chooses to challenge a prediction of the presence or absence of service, that challenge can be met only with appropriate field strength measurements.

Local Field Strength Measurements

A procedure for making field strength measurements at individual locations is described in Commission rules at 73.686(d). With one major modification, that procedure is appropriate for digital television broadcasting. Section 73.686(d)(2)(i) describes the testing equipment and procedure to follow for measuring the received field strength. The equipment and procedure are appropriate to measurement of a NTSC signal, but not digital.

The field strength desired in the NTSC case is that at the peak of the synchronizing pulse. That is a convenient parameter because the synchronizing pulse has a relatively narrow bandwidth and is independent of the varying video modulation. In the digital case, the necessary measurement is the integrated average power over the full 6 MHz band. Instruments used in the NTSC case cover bandwidth too narrow for measurement of the digital signal. The most practical instrument to use for digital power measurement is a spectrum analyzer such as the Agilent Technologies Model E441B ESA-L (list price about $8,000).

Use of a high gain antenna of known characteristics rather than a dipole is strongly recommended to eliminate to the extent possible interfering signals and to reflect the type of antenna employed by the viewers.

Conclusions

Determining the eligibility for satellite-delivered network stations requires an assumption that receiving equipment appropriate to the point of reception is in use. Threshold signal levels presently used as criteria for acceptable reception in the three TV bands are suitable because the planning factors used to develop those levels are consistent with readily available equipment. The presence or absence of those threshold signal levels is best determined by existing ILLR calculation procedures. In the event of challenge to the analytical results, only field testing is appropriate to reach a definitive conclusion. Field testing should be done by the presently specified procedure with the exception of substituting an appropriate wide-band instrument for the narrow-band field strength meter now used for NTSC.

s/Jules Cohen, P.E.

June 16, 2005

Exhibit 1

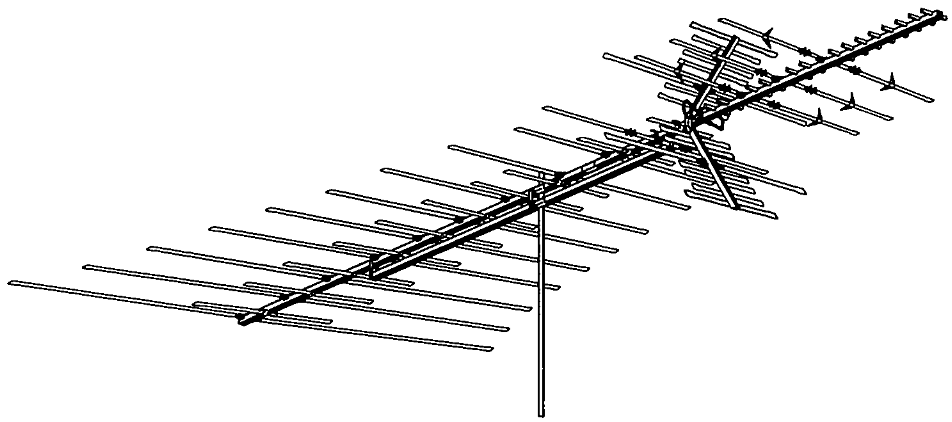
Antennas

Antennacraft Antennas

Engineering Specifications

ANTENNACRAFT®

Model HD1850 Heavy-Duty, High-Definition VHF/UHF/FM Antenna



Model Number:	HD-1850

General:

Channels	2 - 69
Electronic Elements	84
Output Impedance	300 ohms

Physical:

Boom Length	180"
Maximum Width	112"
Vertical Height	38"
Turning Radius	102"
Element Diameter	.375"
Shipping Weight	16.0
Carton Dimensions	7" x 9" x 98"

Performance:

1 Gain (dB)	
VHF Low Band	6.2
VHF High Band	10.7
UHF Band	10.0
2 Half-Power Beamwidth (deg.)	
VHF Low Band	65.0
VHF High Band	34.0
UHF Band	37.5
3 Front-To-Back Ratio (dB)	
VHF Low Band	20.2
VHF High Band	17.3
UHF Band	13.7

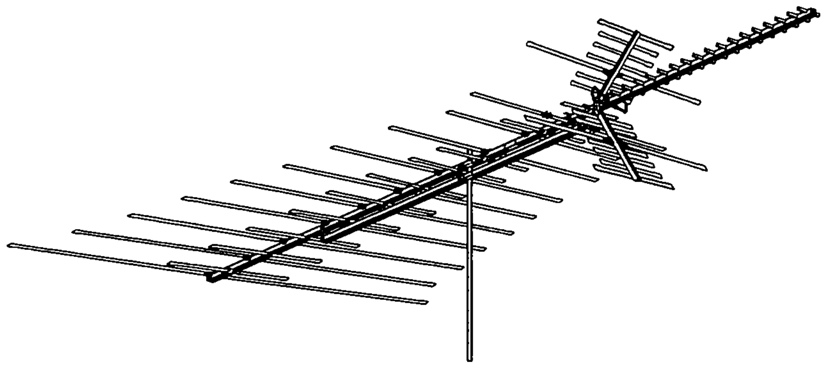
1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model HD1800 Heavy-Duty, High-Definition VHF/UHF/FM Antenna



Model Number:	HD-1800

General:

Channels	2 - 69
Electronic Elements	69
Output Impedance	300 ohms

Physical:

Boom Length	180"
Maximum Width	112"
Vertical Height	38"
Turning Radius	102"
Element Diameter	.375"
Shipping Weight	15.0
Carton Dimensions	7" x 9" x 98"

Performance:

[1] Gain (dB)	
VHF Low Band	6.2
VHF High Band	9.4
UHF Band	10.0
[2] Half-Power Beamwidth (deg.)	
VHF Low Band	65.0
VHF High Band	35.5
UHF Band	37.5
[3] Front-To-Back Ratio (dB)	
VHF Low Band	20.2
VHF High Band	17.3
UHF Band	13.7

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

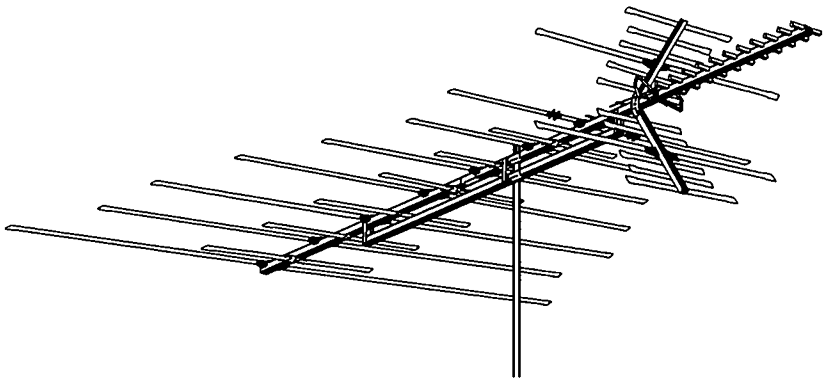
2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®

Model HD1200 Heavy-Duty, High-Definition VHF/UHF/FM Antenna



Model Number:	HD-1200

General:

Channels	*2 - 69*
Electronic Elements	*51*
Output Impedance	*300 ohms*

Physical:

Boom Length	*120"*
Maximum Width	*109"*
Vertical Height	*31"*
Turning Radius	*78"*
Element Diameter	*.375"*
Shipping Weight	*12.0*
Carton Dimensions	*6.5" x 6.75" x 101"*

Performance:

1 Gain (dB)	
VHF Low Band	*5.1*
VHF High Band	*8.0*
UHF Band	*8.5*
2 Half-Power Beamwidth (deg.)	
VHF Low Band	*67.0*
VHF High Band	*33.0*
UHF Band	*39.0*
3 Front-To-Back Ratio (dB)	
VHF Low Band	*16.5*
VHF High Band	*14.0*
UHF Band	*13.5*

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

2: -3 dB Down Points

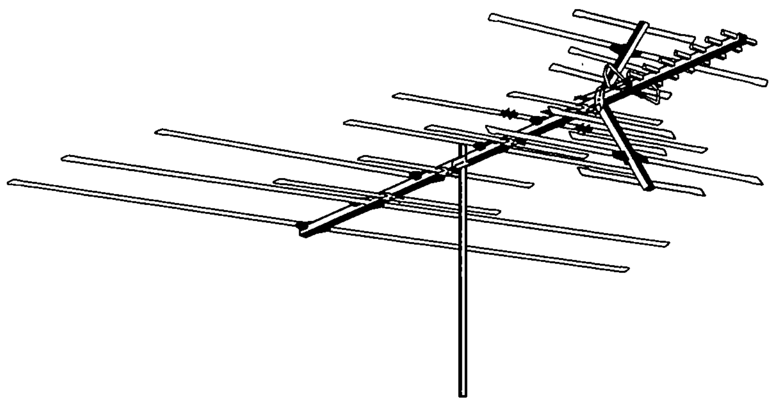
3: Opposite Hemisphere

Antennacraft, P.O. Box 1005, Burlington, IA 52601

Engineering Specifications

ANTENNACRAFT®

Model HD850 Heavy-Duty, High-Definition VHF/UHF/FM Antenna



Model Number:	HD-850

General:		
	Channels	2 - 69
	Electronic Elements	36
	Output Impedance	300 ohms

Physical:		
	Boom Length	85"
	Maximum Width	111"
	Vertical Height	24"
	Turning Radius	64"
	Element Diameter	.375"
	Shipping Weight	9.0
	Carton Dimensions	6.5" x 6.75" x 101"

Performance:		
1	Gain (dB)	
	VHF Low Band	3.3
	VHF High Band	6.9
	UHF Band	7.7
2	Half-Power Beamwidth (deg.)	
	VHF Low Band	72.0
	VHF High Band	36.0
	UHF Band	40.0
3	Front-To-Back Ratio (dB)	
	VHF Low Band	11.0
	VHF High Band	13.0
	UHF Band	12.0

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

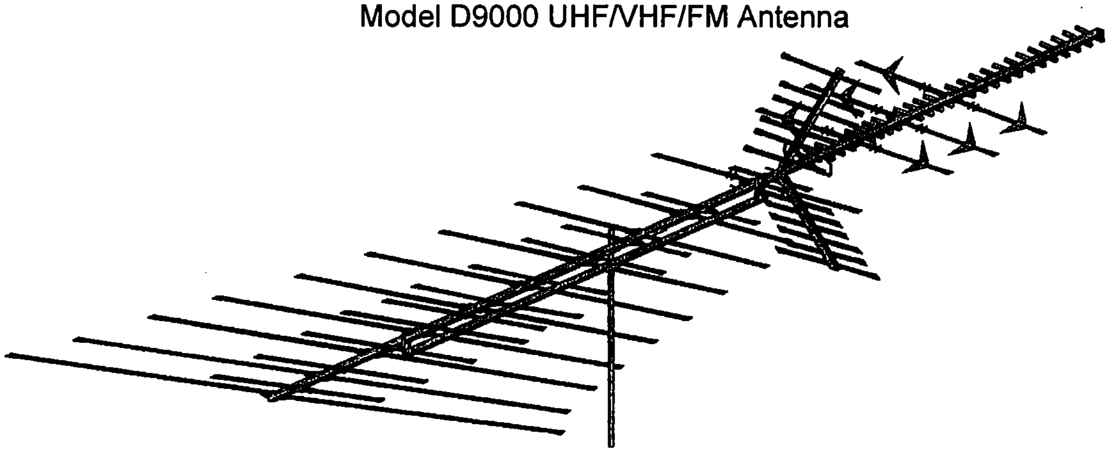
2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®

Model D9000 UHF/VHF/FM Antenna



Model Number:	D-9000

General:

Channels	2 - 69
Electronic Elements	91
Output Impedance	300 ohms

Physical:

Boom Length	180"
Maximum Width	112"
Vertical Height	38"
Turning Radius	101.5"
Element Diameter	.375"
Shipping Weight	14.5 lbs.
Carton Dimensions	7" x 8.25" x 101"

Performance:

1 Gain (dB)	
VHF Low Band	6.0
VHF High Band	9.8
UHF Band	9.9
2 Half-Power Beamwidth (deg.)	
VHF Low Band	67.0
VHF High Band	35.5
UHF Band	37.5
3 Front-To-Back Ratio (dB)	
VHF Low Band	20.2
VHF High Band	17.3
UHF Band	13.7

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

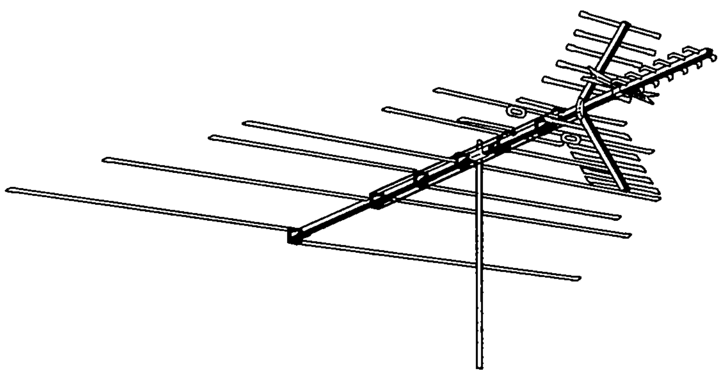
2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®

Model 4BG30 Permacolor® UHF/VHF/FM



Model Number: 4BG30

General:

Channels	2 - 69
Electronic Elements	31
Output Impedance	300 ohms

Physical:

Boom Length	106"
Maximum Width	108"
Vertical Height	36"
Turning Radius	75"
Element Diameter	.375"
Shipping Weight	8.5 lbs.
Carton Dimensions	5" x 5.25" x 108"

Performance:

1 Gain (dB)	
VHF Low Band	3.9
VHF High Band	7.5
UHF Band	7.0
2 Half-Power Beamwidth (deg.)	
VHF Low Band	71.0
VHF High Band	46.0
UHF Band	44.0
3 Front-To-Back Ratio (dB)	
VHF Low Band	13.6
VHF High Band	12.9
UHF Band	16.0

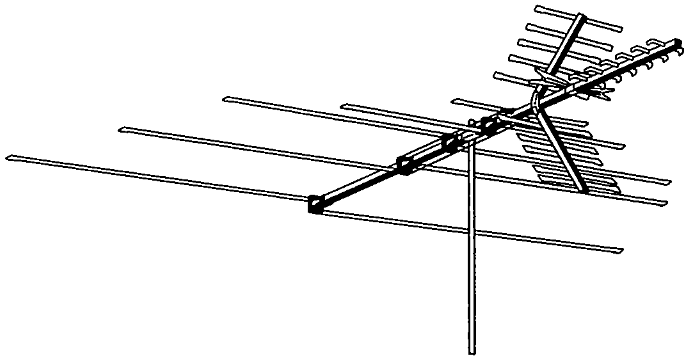
1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model 4BG26 Permacolor® UHF/VHF/FM



Model Number:	4BG26

General:

Channels	2 - 69
Electronic Elements	27
Output Impedance	300 ohms

Physical:

Boom Length	91"
Maximum Width	108"
Vertical Height	36"
Turning Radius	68"
Element Diameter	.375"
Shipping Weight	7.1 lbs.
Carton Dimensions	5" x 5.25" x 103"

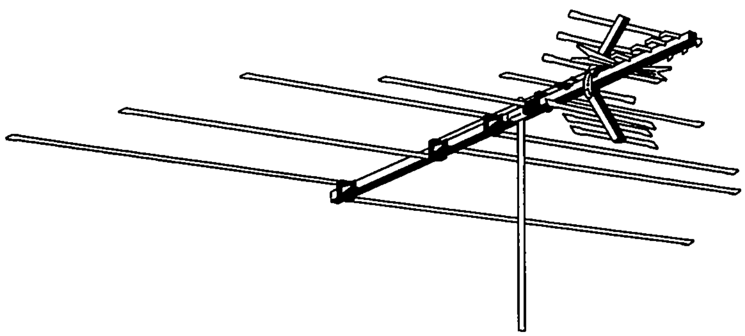
Performance:

1 Gain (dB)	
VHF Low Band	3.6
VHF High Band	5.6
UHF Band	7.0
2 Half-Power Beamwidth (deg.)	
VHF Low Band	73.3
VHF High Band	49.0
UHF Band	53.4
3 Front-To-Back Ratio (dB)	
VHF Low Band	9.3
VHF High Band	10.4
UHF Band	14.3

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)
2: -3 dB Down Points
3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model 4BG20 Permacolor® UHF/VHF/FM



Model Number:	4BG20

General:		
	Channels	2 - 69
	Electronic Elements	21
	Output Impedance	300 ohms

Physical:		
	Boom Length	81"
	Maximum Width	108"
	Vertical Height	20"
	Turning Radius	68"
	Element Diameter	.375"
	Shipping Weight	6.0 lbs.
	Carton Dimensions	6 x 4.75 x 81"

Performance:		
1	Gain (dB)	
	VHF Low Band	3.5
	VHF High Band	3.9
	UHF Band	6.1
2	Half-Power Beamwidth (deg.)	
	VHF Low Band	70.3
	VHF High Band	52.0
	UHF Band	52.2
3	Front-To-Back Ratio (dB)	
	VHF Low Band	9.3
	VHF High Band	10.4
	UHF Band	13.8

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

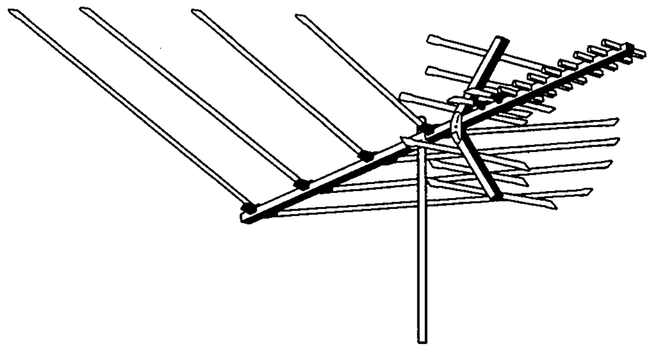
2: -3 dB Down Points

3: Opposite Hemisphere

12/2001 Antennacraft, P.O. Box 1005, Burlington, IA 52601

Engineering Specifications

ANTENNACRAFT®
Model 4BG18 Permacolor® UHF/VHF/FM



Model Number:	4BG18

General:

Channels	2 - 69
Electronic Elements	19
Output Impedance	300 ohms

Physical:

Boom Length	71"
Maximum Width	96"
Vertical Height	25"
Turning Radius	50"
Element Diameter	.375"
Shipping Weight	5.8 lbs.
Carton Dimensions	5.5" x 6.75" x 72"

Performance:

[1] Gain (dB)	
VHF Low Band	2.1
VHF High Band	6.4
UHF Band	5.7

[2] Half-Power Beamwidth (deg.)	
VHF Low Band	79.3
VHF High Band	37.5
UHF Band	41.4

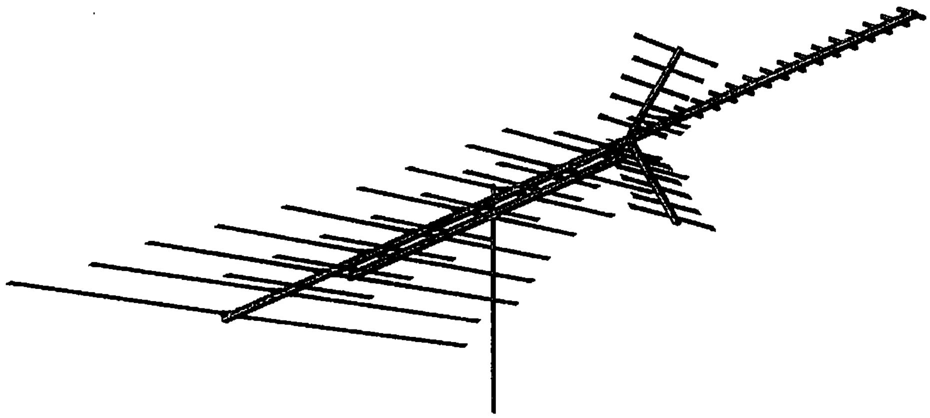
[3] Front-To-Back Ratio (dB)	
VHF Low Band	6.3
VHF High Band	13.2
UHF Band	14.1

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)
2: -3 dB Down Points
3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®

Model CCS1843 VHF/UHF/FM Antenna



Model Number:	CCS-1843

General:

Channels	2 - 69
Electronic Elements	54
Output Impedance	300 ohms

Physical:

Boom Length	180"
Maximum Width	110"
Vertical Height	38"
Turning Radius	105"
Element Diameter	.375"
Shipping Weight	11.8 lbs.
Carton Dimensions	6.5" x 6.5" x 101"

Performance:

1 Gain (dB)	
VHF Low Band	6.0
VHF High Band	9.1
UHF Band	9.3
2 Half-Power Beamwidth (deg.)	
VHF Low Band	66.7
VHF High Band	41.8
UHF Band	36.4
3 Front-To-Back Ratio (dB)	
VHF Low Band	19.6
VHF High Band	17.2
UHF Band	16.1

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

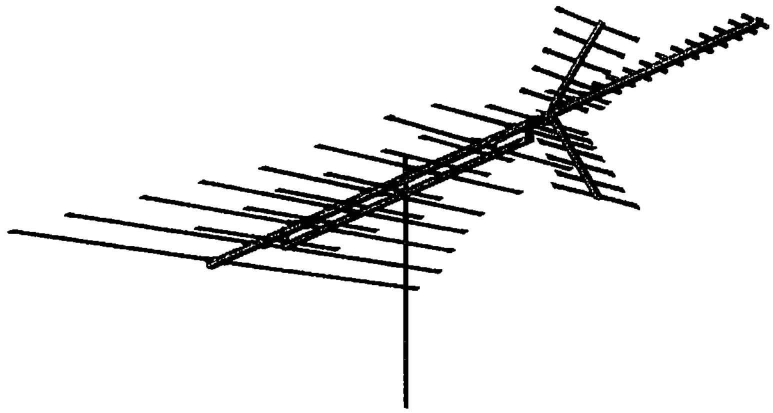
2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®

Model CCS1538 VHF/UHF/FM Antenna



Model Number:	CCS-1538

General:

Channels	2 - 69
Electronic Elements	48
Output Impedance	300 ohms

Physical:

Boom Length	150"
Maximum Width	102"
Vertical Height	38"
Turning Radius	93.5"
Element Diameter	.375"
Shipping Weight	10.6 lbs.
Carton Dimensions	6.5" x 6.5" x 81"

Performance:

1 Gain (dB)	
VHF Low Band	5.5
VHF High Band	8.5
UHF Band	8.3
2 Half-Power Beamwidth (deg.)	
VHF Low Band	67.0
VHF High Band	43.3
UHF Band	38.6
3 Front-To-Back Ratio (dB)	
VHF Low Band	14.8
VHF High Band	16.1
UHF Band	13.7

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

2: -3 dB Down Points

3: Opposite Hemisphere

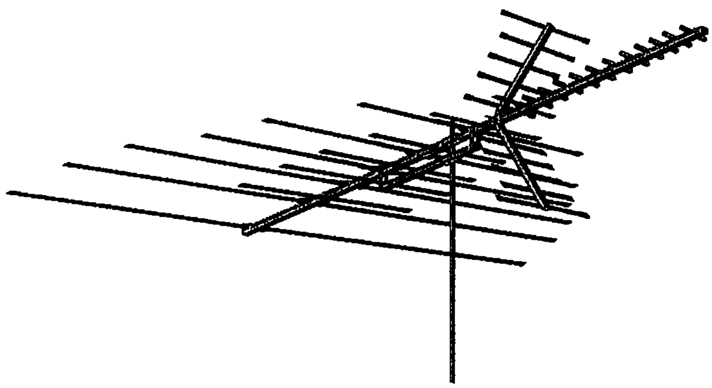
12/2001

Antennacraft, P.O. Box 1005, Burlington, IA 52601

Engineering Specifications

ANTENNACRAFT®

Model CCS1233 VHF/UHF/FM Antenna



Model Number:	CCS-1233

General:

Channels	2 - 69
Electronic Elements	39
Output Impedance	300 ohms

Physical:

Boom Length	120"
Maximum Width	111"
Vertical Height	38"
Turning Radius	79.5"
Element Diameter	.375"
Shipping Weight	9.2 lbs.
Carton Dimensions	6.5" x 6.5" x 81"

Performance:

1 Gain (dB)	
VHF Low Band	3.9
VHF High Band	7.2
UHF Band	6.8

2 Half-Power Beamwidth (deg.)	
VHF Low Band	66.7
VHF High Band	31.8
UHF Band	39.2

3 Front-To-Back Ratio (dB)	
VHF Low Band	13.4
VHF High Band	14.5
UHF Band	11.4

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

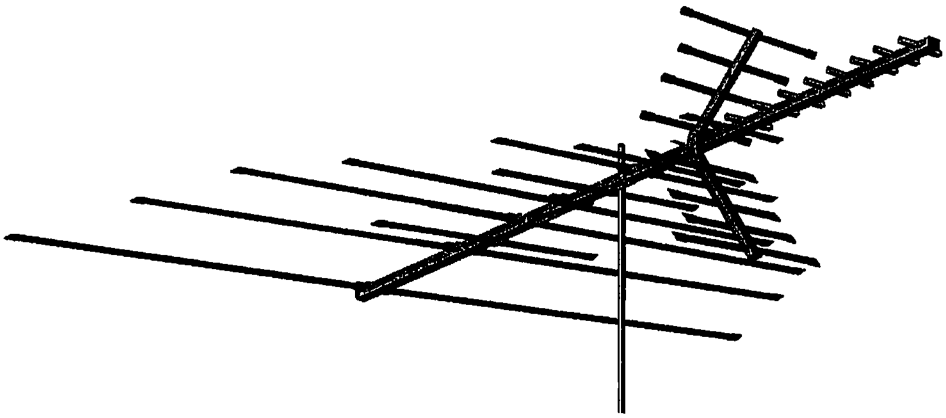
2: -3 dB Down Points

3: Opposite Hemisphere

Antennacraft, P.O. Box 1005, Burlington, IA 52601

Engineering Specifications

ANTENNACRAFT®
Model CCS1025 VHF/UHF/FM Antenna



Model Number:	CCS-1025

General:

Channels	2 - 69
Electronic Elements	30
Output Impedance	300 ohms

Physical:

Boom Length	100"
Maximum Width	111"
Vertical Height	32"
Turning Radius	72.5"
Element Diameter	.375"
Shipping Weight	7.0 lbs.
Carton Dimensions	6.25" x 6.5" x 81"

Performance:

1 Gain (dB)	
VHF Low Band	3.6
VHF High Band	6.6
UHF Band	5.9
2 Half-Power Beamwidth (deg.)	
VHF Low Band	72.0
VHF High Band	35.8
UHF Band	39.4
3 Front-To-Back Ratio (dB)	
VHF Low Band	10.6
VHF High Band	12.6
UHF Band	10.3

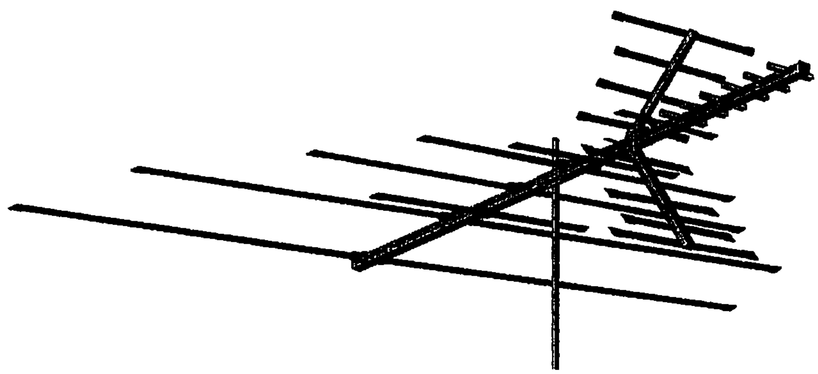
1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model CCS822 VHF/UHF/FM Antenna



Model Number:	CCS-822

General:

Channels	2 - 69
Electronic Elements	26
Output Impedance	300 ohms

Physical:

Boom Length	80"
Maximum Width	111"
Vertical Height	32"
Turning Radius	66.5"
Element Diameter	.375"
Shipping Weight	5.8 lbs.
Carton Dimensions	6.5" x 6.5" x 81"

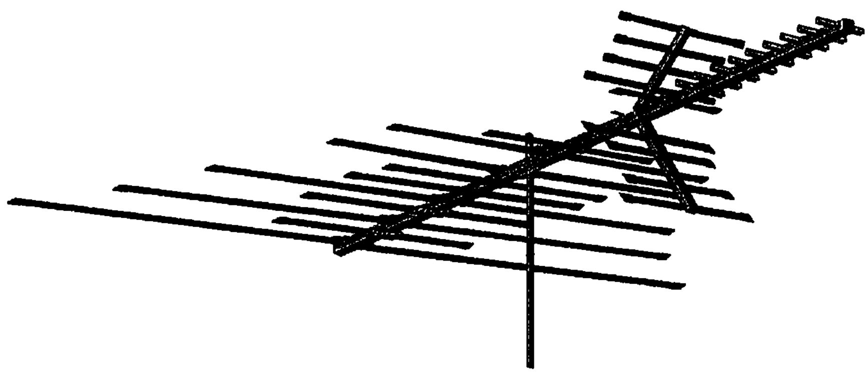
Performance:

1 Gain (dB)	
VHF Low Band	3.3
VHF High Band	6.1
UHF Band	5.4
2 Half-Power Beamwidth (deg.)	
VHF Low Band	71.0
VHF High Band	41.8
UHF Band	45.2
3 Front-To-Back Ratio (dB)	
VHF Low Band	10.1
VHF High Band	11.2
UHF Band	10.9

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)
2: -3 dB Down Points
3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model 5885 ColorKing® VHF/UHF/FM Antenna



Model Number:	5885

General:

Channels	2 - 69
Electronic Elements	34
Output Impedance	300 ohms

Physical:

Boom Length	90"
Maximum Width	102"
Vertical Height	25"
Turning Radius	62"
Element Diameter	.375"
Shipping Weight	6.6 lbs.
Carton Dimensions	7.875" x 6.375" x 54.5"

Performance:

1 Gain (dB)	
VHF Low Band	2.2
VHF High Band	5.7
UHF Band	5.9
2 Half-Power Beamwidth (deg.)	
VHF Low Band	72.0
VHF High Band	51.3
UHF Band	42.7
3 Front-To-Back Ratio (dB)	
VHF Low Band	8.9
VHF High Band	6.9
UHF Band	10.6

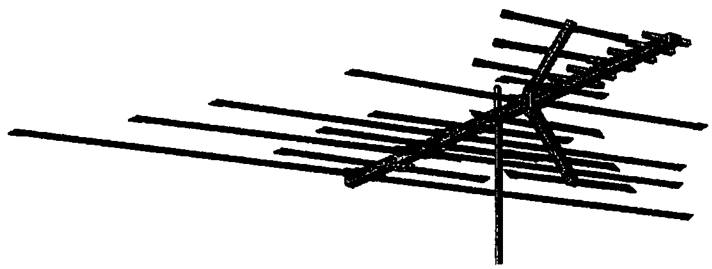
1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model 5884 ColorKing® VHF/UHF/FM Antenna



Model Number:	5884

General:		
	Channels	2 - 69
	Electronic Elements	25
	Output Impedance	300 ohms

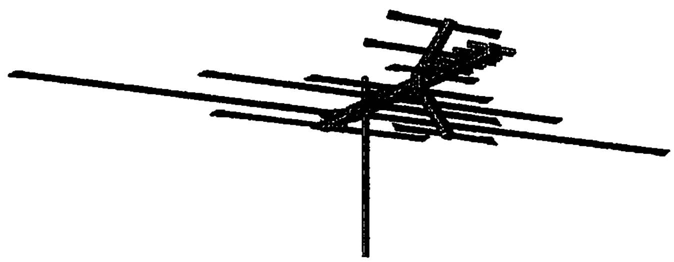
Physical:		
	Boom Length	58"
	Maximum Width	102"
	Vertical Height	25"
	Turning Radius	58"
	Element Diameter	.375"
	Shipping Weight	5.1 lbs.
	Carton Dimensions	6.375" x 5.875" x 58.5"

Performance:		
1	Gain (dB)	
	VHF Low Band	2.5
	VHF High Band	6.5
	UHF Band	6.0
2	Half-Power Beamwidth (deg.)	
	VHF Low Band	70.0
	VHF High Band	39.8
	UHF Band	45.4
3	Front-To-Back Ratio (dB)	
	VHF Low Band	7.3
	VHF High Band	9.0
	UHF Band	9.9

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)
2: -3 dB Down Points
3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model 5883 ColorKing® VHF/UHF/FM Antenna



Model Number:	5883

General:

Channels	2 - 69
Electronic Elements	16
Output Impedance	300 ohms

Physical:

Boom Length	30"
Maximum Width	98"
Vertical Height	16.25"
Turning Radius	50.5"
Element Diameter	.375"
Shipping Weight	3.5 lbs.
Carton Dimensions	6.375" x 5.875" x 51.375"

Performance:

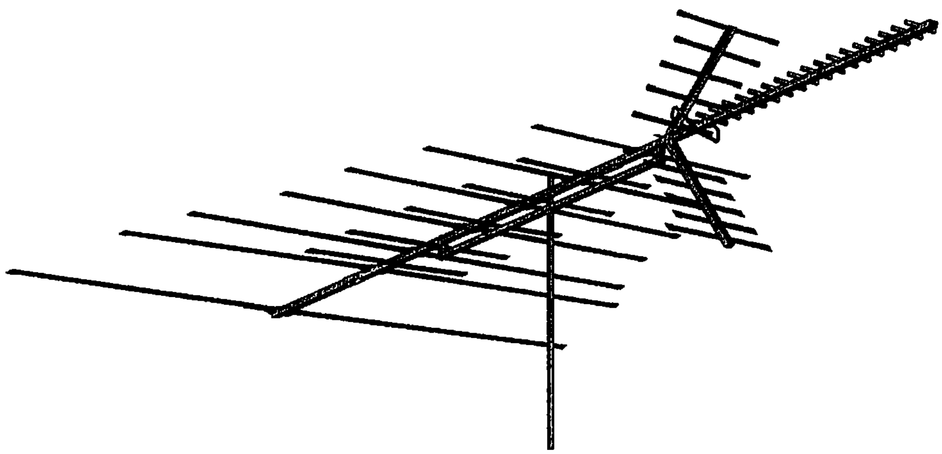
1 Gain (dB)	
VHF Low Band	0.5
VHF High Band	4.8
UHF Band	4.1
2 Half-Power Beamwidth (deg.)	
VHF Low Band	74.7
VHF High Band	52.0
UHF Band	47.0
3 Front-To-Back Ratio (dB)	
VHF Low Band	1.1
VHF High Band	8.6
UHF Band	7.3

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)
2: -3 dB Down Points
3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®

Model C480 VHF/UHF/FM Antenna



Model Number:	C-480

General:

Channels	2 - 69
Electronic Elements	48
Output Impedance	300 ohms

Physical:

Boom Length	150"
Maximum Width	112"
Vertical Height	38"
Turning Radius	86.5"
Element Diameter	.375"
Shipping Weight	8.7 lbs.
Carton Dimensions	5.75" x 8.75" x 71"

Performance:

[1] Gain (dB)	
VHF Low Band	5.0
VHF High Band	8.6
UHF Band	8.4
[2] Half-Power Beamwidth (deg.)	
VHF Low Band	66.7
VHF High Band	34.5
UHF Band	42.7
[3] Front-To-Back Ratio (dB)	
VHF Low Band	18.0
VHF High Band	15.1
UHF Band	13.0

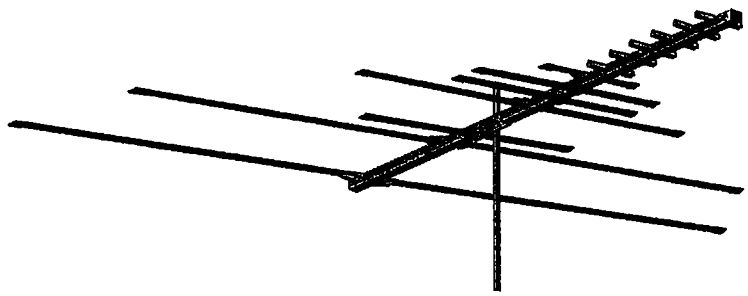
1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model AC13 VHF/UHF/FM Antenna



Model Number:	AC-13

General:

Channels	2 - 69
Electronic Elements	16
Output Impedance	300 ohms

Physical:

Boom Length	70"
Maximum Width	112"
Vertical Height	4"
Turning Radius	62.5"
Element Diameter	.375"
Shipping Weight	3.9 lbs.
Carton Dimensions	5.25" x 4.75" x 71"

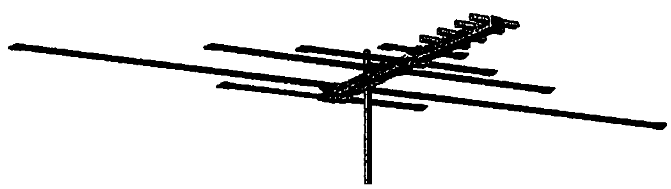
Performance:

1	Gain (dB)	
	VHF Low Band	1.4
	VHF High Band	4.1
	UHF Band	2.0
2	Half-Power Beamwidth (deg.)	
	VHF Low Band	71.3
	VHF High Band	57.8
	UHF Band	47.5
3	Front-To-Back Ratio (dB)	
	VHF Low Band	7.2
	VHF High Band	10.0
	UHF Band	5.3

1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)
2: -3 dB Down Points
3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model AC9 VHF/UHF/FM Antenna



Model Number:	AC-9

General:

Channels	2 - 69
Electronic Elements	12
Output Impedance	300 ohms

Physical:

Boom Length	30"
Maximum Width	98"
Vertical Height	4"
Turning Radius	50.5"
Element Diameter	.375"
Shipping Weight	2.8 lbs.
Carton Dimensions	5.75" x 4.75" x 51"

Performance:

1 Gain (dB)	
VHF Low Band	0.4
VHF High Band	3.7
UHF Band	3.0
2 Half-Power Beamwidth (deg.)	
VHF Low Band	75.7
VHF High Band	54.8
UHF Band	52.1
3 Front-To-Back Ratio (dB)	
VHF Low Band	1.0
VHF High Band	7.5
UHF Band	6.9

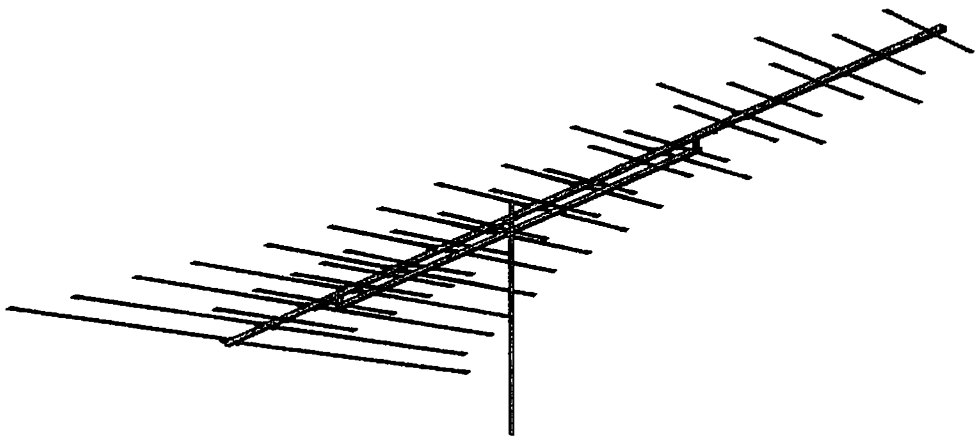
1: Over Half-Wave Tuned Dipole (Ch. 2 - 62)

2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model CS1100 VHF/FM Antenna



Model Number:	CS-1100

General:

Channels	2 - 13
Electronic Elements	42
Output Impedance	300 ohms

Physical:

Boom Length	180"
Maximum Width	110"
Vertical Height	6"
Turning Radius	108"
Element Diameter	.375"
Shipping Weight	11.8 lbs.
Carton Dimensions	5.25" x 6" x 112"

Performance:

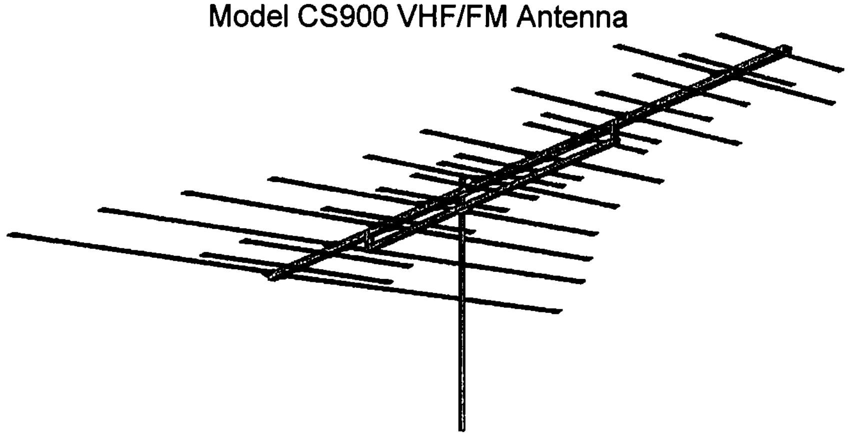
1 Gain (dB)	
VHF Low Band	6.9
VHF High Band	9.6
UHF Band	N/A
2 Half-Power Beamwidth (deg.)	
VHF Low Band	61.0
VHF High Band	38.5
UHF Band	N/A
3 Front-To-Back Ratio (dB)	
VHF Low Band	19.4
VHF High Band	17.6
UHF Band	N/A

1: Over Half-Wave Tuned Dipole
2: -3 dB Down Points
3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®

Model CS900 VHF/FM Antenna



Model Number:	CS-900

General:		
	Channels	2 - 13
	Electronic Elements	33
	Output Impedance	300 ohms

Physical:		
	Boom Length	120"
	Maximum Width	112"
	Vertical Height	6"
	Turning Radius	73"
	Element Diameter	.375"
	Shipping Weight	8.2 lbs.
	Carton Dimensions	6.5" x 6.5"x 81"

Performance:		
[1]	Gain (dB)	
	VHF Low Band	5.9
	VHF High Band	8.0
	UHF Band	N/A
[2]	Half-Power Beamwidth (deg.)	
	VHF Low Band	64.7
	VHF High Band	37.5
	UHF Band	N/A
[3]	Front-To-Back Ratio (dB)	
	VHF Low Band	13.6
	VHF High Band	13.4
	UHF Band	N/A

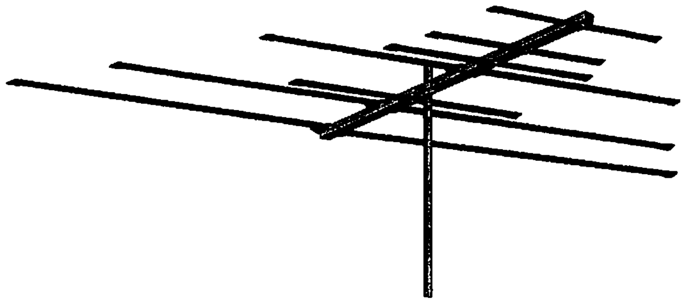
1: Over Half-Wave Tuned Dipole

2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model CS600 VHF/FM Antenna



Model Number:	CS-600

General:

Channels	2 - 13
Electronic Elements	10
Output Impedance	300 ohms

Physical:

Boom Length	50"
Maximum Width	102"
Vertical Height	4"
Turning Radius	55"
Element Diameter	.375"
Shipping Weight	3.5 lbs.
Carton Dimensions	5.875" x 4.75" x 61"

Performance:

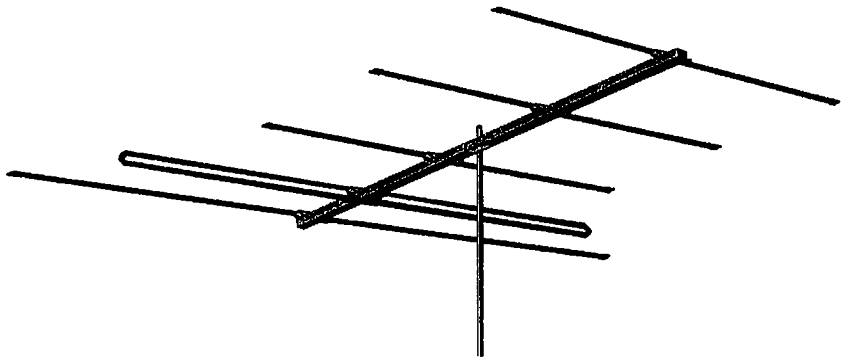
1 Gain (dB)	
VHF Low Band	2.3
VHF High Band	5.5
UHF Band	N/A
2 Half-Power Beamwidth (deg.)	
VHF Low Band	72.0
VHF High Band	37.3
UHF Band	N/A
3 Front-To-Back Ratio (dB)	
VHF Low Band	6.4
VHF High Band	7.9
UHF Band	N/A

1: Over Half-Wave Tuned Dipole
2: -3 dB Down Points
3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®

Model Y5-2-6 VHF Yagi Antenna



Model Number:	Y5-2-6

General:

Channels	2 - 6
Electronic Elements	5
Output Impedance	300 ohms

Physical:

Boom Length	80"
Maximum Width	112"
Vertical Height	4"
Turning Radius	69"
Element Diameter	.375"
Shipping Weight	4.5 lbs.
Carton Dimensions	5.875" x 4.75" x 81"

Performance:

1 Gain (dB)	
VHF Low Band	4.9
VHF High Band	N/A
UHF Band	N/A
2 Half-Power Beamwidth (deg.)	
VHF Low Band	66.3
VHF High Band	N/A
UHF Band	N/A
3 Front-To-Back Ratio (dB)	
VHF Low Band	9.8
VHF High Band	N/A
UHF Band	N/A

1: Over Half-Wave Tuned Dipole

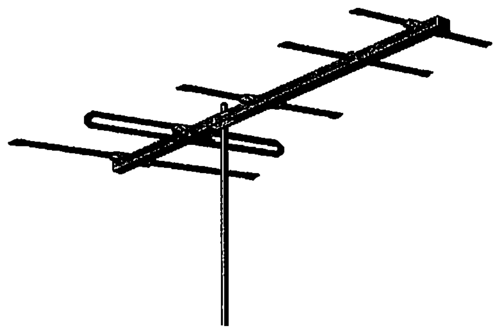
2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®

Model Y5-7-13 VHF Yagi Antenna



Model Number:	Y5-7-13

General:

Channels	7 - 13
Electronic Elements	5
Output Impedance	300 ohms

Physical:

Boom Length	60"
Maximum Width	35.75"
Vertical Height	4"
Turning Radius	41.5"
Element Diameter	.375"
Shipping Weight	4.7 lbs.
Carton Dimensions	5.875" x 4.75" x 61"

Performance:

1 Gain (dB)	
VHF Low Band	N/A
VHF High Band	6.9
UHF Band	N/A
2 Half-Power Beamwidth (deg.)	
VHF Low Band	N/A
VHF High Band	55.5
UHF Band	N/A
3 Front-To-Back Ratio (dB)	
VHF Low Band	N/A
VHF High Band	13.3
UHF Band	N/A

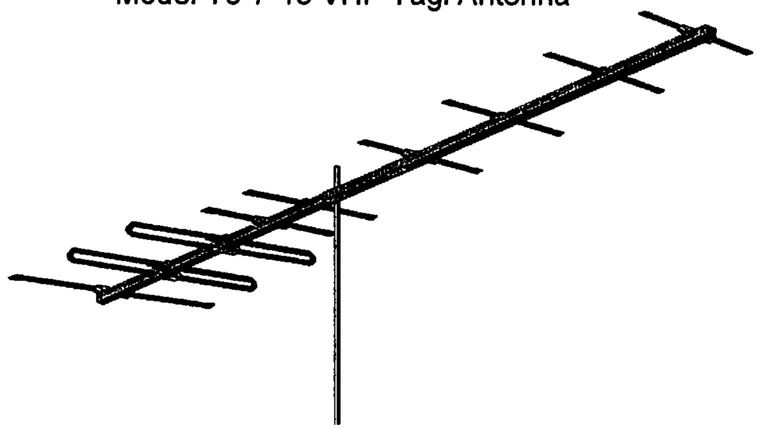
1: Over Half-Wave Tuned Dipole

2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNAÇRAFT®
Model Y5-7-13 VHF Yagi Antenna



Model Number:	Y10-7-13

General:

Channels	7 - 13
Electronic Elements	10
Output Impedance	300 ohms

Physical:

Boom Length	120"
Maximum Width	35.75"
Vertical Height	4"
Turning Radius	70"
Element Diameter	.375"
Shipping Weight	4.8 lbs.
Carton Dimensions	4.5" x 6" x 71"

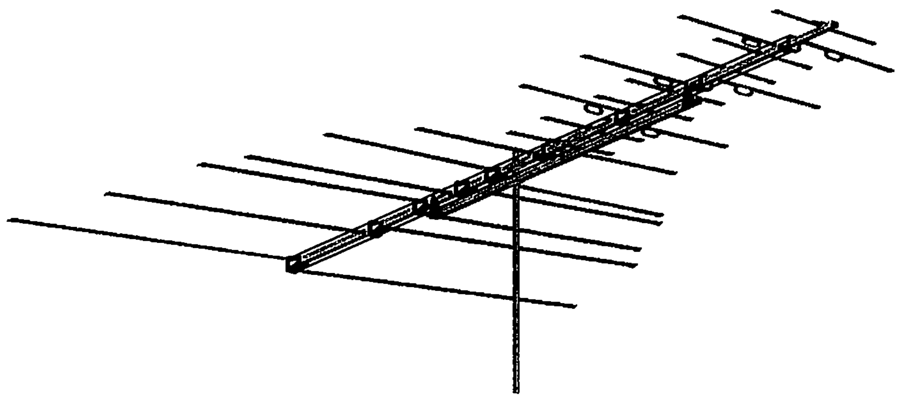
Performance:

1 Gain (dB)	
VHF Low Band	N/A
VHF High Band	9.4
UHF Band	N/A
2 Half-Power Beamwidth (deg.)	
VHF Low Band	N/A
VHF High Band	44.5
UHF Band	N/A
3 Front-To-Back Ratio (dB)	
VHF Low Band	N/A
VHF High Band	16.5
UHF Band	N/A

1: Over Half-Wave Tuned Dipole
2: -3 dB Down Points
3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT.
Model 3BG22 Permacolor. VHF/FM Antenna



Model Number:	3BG22

General:

Channels	2 - 13
Electronic Elements	22
Output Impedance	300 ohms

Physical:

Boom Length	134"
Maximum Width	108"
Vertical Height	4"
Turning Radius	82.5"
Element Diameter	.375"
Shipping Weight	7.5 lbs.
Carton Dimensions	5.75" x 8.75" x 88.25"

Performance:

1 Gain (dB)	
VHF Low Band	5.3
VHF High Band	9.0
UHF Band	N/A
2 Half-Power Beamwidth (deg.)	
VHF Low Band	66.0
VHF High Band	37.3
UHF Band	N/A
3 Front-To-Back Ratio (dB)	
VHF Low Band	15.8
VHF High Band	15.5
UHF Band	N/A

1: Over Half-Wave Tuned Dipole

2: -3 dB Down Points

3: Opposite Hemisphere

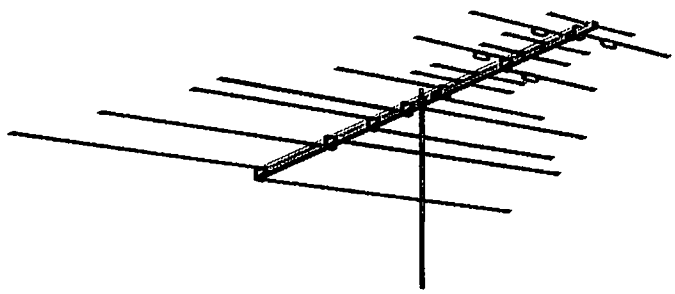
Printed in U.S.A

Antennacraft, P.O. Box 1005, Burlington, IA 52601

Engineering Specifications

ANTENNACRAFT®

Model 3BG17 Permacolor® VHF/FM Antenna



Model Number:	3BG17

General:

Channels	2 - 13
Electronic Elements	17
Output Impedance	300 ohms

Physical:

Boom Length	97"
Maximum Width	108"
Vertical Height	4"
Turning Radius	73"
Element Diameter	.375"
Shipping Weight	7.0 lbs.
Carton Dimensions	5" x 5.25" x 103"

Performance:

Gain (dB)	
VHF Low Band	4.9
VHF High Band	8.0
UHF Band	N/A
Half-Power Beamwidth (deg.)	
VHF Low Band	68.0
VHF High Band	46.8
UHF Band	N/A
Front-To-Back Ratio (dB)	
VHF Low Band	13.2
VHF High Band	14.3
UHF Band	N/A

1: Over Half-Wave Tuned Dipole

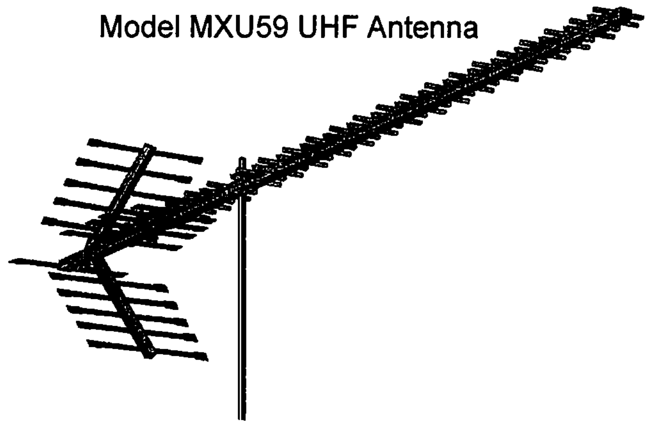
2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®

Model MXU59 UHF Antenna



Model Number:	MXU-59

General:

Channels	14 - 69
Electronic Elements	59
Output Impedance	300 ohms

Physical:

Boom Length	100"
Maximum Width	20"
Vertical Height	38"
Turning Radius	66"
Element Diameter	.375"
Shipping Weight	7.0 lbs.
Carton Dimensions	6.25" x 6.25" x 101"

Performance:

1 Gain (dB)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	10.7
2 Half-Power Beamwidth (deg.)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	32.4
3 Front-To-Back Ratio (dB)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	17.0

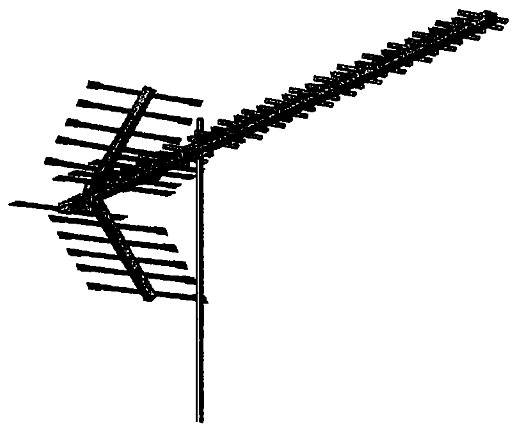
1: Over Half-Wave Tuned Dipole (Ch. 14 - 62)

2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model MXU47 UHF Antenna



Model Number:	MXU-47

General:

Channels	14 - 69
Electronic Elements	47
Output Impedance	300 ohms

Physical:

Boom Length	80"
Maximum Width	20"
Vertical Height	32"
Turning Radius	52.5"
Element Diameter	.375"
Shipping Weight	6.0 lbs.
Carton Dimensions	6.25" x 6.25" x 81"

Performance:

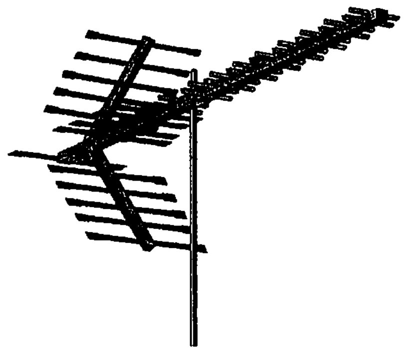
1 Gain (dB)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	10.1
2 Half-Power Beamwidth (deg.)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	33.0
3 Front-To-Back Ratio (dB)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	16.1

1: Over Half-Wave Tuned Dipole (Ch. 14 - 62)
2: -3 dB Down Points
3: Opposite Hemisphere

12/2001 Antennacraft, P.O. Box 1005, Burlington, IA 52601

Engineering Specifications

ANTENNACRAFT®
Model MXU37 UHF Antenna



Model Number:	MXU-37

General:		
	Channels	14 - 69
	Electronic Elements	37
	Output Impedance	300 ohms

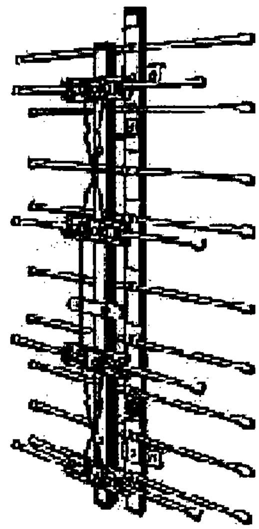
Physical:		
	Boom Length	60"
	Maximum Width	20"
	Vertical Height	32"
	Turning Radius	34.5"
	Element Diameter	.375"
	Shipping Weight	5.0 lbs.
	Carton Dimensions	6.25" x 6.25" x 61"

Performance:		
	1 Gain (dB)	
	VHF Low Band	N/A
	VHF High Band	N/A
	UHF Band	9.2
	2 Half-Power Beamwidth (deg.)	
	VHF Low Band	N/A
	VHF High Band	N/A
	UHF Band	37.9
	3 Front-To-Back Ratio (dB)	
	VHF Low Band	N/A
	VHF High Band	N/A
	UHF Band	14.8

1: Over Half-Wave Tuned Dipole (Ch. 14 - 62)
2: -3 dB Down Points
3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model U1000 UHF Antenna



Model Number:	U-1000

General:

Channels	14 - 69
Electronic Elements	17
Output Impedance	300 ohms

Physical:

Boom Length	35"
Maximum Width	20"
Vertical Height	35"
Turning Radius	10"
Element Diameter	.375"
Shipping Weight	3.1 lbs.
Carton Dimensions	5.75" x 6.75" x 51.5"

Performance:

1 Gain (dB)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	8.1
2 Half-Power Beamwidth (deg.)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	51.0
3 Front-To-Back Ratio (dB)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	20.5

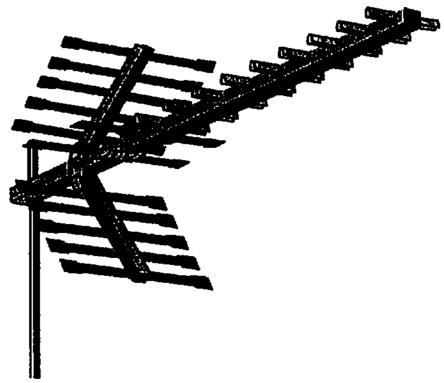
1: Over Half-Wave Tuned Dipole (Ch. 14 - 62)

2: -3 dB Down Points

3: Opposite Hemisphere

Engineering Specifications

ANTENNACRAFT®
Model CY1470 UHF Antenna



Model Number:	CY-1470

General:

Channels	14 - 69
Electronic Elements	21
Output Impedance	300 ohms

Physical:

Boom Length	50"
Maximum Width	16"
Vertical Height	25"
Turning Radius	48.5"
Element Diameter	.375"
Shipping Weight	3.3 lbs.
Carton Dimensions	6.25" x 5.75" x 51"

Performance:

1 Gain (dB)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	7.3
2 Half-Power Beamwidth (deg.)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	44.6
3 Front-To-Back Ratio (dB)	
VHF Low Band	N/A
VHF High Band	N/A
UHF Band	16.4

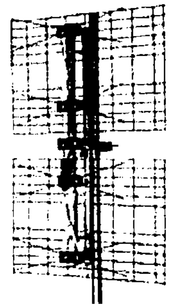
1: Over Half-Wave Tuned Dipole (Ch. 14 - 62)
2: -3 dB Down Points
3: Opposite Hemisphere

Antennas Direct Antennas

ANTENNAS DIRECT

HDTV Antenna Review

The following chart highlights the main characteristics for all of our HDTV antennas. It is important to note that the range of an antenna will vary greatly depending on the height, power, and frequency of the transmitting tower as well as the height of the antenna and the terrain and number of obstacles between it and the receiver. See our **Choosing the Best HDTV Antenna** page for more information.



Product Name	Range*	Style	Indoor | Outdoor	Primary Channels	Gain	Length/ Depth	Width	Height	Weight
Short Range									
DB2	1-30	Multi-Directional	Indoor | Outdoor	UHF 14-69	11.4 dB	4"	19"	12"	2.8 lbs.
SR8	1-15	Uni-Directional	Indoor	UHF 14-69	6.5 dB				
SR15	1-30	Uni-Directional	Outdoor	UHF 14-69	11.0 dB	35"	13"	14"	4.5 lbs.
PF7	1-15	Multi-Directional	Indoor	UHF 14-69	6.5 dB	1"	11"	8"	1.5 lbs.
Medium Range									
DB2	1-30	Multi-Directional	Indoor | Outdoor	UHF 14-69	11.4 dB	4"	19"	12"	2.8 lbs.
DB4	15-55	Multi-Directional	Outdoor	UHF 14-69	13.7 dB	4"	19"	29"	4.5 lbs.
SR15	1-30	Uni-Directional	Outdoor	UHF 14-69	11.0 dB	35"	13"	14"	4.5 lbs.
42XG	10-50	Uni-Directional	Outdoor	UHF 14-69	14.2 dB	39"	19"	15"	4.0 lbs.
Long Range									
DB8	50-70+	Multi-Directional	Outdoor	UHF 14-69	15.8 dB	4"	42"	29"	10.0 lbs.
43XG	15-60	Uni-Directional	Outdoor	UHF 14-69	15.7 dB	62"	18"	19"	5.0 lbs.
91XG	50-70+	Uni-Directional	Outdoor	UHF 14-69	16.7 dB	93"	20"	22"	6.5 lbs.
VHF									
V10	1-25	Uni-Directional	Outdoor	VHF 7-13, UHF 14-69	7.8 dB	32"	69"	n/a	4.5 lbs.
V15	1-45	Uni-Directional	Outdoor	VHF 7-13, UHF 14-69	10.8 dB	43"	95"	n/a	6.5 lbs.
V21	15-65	Uni-Directional	Outdoor	VHF 2-13, UHF 14-69	12.9 dB	59"	110"	n/a	8.5 lbs.
V4	1-55	Uni-Directional	Outdoor	VHF 2-6	4.5 dB	48"	112"	n/a	5.5 lbs.

*The range of an antenna will vary greatly depending on many factors including the height of the mount, topography, direction, etc...

note: all measurements are taken at the widest/highest part of the antenna

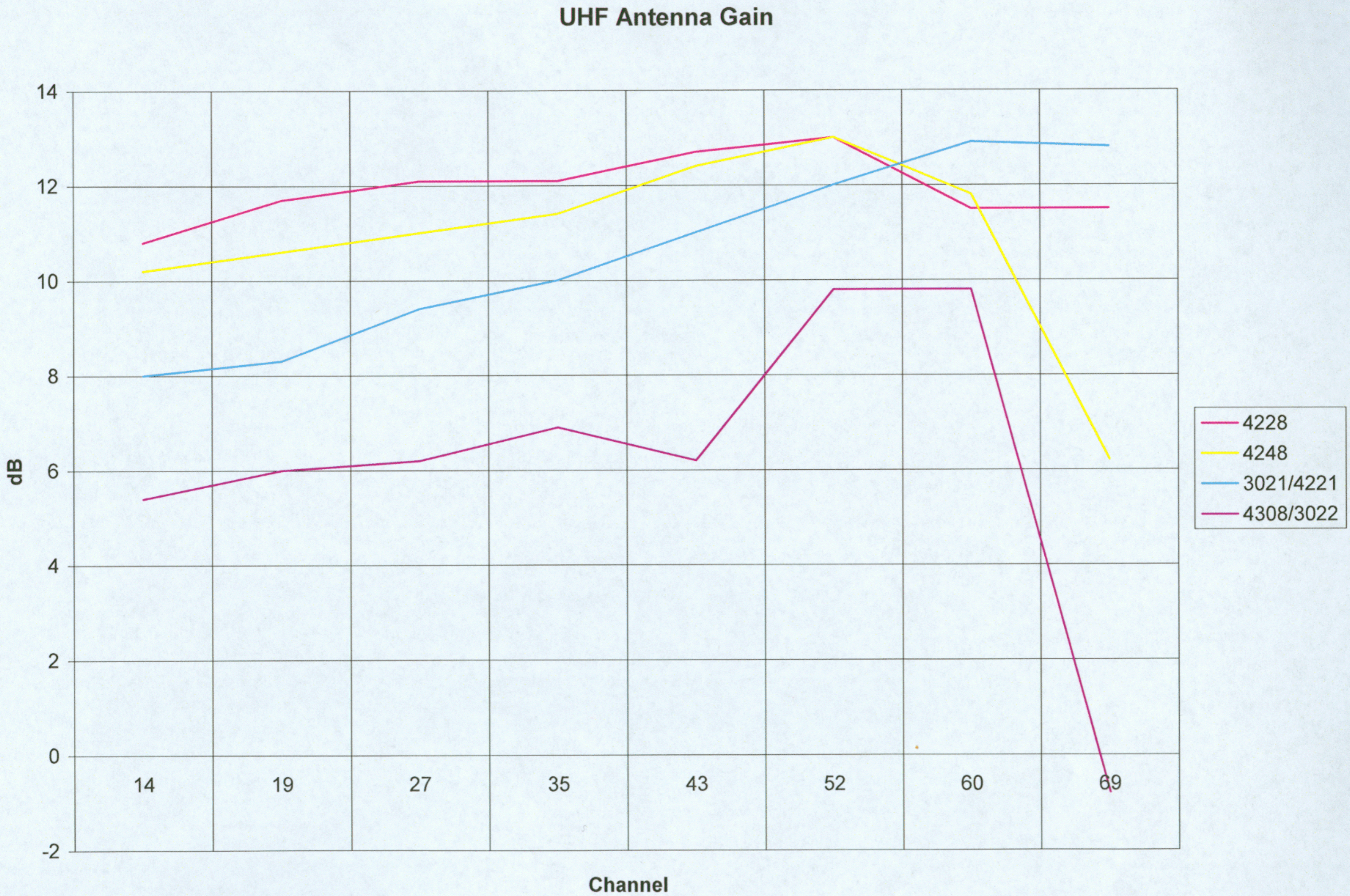
Channel Master Antennas

(Data provided directly by Channel Master.)

UHF ANTENNAS

		Antenna Model	4228	4248	3023	3021/4221	4308/3022
Channel	**Frequency(MHz)**		**Gain**	**Gain**	**Gain**	**Gain**	**Gain**
14	470		10.8	10.2	9.3	8	5.4
19	500		11.7	10.6	9.7	8.3	6
27	548		12.1	11	10.5	9.4	6.2
35	596		12.1	11.4	10.8	10	6.9
43	644		12.7	12.4	11	11	6.2
52	698		13	13	12.4	12	9.8
60	746		11.5	11.8	11.8	12.9	9.8
69	800		11.5	6.2	8.7	12.8	-0.8
		Average Gain	11.9	10.8	10.5	10.6	6.2
		Size	2.77	2.56	2.56	0.9	0.51
		Length	NA	82	82	NA	41

Gain in db over tuned dipole
Size in square feet
Length in inches


UHF Antenna Gain
14
12
10
8
6
4
2
0
-2
dB
14
19
27
35
43
52
60
69
Channel
4228
4248
3021/4221
4308/3022

UHF only pattern summary

		antenna model	4228	4248	3023	4221/3021	4308/3022
Channel	Frequency(MHz)		BW, F/B	BW, F/B	BW, F/B	BW, F/B	BW, F/B
14	470		37deg, 22db	42deg, 17db	43deg, 18db	59deg, 17db	56deg, 21db
19	500		29deg, 23db	36deg, 22db	37deg, 19db	57deg, 16db	54deg, 19db
27	548		26deg, 21db	32deg, 19db	37deg, 23db	54deg, 15db	52deg, 20db
35	596		24deg, 19db	30deg, 21db	34deg, 16db	52deg, 17db	48deg, 15db
43	644		23deg, 24db	27deg, 24db	32deg, 17db	48deg, 16db	43deg, 18db
52	698		20deg, 21db	23deg, 18db	31deg, 19db	44deg, 17db	37deg, 20db
60	746		18deg, 20db	20deg, 15db	24deg, 18db	41deg, 15db	31deg, 16db

BW= 3db beamwidth in degrees
F/B= front to back ratio in db

CROSSFIRE VHF ANTENNAS

	Antenna Model	3610	3611	3612	3613	3614
Channel		Gain	Gain	Gain	Gain	Gain
2		5	4.8	4.2	3.8	2
3		5.6	5.3	5.3	5	3.5
4		5.4	5.2	5.2	5.3	3.8
5		6.7	6.1	6.2	4.4	3.8
6		6.2	5.2	5	4.2	3.9
	Low band avg	5.8	5.3	5.2	4.5	3.4
7		10.6	10.5	10.5	9.6	8.3
8		11.4	10.4	10.3	9.6	8.5
9		11.5	10.1	10.2	9.8	8.6
10		11.6	10.3	10	9.6	8.4
11		11.8	10	9.5	9.6	8.6
12		11.2	10.2	9.1	9	8.1
13		11.6	9.4	7.5	7.4	6.2
	High band avg	11.4	10.1	9.6	9.2	8.1
	Size	4.49	3.89	3.5	2.8	1.91
	Length	147	122	111	87	63

Gain in db over tuned dipole
Size in square feet

Crossfire VHF only Gain

CROSSFIRE U/V ANTENNAS

		Antenna Model	3671	3678	3679	3677
Channel	**Frequency(MHz)**		Gain	Gain	Gain	Gain
2	54		4.9	5.2	3.8	2.2
3	60		5.5	4.8	5	2.7
4	66		5	5.2	3.5	3
5	76		6.2	4.8	4	1.5
6	82		6.2	3.7	3.5	2.2
		Low band avg	5.6	4.7	4.0	2.3
7	174		11	10.5	8.8	7.2
8	180		11.5	10.4	8	7.7
9	186		11	9.6	7.9	8
10	192		11	10	8.4	8.2
11	198		10.9	10	8.8	8.2
12	204		11	9.8	8.2	9
13	210		9.6	7	6.7	7
		High band avg	10.9	9.6	8.1	7.9
14	470		7.5	8.8	7.2	7.8
19	500		9.5	9	9	7.9
27	548		9.8	8.6	8.2	7.8
35	596		9.9	9.8	9.8	8.1
43	644		10	10	9.6	9
52	698		12.5	12.1	11.8	10.2
60	746		11	9	10.9	9
69	800		7.2	-0.5	4	7
		uhf avg	9.7	8.4	8.8	8.4
		size	4.92	3.98	3.2	2.51
		length	173	151	122	97

Gain in db over tuned dipole
Size in square feet
Length in inches

	Antenna Model	3671	3672	3678	3679	3674	3675	3677
Channel		Gain	Gain	Gain	Gain	Gain	Gain	Gain
2		4.9	5	5.2	3.8	3.8	2.8	2.2
3		5.5	5	4.8	5	4.7	2.7	2.7
4		5	5.1	5.2	3.5	4	2.8	3
5		6.2	4.9	4.8	4	4.1	3.2	1.5
6		6.2	4.6	3.7	3.5	3.9	4	2.2
	Low band avg	5.6	4.9	4.7	4.0	4.1	3.1	2.3
7		11	10.8	10.5	8.8	9.5	7.2	7.2
8		11.5	10.5	10.4	8	9	7.6	7.7
9		11	10.2	9.6	7.9	8.4	8	8
10		11	10.8	10	8.4	9.2	7.9	8.2
11		10.9	10.8	10	8.8	9.5	7.7	8.2
12		11	10.8	9.8	8.2	8.8	8.8	9
13		9.6	10	7	6.7	7	5	7
	High band avg	10.9	10.6	9.6	8.1	8.8	7.5	7.9
14		7.5	6	8.8	7.2	6	6	7.8
19		9.5	9	9	9	8	6.8	7.9
27		9.8	9.8	8.6	8.2	7.1	6.5	7.8
35		9.9	10.2	9.8	9.8	8.2	7.2	8.1
43		10	9.8	10	9.6	8.8	8	9
52		12.5	12.5	12.1	11.8	10.5	9.2	10.2
60		11	10	9	10.9	10.5	8.3	9
	uhf avg	10.0	9.6	9.6	9.5	8.4	7.4	8.5
	size	4.92	4.4	3.98	3.2	2.67	2.42	2.51
	length	173	154	151	122	109	96	97

Gain in db over tuned dipole
Size in square feet
Length in inches

	Antenna model	3671	3672	3678	3679	3674	3677	3675	3676
Channel		BW, F/B	BW, F/B	BW, F/B	BW, F/B	BW, F/B	BW, F/B	BW, F/B	BW, F/B
2		69deg, 24db	67deg, 21db	69deg, 21db	74deg, 10db	74deg, 10db	73deg, 12db	73deg, 11db	73deg, 12db
4		69deg, 24db	66deg, 21db	69deg, 20db	65deg, 18db	66deg, 17db	76deg, 10db	72deg, 12db	76deg, 10db
6		68deg, 26db	71deg, 21db	74deg, 22db	72deg, 15db	73deg, 15db	76deg, 11db	77deg, 13db	77deg, 10db
7		26deg, 18db	24deg, 14db	30deg, 17db	30deg, 15db	30deg, 15db	45deg, 16db	32deg, 11db	45deg, 18db
9		34deg, 18db	34deg, 17db	36deg, 15db	32deg, 16db	31deg, 15db	42deg, 11db	46deg, 14db	43deg, 11db
11		36deg, 14db	37deg, 17db	37deg, 14db	32deg, 12db	32deg, 13db	33deg, 9db	33deg, 10db	34deg, 9db
13		35deg, 16db	34deg, 16db	33deg, 13db	26deg, 10db	29deg, 9db	38deg, 11db	30deg, 11db	39deg, 11db
14		32deg, 12db	31deg, 12db	35deg, 17db	44deg, 13db	47deg, 10db	52deg, 10db	43deg, 5db	54deg, 8db
19		25deg, 13db	25deg, 13db	55deg, 17db	47deg, 21db	57deg, 15db	59deg, 12db	60deg, 12db	63deg, 11db
27		37deg, 17db	39deg, 15db	53deg, 14db	51deg, 12db	54deg, 11db	52deg, 11db	57deg, 11db	56deg, 9db
35		32deg, 15db	32deg, 14db	37deg, 14db	41deg, 13db	44deg, 12db	53deg, 16db	51deg, 12db	63deg, 16db
43		28deg, 15db	29deg, 15db	38deg, 17db	45deg, 15db	50deg, 14db	45deg, 19db	49deg, 14db	51deg, 17db
52		24deg, 16db	26deg, 18db	33deg, 18db	32deg, 23db	36deg, 21db	42deg, 18db	43deg, 17db	51deg, 18db
60		20deg, 9db	21deg, 11db	31deg, 12db	25deg, 14db	31deg, 14db	34deg, 14db	32deg, 16db	39deg, 13db

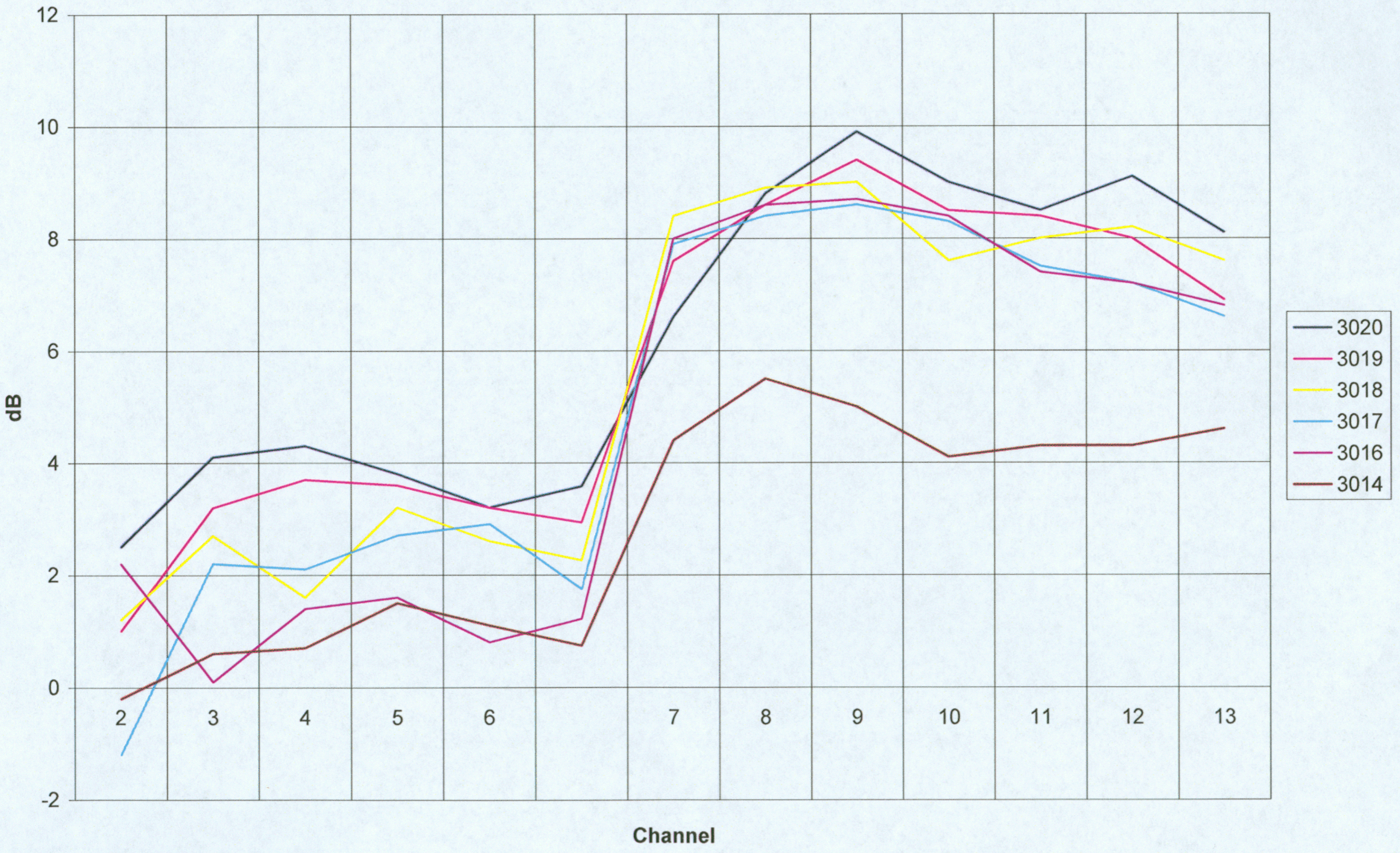
BW= 3db beamwidth in degrees
F/B= front to back ratio in db

ADVANTAGE ANTENNAS

	Antenna Model	3020	3019	3018	3017	3016	3015	3014
Channel		Gain	Gain	Gain	Gain	Gain	Gain	Gain
2		2.5	1	1.2	-1.2	2.2	0.2	-0.2
3		4.1	3.2	2.7	2.2	0.1	0.3	0.6
4		4.3	3.7	1.6	2.1	1.4	0.6	0.7
5		3.8	3.6	3.2	2.7	1.6	1.3	1.5
6		3.2	3.2	2.6	2.9	0.8	1.1	1.1
	Low band avg	3.6	2.9	2.3	1.74	1.2	0.7	0.7
7		6.6	7.6	8.4	7.9	8	5.5	4.4
8		8.8	8.6	8.9	8.4	8.6	6.6	5.5
9		9.9	9.4	9	8.6	8.7	6.7	5
10		9	8.5	7.6	8.3	8.4	6.2	4.1
11		8.5	8.4	8	7.5	7.4	5.4	4.3
12		9.1	8	8.2	7.2	7.2	5.3	4.3
13		8.1	6.9	7.6	6.6	6.8	5.3	4.6
	High band avg	8.6	8.2	8.2	7.8	7.9	5.9	4.6
14		8.2	7.5	7.1	6	5.5	4.2	2.4
19		9.4	8.4	7.2	6.5	6.5	4.9	1.3
27		9.2	8.5	8	6.8	6.3	8	6
35		10.3	9.7	9.1	9.5	8.1	6.2	6.6
43		9.9	9.3	7.7	8.8	8.9	6.6	6.1
52		9.8	11	9.7	9.8	9.2	8.3	7.6
60		9.5	10.2	10.1	9.6	9.5	3.8	5.7
69		0.6	0.1	0	-1	7	-2	-2
	uhf avg	8.4	8.1	7.4	7.0	7.6	5.0	4.2
	size	4.12	3.22	2.55	2.19	1.72	1.29	0.99
	length	152	133	113	94	66	52	52

Gain in db over tuned dipole
Size in square feet
Length in inches

Advantage Line Antenna Gain



Antenna Model 2001

	Antenna Model	2001			
Channel		Gain		Length	27 inches
2		-2.8		Width	84.75 inches
3		-3.2			
4		-1.5			
5		-0.6			
6		0.2			
	Low band avg	-1.6			
7		3.1			
8		3.4			
9		2.2			
10		2.4			
11		3.8			
12		3.7			
13		1.6			
	High band avg	2.9			
14		3			
19		1.8			
27		2			
35		4.8			
43		2			
52		5.5			
60		6.8			
	uhf avg	3.7			

Gain in db over tuned dipole

Channel Master 4242 U/V Antenna

Ch	Freq	Half Power Beamwidth	F/B Ratio
2P	55.25	69	15.9
4P	67.25	69	19
6P	83.25	65	22.3
6S	87.75	71	18.6
FM	88	72	18.7
FM	98	68	13
FM	108	63	9.9
7P	175.25	24	11.9
9P	187.25	32	13.1
11P	199.25	38	16.7
13P	211.25	40	14.3
13S	215.75	35	12
	470	33	14.8
	500	50	17.7
	550	45	13.5
	600	34	13
	650	35	10.7
	700	34	18.5
	750	30	13.6
	800	24	13.2

CM 3010A

Pattern Summary

Frequency (MHz)	Channel		Half Power Beamwidth (Deg)		F/B Ratio (dB)
55.25	2		86		0.7
67.25	4		88		0.5
83.25	6		80		-1.1
		VHF L Avg=	85	VHF L Avg=	0.0
175.25	7		51		0.0
187.25	9		51		3.7
199.25	11		59		8.2
211.25	13		106		10.3
		VHF H Avg=	**66.75**	VHF H Avg=	**5.6**
470	14		76		5.6
500	20		47		9.5
550	26		44		13.1
600	32		45		12.0
650	38		36		8.4
700	44		79		11.4
750	50		108		7.5
800	56		60		6.6
		UHF Avg.=	**62**	UHF Avg.=	**9.3**

Gain Summary

Frequency (MHz)		Gain (dB)
55.25		-10.71
61.25		-9.31
67.25		-7.61
77.25		-3.33
83.25		-2.04
87.75		-0.94
	VHF L Avg=	**-5.7**
175.25		0
181.25		0.66
187.25		1.25
193.25		2.08
199.25		0.02
205.25		-0.75
211.25		-1.10
215.75		-1.24
	VHF H Avg=	**0.12**
470		-3.93
500		-2.26
550		-0.88
600		1.76
650		-2.69
700		-0.14
750		-2.60
800		-0.27
	UHF Avg.=	**-1.38**

***CEMA Classification: Large Multi-Directional**

*Engineering Bulletin EIA/CEB-6-C March 26,1999

dedwards(Q:)\excel\UHFsummary sheet2

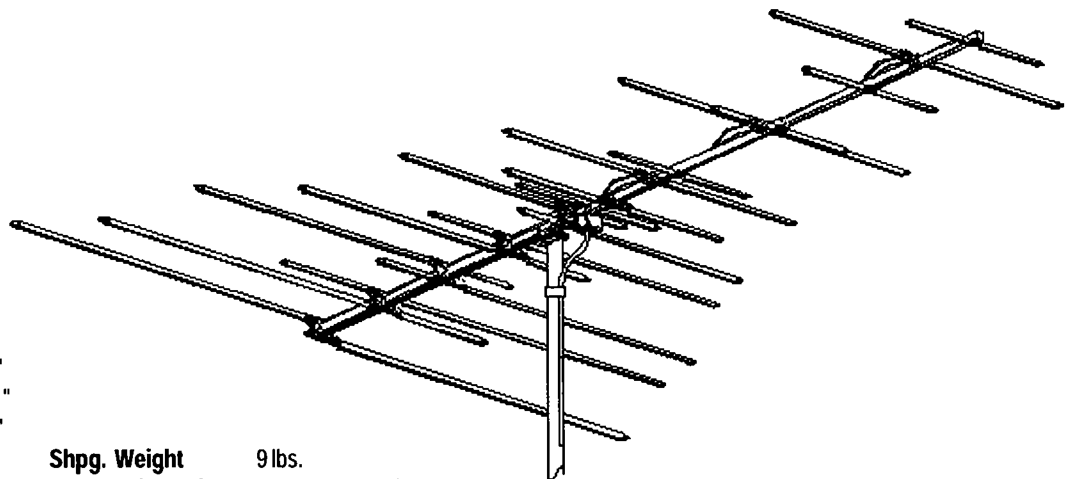
Winegard Antennas

WINEGARD®
Clearly the World's Best®

engineering specifications

PLATINUM SERIES
HIGH DEFINITION VHF ANTENNA

Model HD4053P



Active Elements 24
Boom Length 111"
Turning Radius 72.5"
Maximum Width 110"
Vertical Height 3"
Element Diameter 3/8"

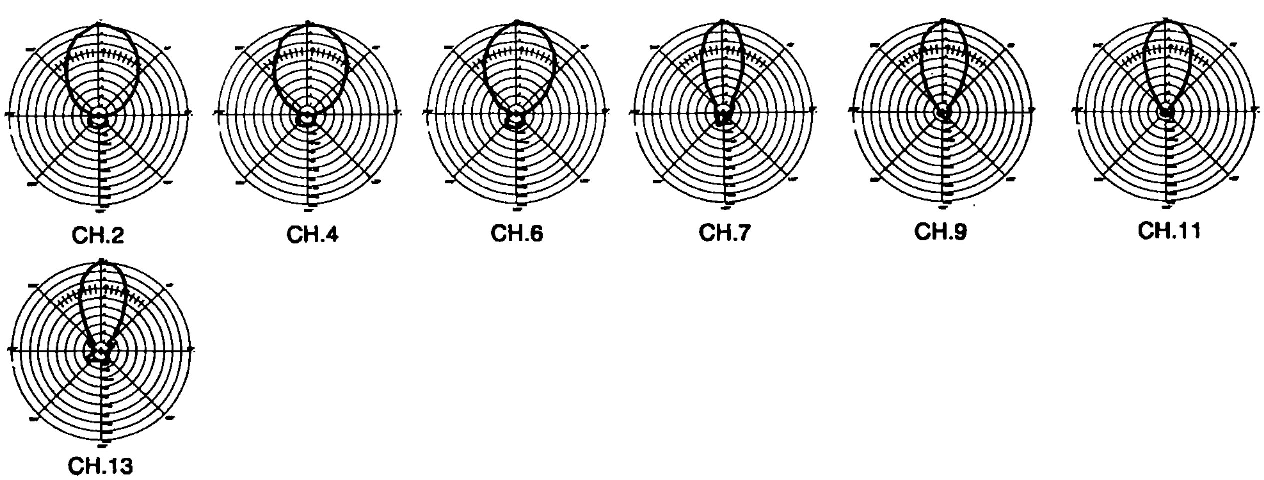
Shpg. Weight 9 lbs.
Carton Dimensions 6.25"x6.25"x89"

Output Impedance: 75 ohm
Recommended Preamp: AP Series

Made in U.S.A.

GAIN	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13
dB over reference dipole	5.9	6.6	6.4	9.6	11.1	9.8	10.6
beamwidth at half power points	70°	69°	66°	37°	42°	43°	42°
front-to-back ratio	17dB	18dB	17dB	18dB	greater than 20dB	greater than 20dB	17dB

POLAR PATTERNS



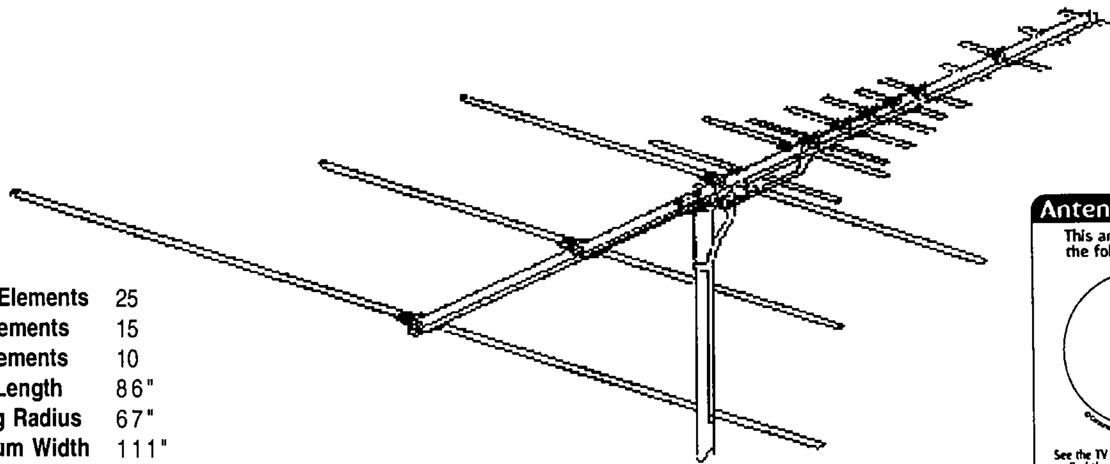
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 4-02

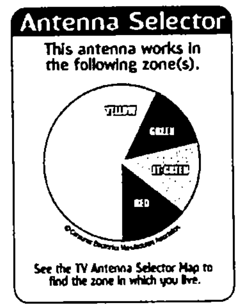
WINEGARD®
Clearly the World's Best®

PLATINUM SERIES
HIGH DEFINITION VHF/UHF ANTENNA

engineering specifications

Model HD7210P
GHOST KILLER™





Active Elements	25		
UHF Elements	15		
VHF Elements	10		
Boom Length	86"		
Turning Radius	67"		
Maximum Width	111"		
Vertical Height	3.5"	**Shpg. Weight**	6.5 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25"x6.25"x89"

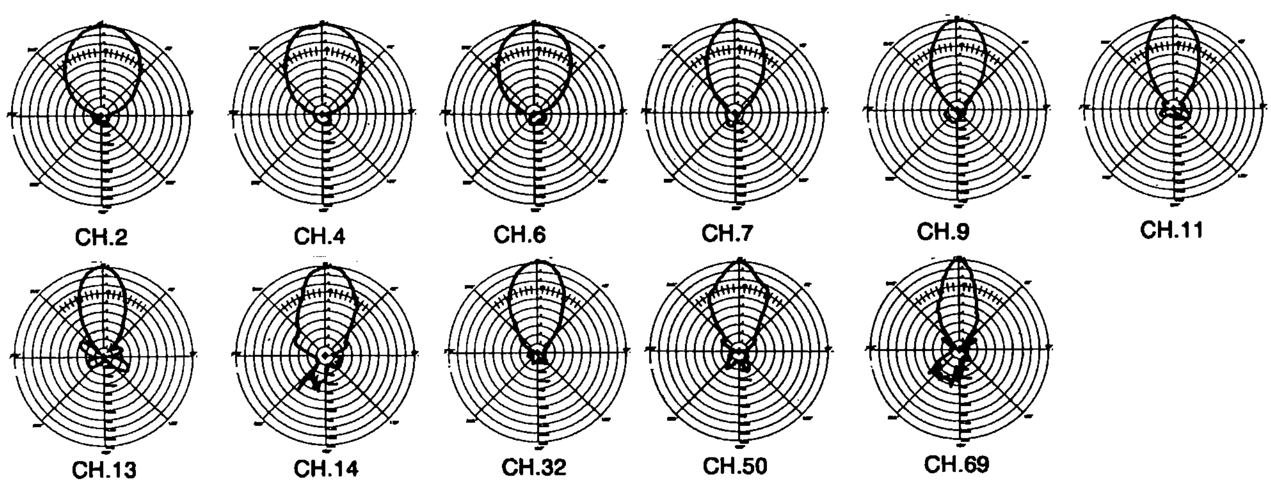
"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

Output Impedance: 75 ohm
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
beamwidth at half power points	73°	73°	70°	53°	50°	48°	42°	50°	50°	56°	31°
front-to-back ratio	greater than 20dB	20dB	19dB	17dB	17dB	15dB	10.5dB	8dB	17dB	13dB	9dB

POLAR PATTERNS



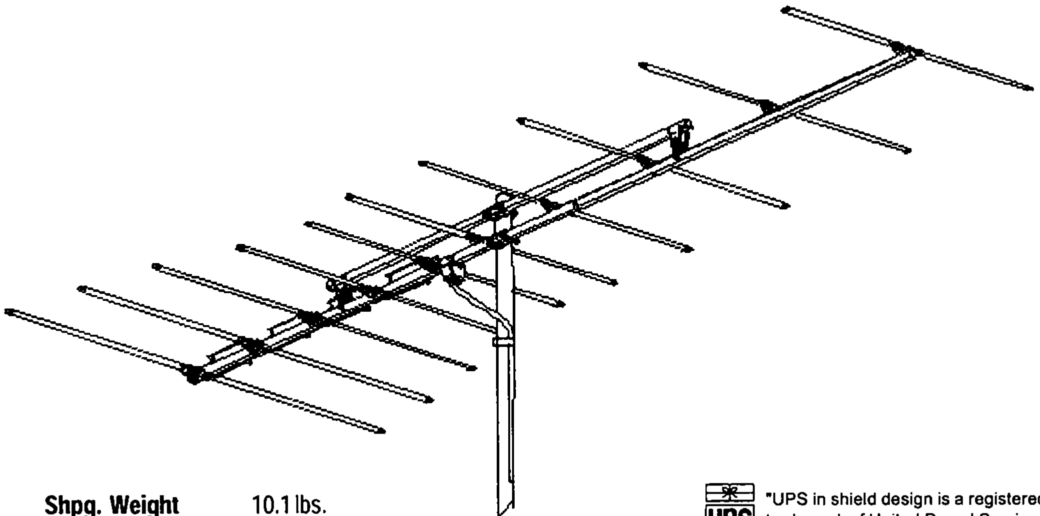
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/02

PLATINUM SERIES
HIGH DEFINITION
FM
ANTENNA

WINEGARD®
Clearly the World's Best®

engineering specifications

Model HD6065P



Active Elements 10
Boom Length 127"
Turning Radius 76"
Maximum Width 69"
Vertical Height 6"
Element Diameter 3/8"

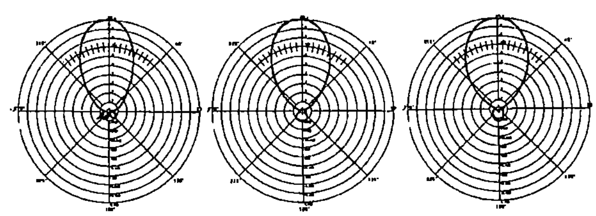
Shpg. Weight 10.1 lbs.
Carton Dimensions 6.25"x6.25"x76"

Made in U.S.A.

Output Impedance: 75 ohm
Recommended Preamp: AP Series

GAIN	88MHz	98MHz	108MHz
dB over reference dipole	9.4	10.6	10.6
beamwidth at half power points	59°	53°	48°
front-to-back ratio	18dB	19dB	20dB

POLAR PATTERNS



88MHz 98MHz 108MHz

Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 4/02

WINEGARD®

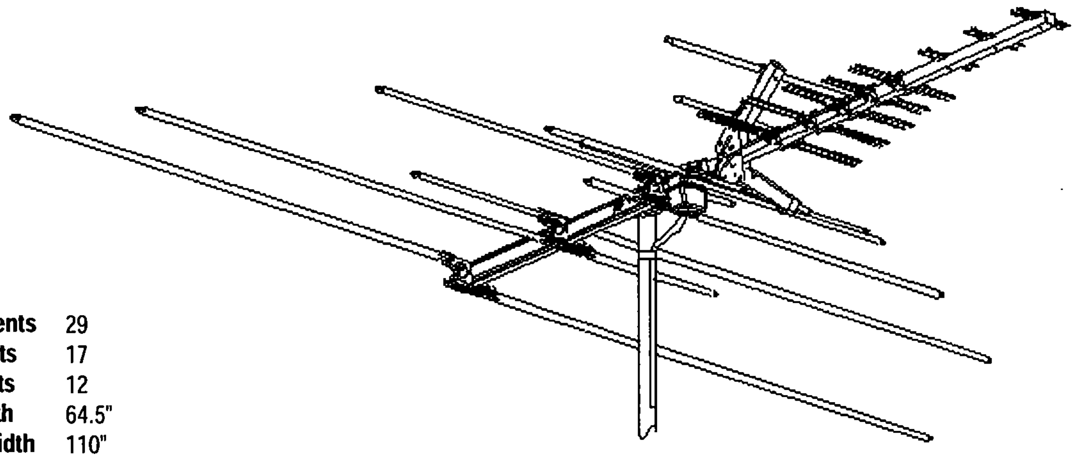
Clearly the World's Best®

PLATINUM SERIES

HIGH DEFINITION VHF/UHF ANTENNA

engineering specifications

Model HD7078P



Active Elements 29
UHF Elements 17
VHF Elements 12
Boom Length 64.5"
Maximum Width 110"
Vertical Height 13.6"
Element Diameter 3/8"

Shpg. Weight 7 lbs.
Carton Dimensions 6.25"x6.25"x77"

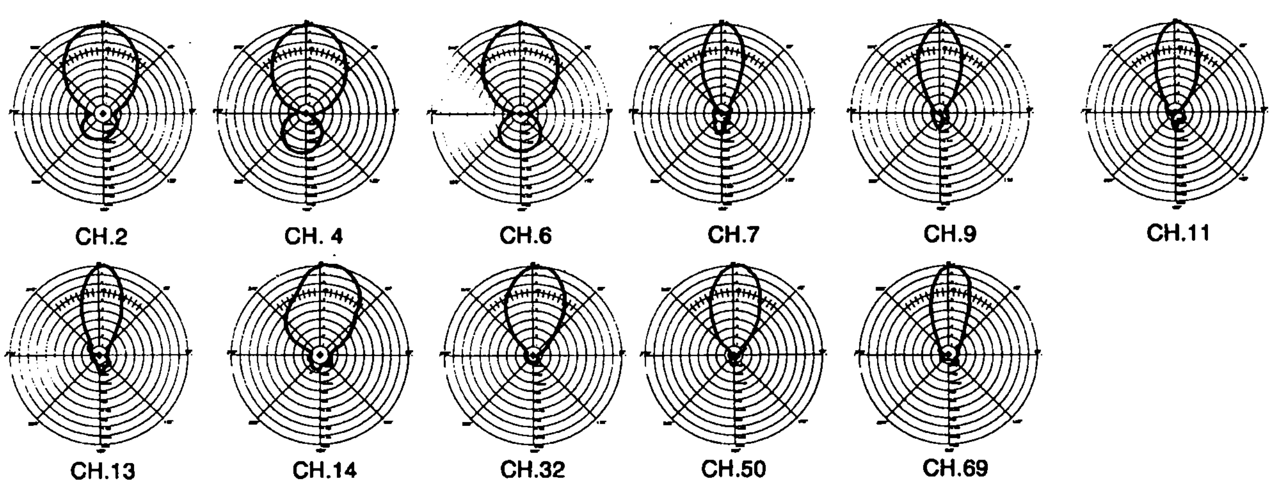
"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

Output Impedance: 75 ohm
Recommended Preamp: AP Series

Made in U.S.A.

GAIN	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB over reference dipole	3.5	3.4	1.6	8.3	9.6	8	9.9	11.5	10.4	10.7	9.7
beamwidth at half power points	70°	73°	70°	37°	38°	39°	37°	61°	54°	46°	34°
front-to-back ratio	10.5dB	7dB	7.5dB	13dB	16dB	15dB	16dB	16dB	greater than 20dB	19dB	18dB

POLAR PATTERNS



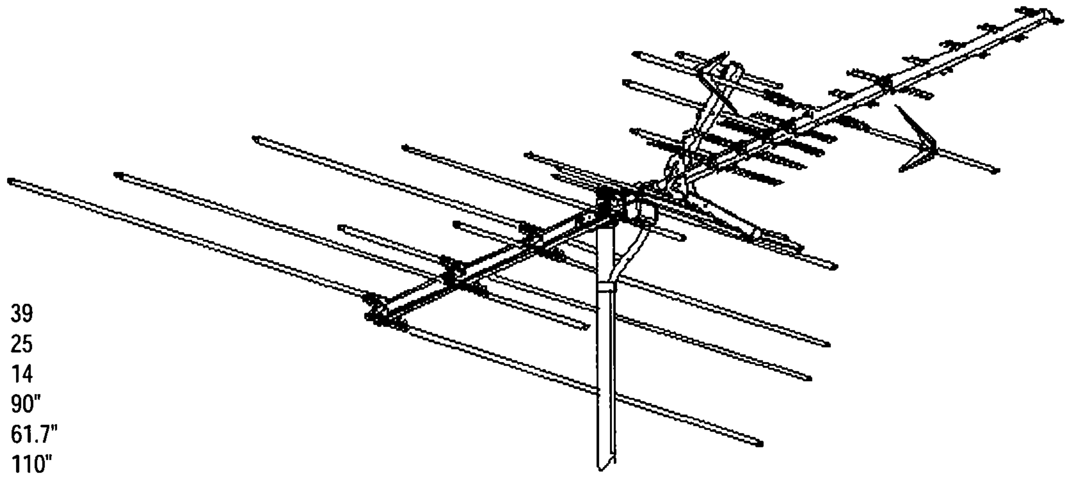
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 4/02

WINEGARD®
Clearly the World's Best®

PLATINUM SERIES
HIGH DEFINITION VHF/UHF ANTENNA

engineering specifications

Model HD7080P



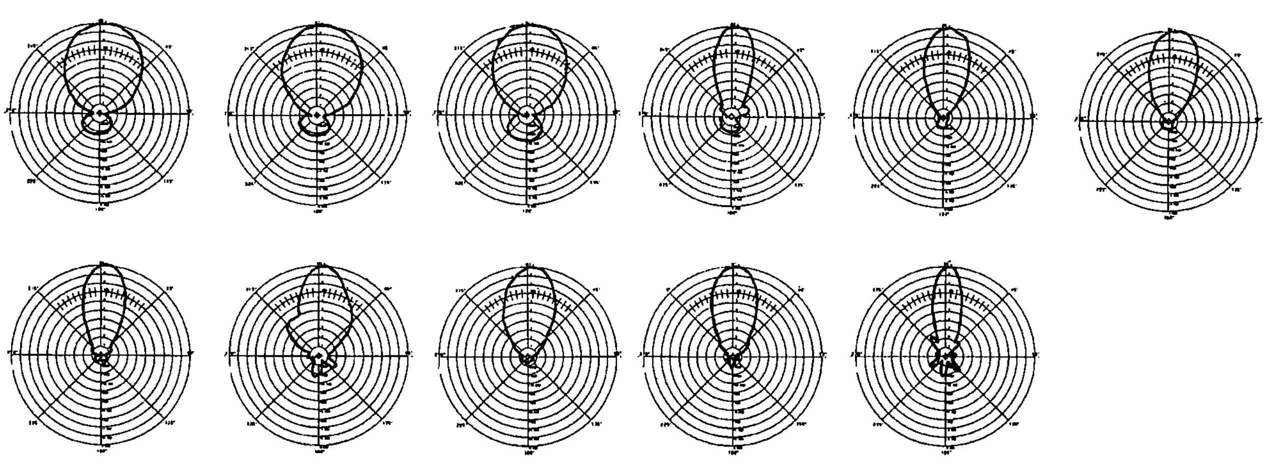
Active Elements 39
UHF Elements 25
VHF Elements 14
Boom Length 90"
Turning Radius 61.7"
Maximum Width 110"
Vertical Height 19.3"
Element Diameter 3/8"
Shpg. Weight 9.5 lbs.
Carton Dimensions 6.25"x6.25"x101"

Output Impedance: 75 ohm
Recommended Preamp: AP Series

Made in U.S.A.

GAIN	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB over reference dipole	5.1	5	2.8	7.6	9.5	9.2	11	11.7	11.4	11	10.2
beamwidth at half power points	75°	77°	77°	36°	42°	45°	39°	45°	46°	41°	35°
front-to-back ratio	13dB	13dB	11dB	15dB	19dB	greater than 20dB	greater than 18dB	13dB	greater than 20dB	20dB	14dB

POLAR PATTERNS



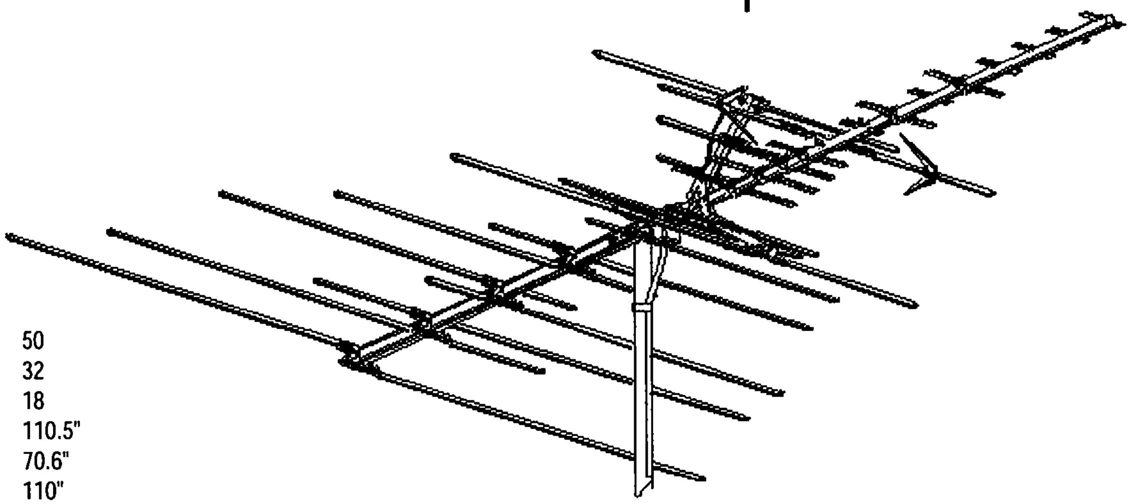
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 4/02

WINEGARD®
Clearly the World's Best®

PLATINUM SERIES
HIGH DEFINITION VHF/UHF ANTENNA

engineering specifications

Model HD7082P



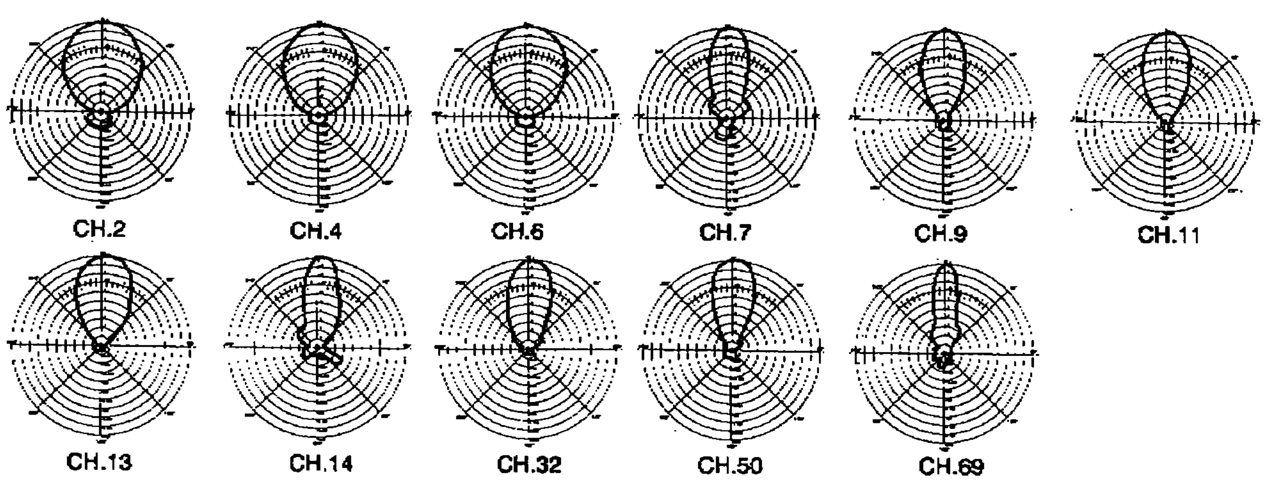
Active Elements 50
UHF Elements 32
VHF Elements 18
Boom Length 110.5"
Turning Radius 70.6"
Maximum Width 110"
Vertical Height 19.3"
Element Diameter 3/8"
Shpg. Weight 10.8 lbs.
Carton Dimensions 6.25"x6.25"x89"

Output Impedance: 75 ohm
Recommended Preamp: AP Series

Made in U.S.A.

GAIN	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB over reference dipole	6.4	6.4	6.2	10	10.9	10.2	10	13	12.2	10.8	12.2
beamwidth at half power points	76°	71°	73°	35°	40°	44°	51°	31°	40°	39°	21°
front-to-back ratio	15dB	20dB	19dB	13dB	20dB	20dB	greater than 20dB	10.5dB	greater than 20dB	20dB	16dB

POLAR PATTERNS



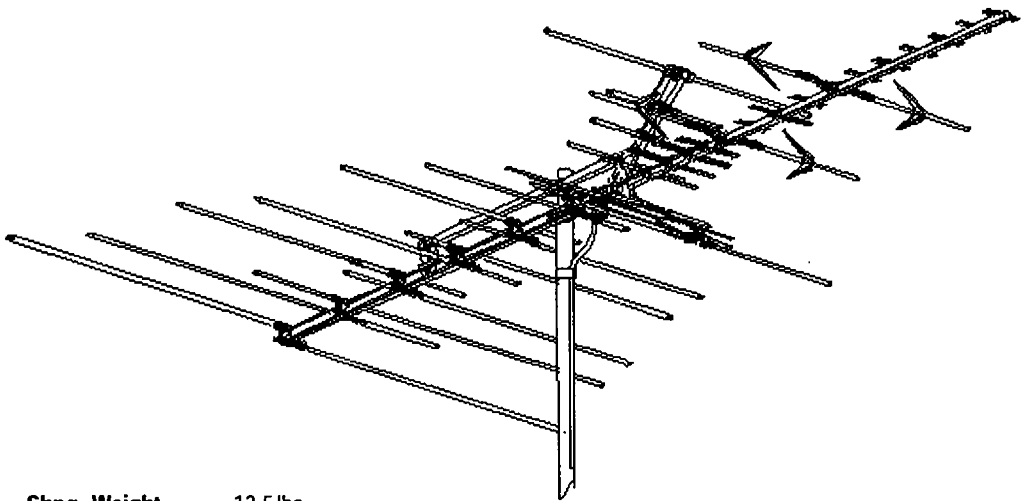
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 4/02

WINEGARD®
Clearly the World's Best®

PLATINUM SERIES
HIGH DEFINITION VHF/UHF ANTENNA

engineering specifications

Model HD7084P



Active Elements 68
UHF Elements 40
VHF Elements 28
Boom Length 131"
Turning Radius 81"
Maximum Width 110"
Vertical Height 25.5"
Element Diameter 3/8"

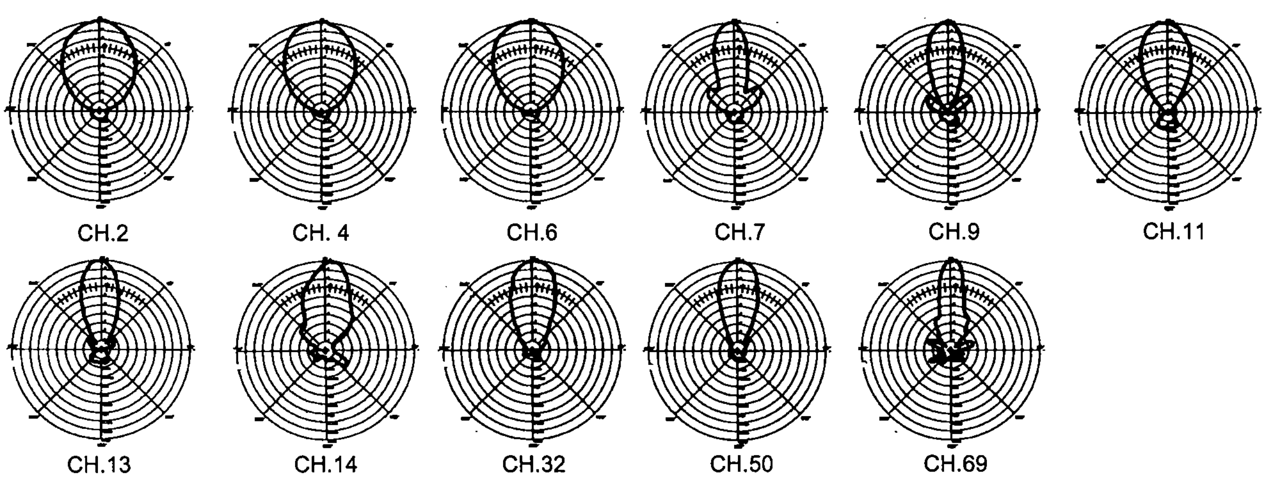
Shpg. Weight 13.5 lbs.
Carton Dimensions 6.25"x6.25"x104.25"

Output Impedance: 75 ohm
Recommended Preamp: AP Series

Made in U.S.A.

GAIN	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB over reference dipole	6.2	7.2	7.6	10.9	12	10.9	10.8	14.6	12.1	11.8	10.2
beamwidth at half power points	69°	68°	68°	31°	33°	46°	34°	42°	41°	36°	22°
front-to-back ratio	20dB	greater than 20dB	greater than 20dB	19dB	17dB	15dB	17dB	11dB	20dB	20dB	12dB

POLAR PATTERNS



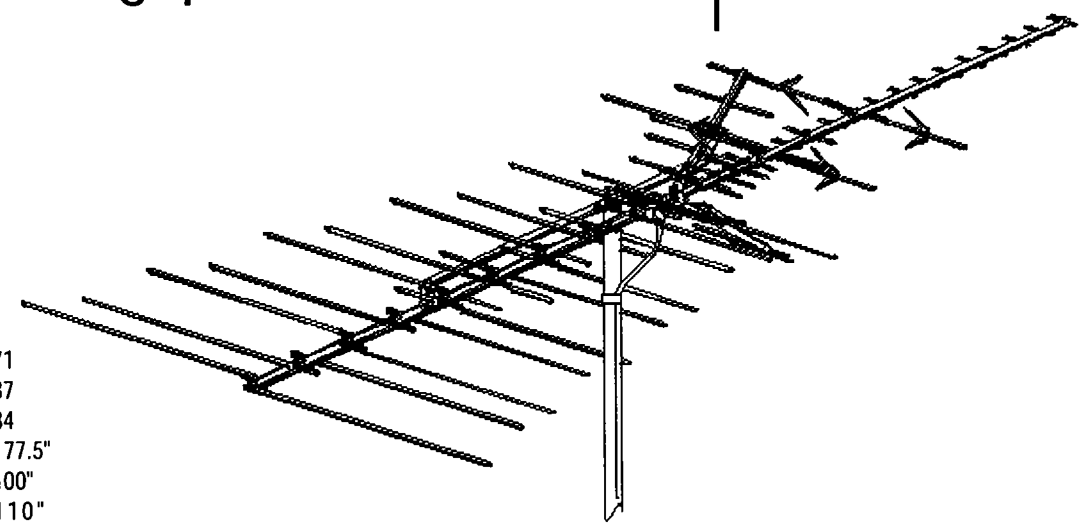
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 4-02

WINEGARD®
Clearly the World's Best®

PLATINUM SERIES
HIGH DEFINITION VHF/UHF ANTENNA

engineering specifications

Model HD8200P



Active Elements 71
UHF Elements 37
VHF Elements 34
Boom Length 177.5"
Turning Radius 100"
Maximum Width 110"
Vertical Height 31.5"
Element Diameter 3/8"

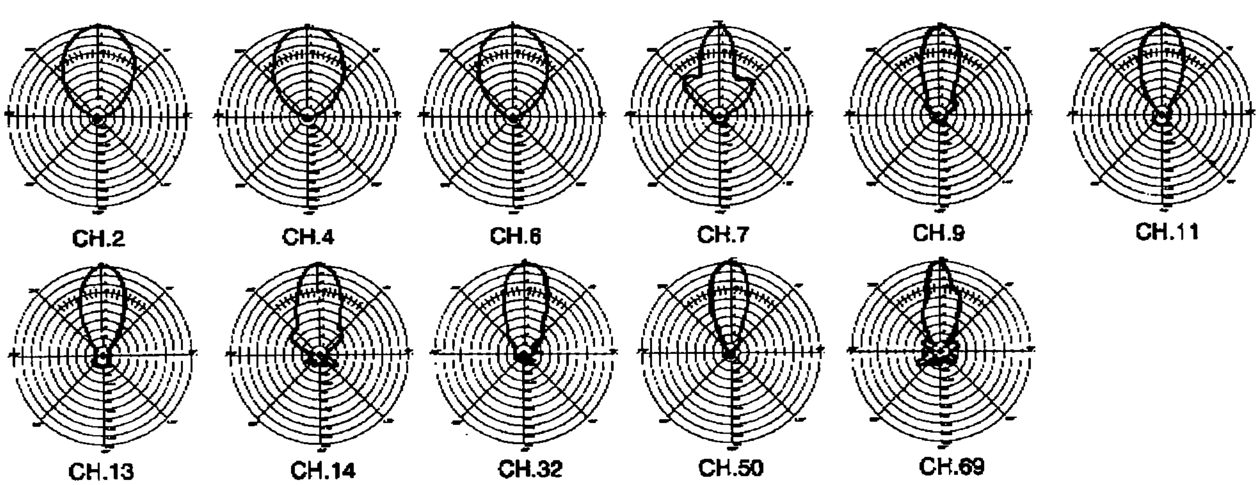
Shpg. Weight 17 lbs.
Carton Dimensions 6.25"x6.25"x122"

Output Impedance: 75 ohm
Recommended Preamp: AP Series

Made in U.S.A.

GAIN	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB over reference dipole	7	7.7	6.4	10.4	12.6	11	12	14.2	13.7	12.2	13
beamwidth at half power points	68°	68°	66°	29°	34°	42°	41°	40°	41°	33°	23°
front-to-back ratio	greater than 20dB	greater than 20dB	greater than 20dB	greater than 20dB	greater than 20dB	19dB	18dB	13dB	20dB	greater than 20dB	10.5dB

POLAR PATTERNS



Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 4/02

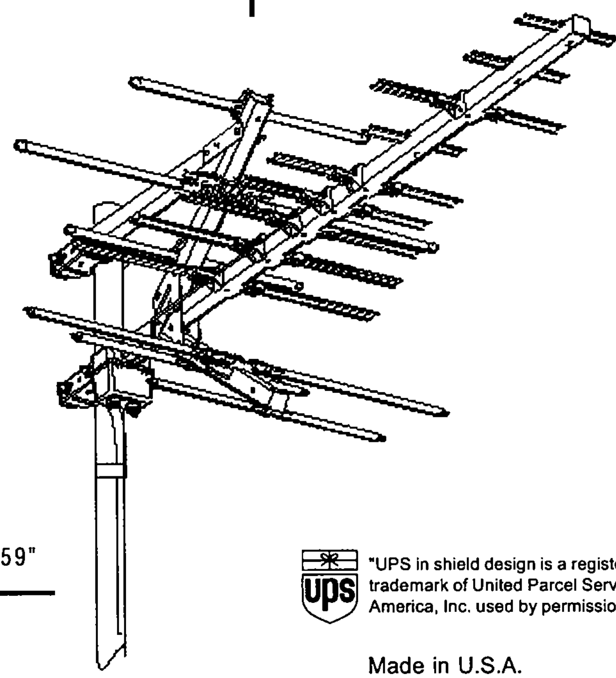
WINEGARD®

Clearly the World's Best®

PLATINUM SERIES
HIGH DEFINITION
UHF
ANTENNA

engineering specifications

Model HD9065P



Active Elements	23		
Boom Length	50"		
Turning Radius	47.7"		
Maximum Width	27"		
Vertical Height	19"	**Shpg. Weight**	6 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25"x6.25"x59"

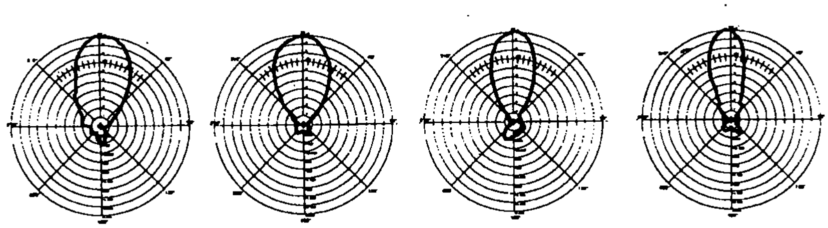
"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

Made in U.S.A.

Output Impedance: 75 ohm
Recommended Preamp: AP Series

CHANNEL	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	11.9	12.1	11.6	10.6
beamwidth at half power points	52°	53°	40°	31°
front-to-back ratio	14dB	19dB	14dB	17dB

POLAR PATTERNS



CH.14 CH.32 CH.50 CH.69

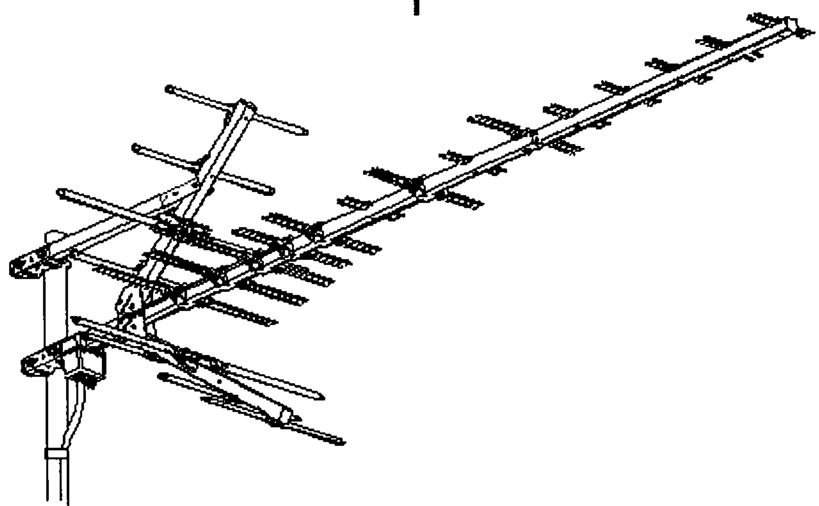
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 2/02

WINEGARD®
Clearly the World's Best®

PLATINUM SERIES
HIGH DEFINITION UHF ANTENNA

engineering specifications

Model HD9085P



Active Elements 31
Boom Length 75"
Turning Radius 72.75"
Maximum Width 27"
Vertical Height 25.5"
Element Diameter 3/8"

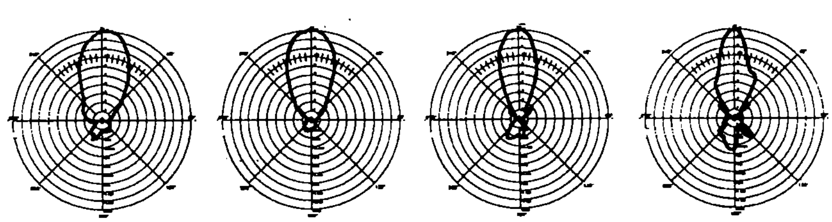
Shpg. Weight 6.5 lbs.
Carton Dimensions 6.25"x6.25"x59"

Output Impedance: 75 ohm
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	11.9	14.6	14.5	12.8
beamwidth at half power points	45°	44°	32°	23°
front-to-back ratio	14dB	18dB	12dB	9dB

POLAR PATTERNS



CH.14 CH.32 CH.50 CH.69

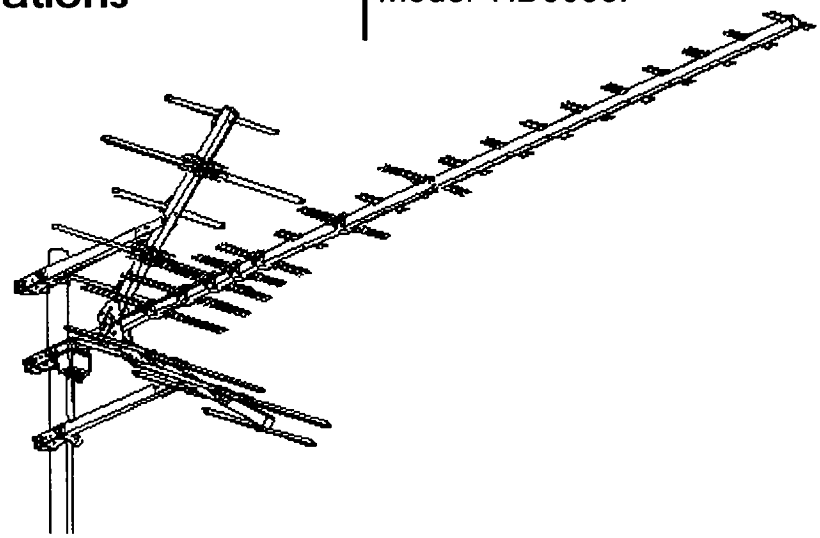
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 2/02

WINEGARD®
Clearly the World's Best®

PLATINUM SERIES
HIGH DEFINITION
UHF
ANTENNA

engineering specifications

Model HD9095P



Active Elements 39
Boom Length 95"
Turning Radius 92.75"
Maximum Width 27"
Vertical Height 31.75"
Element Diameter 3/8"
Shpg. Weight 8 lbs.
Carton Dimensions 6.25"x6.25"x59"

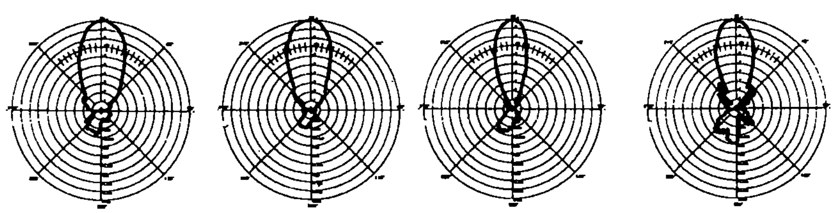
Output Impedance: 75 ohm
Recommended Preamp: AP Series

"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

Made in U.S.A.

CHANNEL	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	14.2	16	15.5	12.2
beamwidth at half power points	43°	41°	30°	34°
front-to-back ratio	11dB	14dB	11dB	8dB

POLAR PATTERNS



CH.14 CH.32 CH.50 CH.69

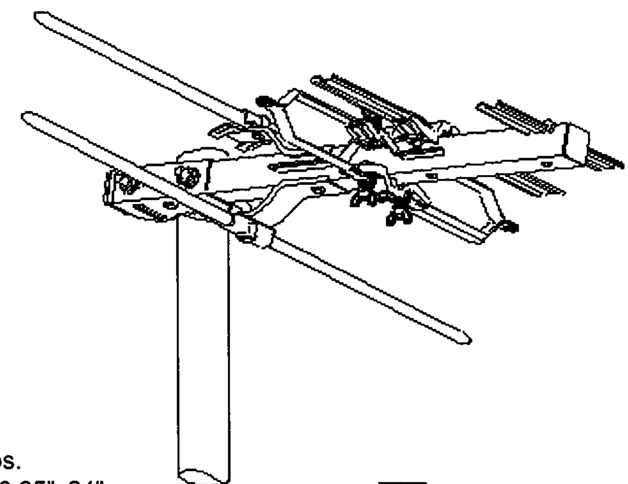
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 2/02

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 UHF ANTENNA

engineering specifications

Model PR-9012

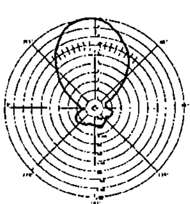


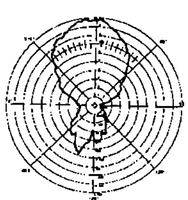
Active Elements	5
Boom Length	17"
Turning Radius	15.5"
Maximum Width	22"
Vertical Height	4"
Element Diameter	3/8"
Shpg. Weight	2 lbs.
Carton Dimensions	4"x6.25"x24"

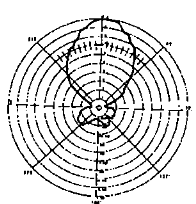
Output Impedance: 300 ohm / 75 ohm with included matching transformer
Recommended Preamp: AP Series

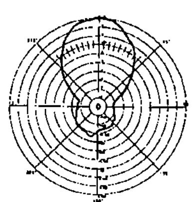
CHANNEL	CH.14	CH.20	CH.26	CH.32	CH.38	CH.44	CH.50	CH.56	CH.62	CH.69
dB gain over reference dipole	3.3	3.9	4.0	5.0	6.4	6.2	6.0	6.2	6.4	6.2
beamwidth at half power points	71°	68°	63°	73°	59°	57°	58°	60°	45°	58°
front-to-back ratio	12dB	5dB	11dB	9dB	10.5dB	10dB	9dB	35dB	9dB	3.5dB

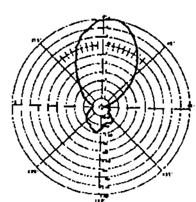
POLAR PATTERNS

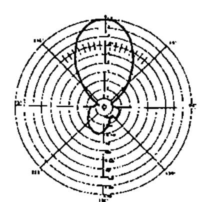

CH.14

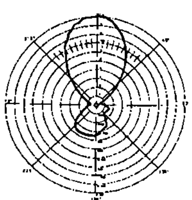

CH. 20

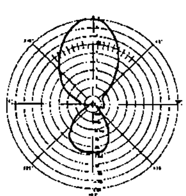

CH.26

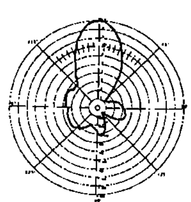

CH.32

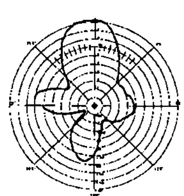

CH.38


CH.44


CH.50


CH.56


CH.62


CH.69

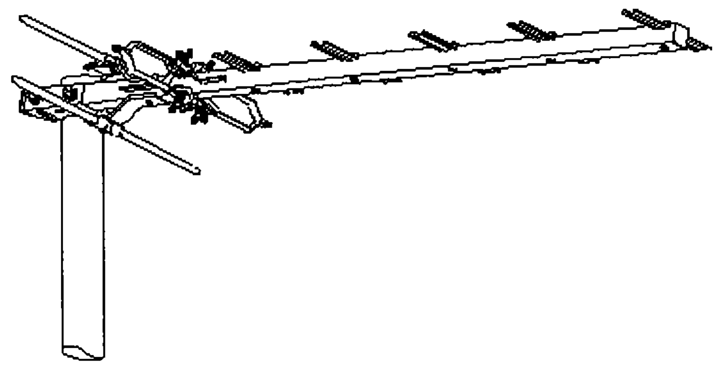
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 1/02

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 UHF ANTENNA

engineering specifications

Model PR-9014



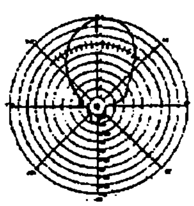
Active Elements 8
Boom Length 39.875"
Turning Radius 38"
Maximum Width 15"
Vertical Height 4" **Shpg. Weight** 7.5 lbs.
Element Diameter 3/8" **Carton Dimensions** 4"x6.25"x43"

Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

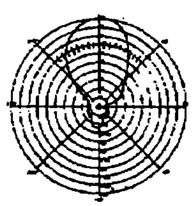
Made in U.S.A.

CHANNEL	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	8.3dB	7.2dB	8.6dB	6.4dB
beamwidth at half power points	65°	62°	50°	35°
front-to-back ratio	15dB	12dB	17dB	14dB

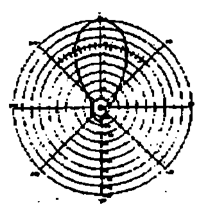
POLAR PATTERNS



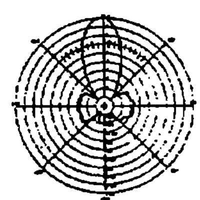
CH.14



CH. 32



CH.50



CH.69

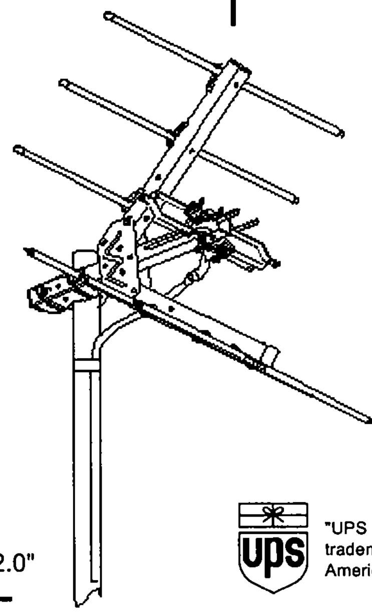
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 UHF ANTENNA

engineering specifications

Model PR-9016



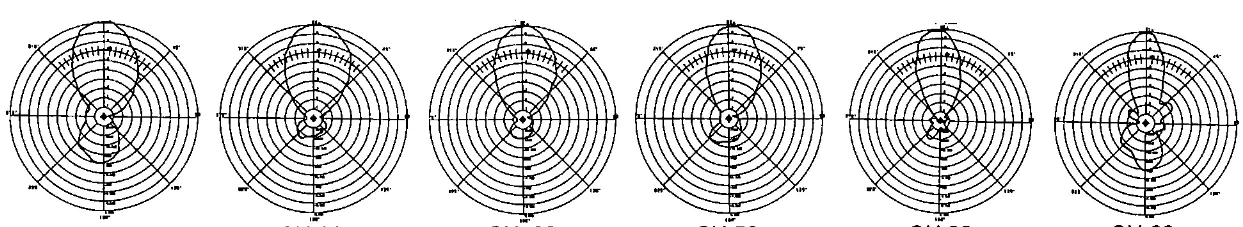
Active Elements 7
Boom Length 15.75"
Turning Radius 17.75"
Maximum Width 22"
Vertical Height 19" **Shpg. Weight** 3.0 lbs.
Element Diameter 3/8" **Carton Dimensions** 6.25"x4.25"x32.0"

Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

Made in U.S.A.

GAIN	CH.14	CH.26	CH.38	CH.50	CH.62	CH.69
dB over reference dipole	5.8dB	6.5dB	7.5dB	8.0dB	8.0dB	7.7dB
beamwidth at half power points	59°	60°	54°	47°	39°	32°
front-to-back ratio	6dB	12dB	14dB	10.5dB	12.5dB	5.5dB

POLAR PATTERNS



CH.14 CH.26 CH. 38 CH.50 CH.62 CH.69

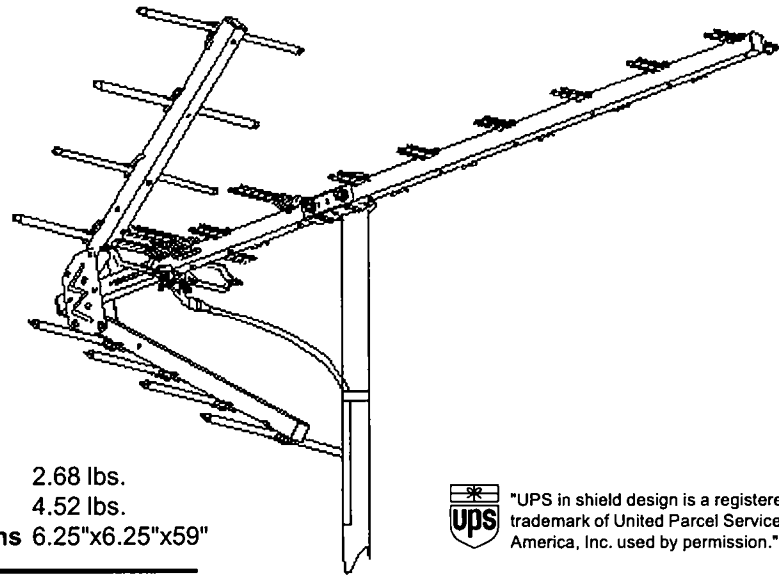
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 1/02

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 UHF ANTENNA

engineering specifications

Model PR-9018



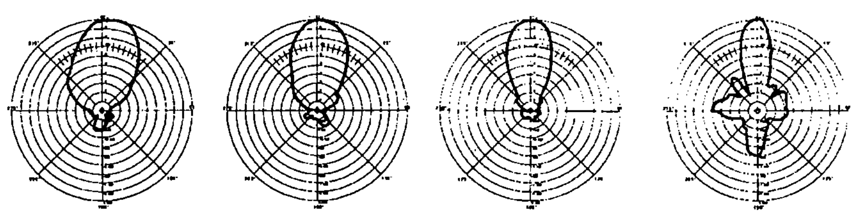
Active Elements	20		
Boom Length	49.875"		
Turning Radius	30"		
Maximum Width	15"	**Net Weight**	2.68 lbs.
Vertical Height	25.5"	**Shpg. Weight**	4.52 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25"x6.25"x59"

Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	13.3	14.5	12.6	9
beamwidth at half power points	60°	55°	40°	26°
front-to-back ratio	13.5dB	14dB	19.5dB	6dB

POLAR PATTERNS



CH.14 CH. 32 CH.50 CH.69

Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

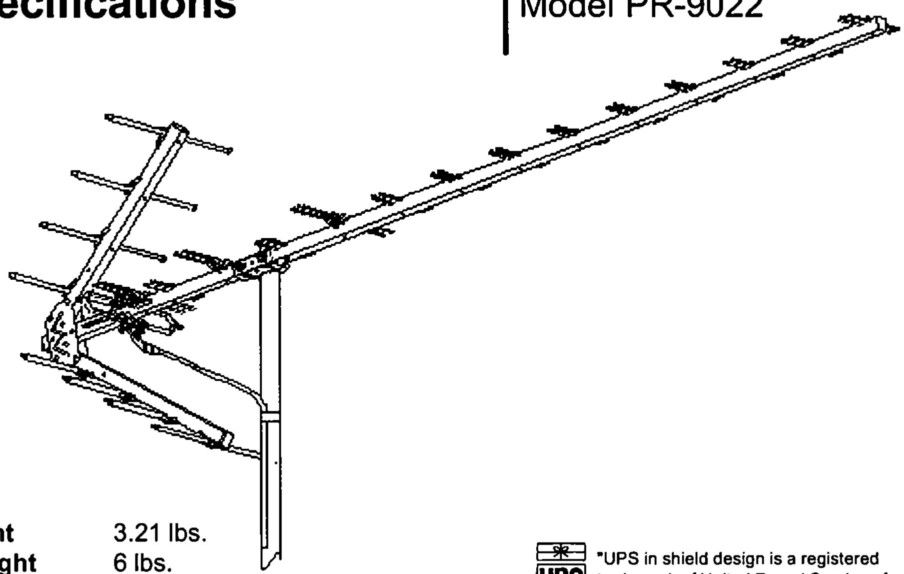
WINEGARD®

Clearly the World's Best®

PROSTAR® 1000 UHF ANTENNA

engineering specifications

Model PR-9022



Active Elements	26		
Boom Length	78.5"		
Turning Radius	58.5"		
Maximum Width	15"	**Net. Weight**	3.21 lbs.
Vertical Height	25.5"	**Shpg. Weight**	6 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25"x6.25"x89"

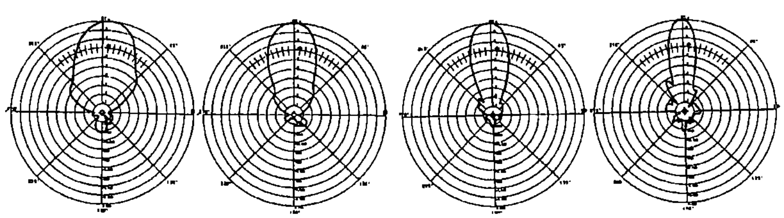
Output Impedance: 300 ohm / 75 ohm with included transformer

Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	14.3	15.2	14.6	9.9
beamwidth at half power points	54°	43°	34°	23°
front-to-back ratio	13.5dB	16dB	18dB	13dB

POLAR PATTERNS



CH.14 CH. 32 CH.50 CH.69

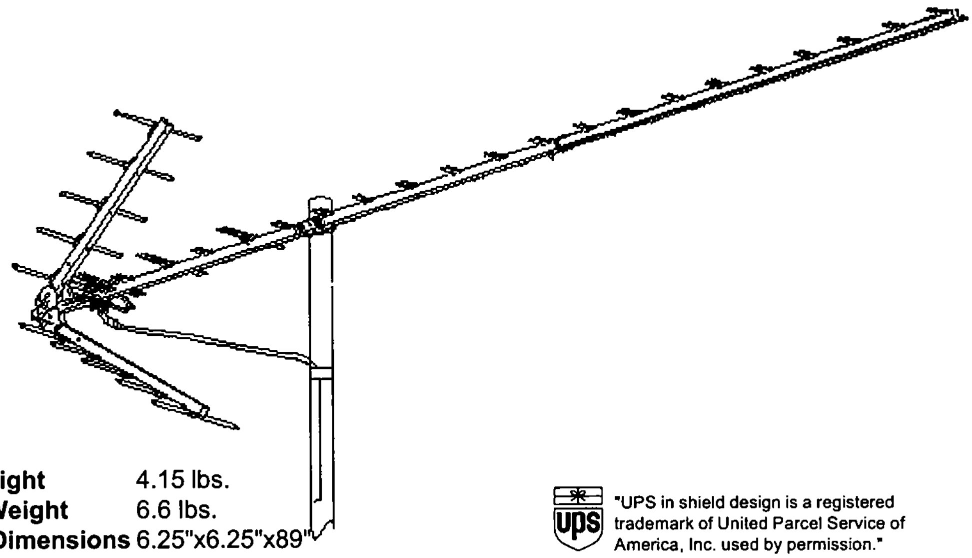
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 UHF ANTENNA

engineering specifications

Model PR-9032



Active Elements	35		
Boom Length	114.5"		
Turning Radius	79.75"		
Maximum Width	15"	**Net. Weight**	4.15 lbs.
Vertical Height	31.5"	**Shpg. Weight**	6.6 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25"x6.25"x89"

"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

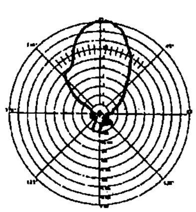
Output Impedance: 300 ohm / 75 ohm with included transformer

Recommended Preamp: AP Series

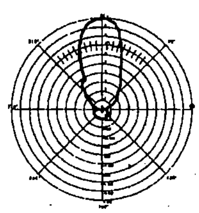
Made in U.S.A.

CHANNEL	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	14.9	16.3	15.7	11.5
beamwidth at half power points	53°	37°	28°	26°
front-to-back ratio	14dB	20dB	20dB	7.5dB

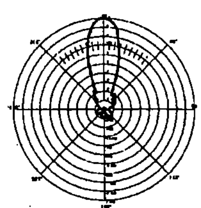
POLAR PATTERNS



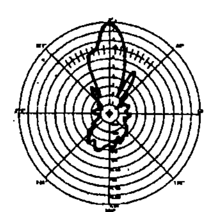
CH.14



CH. 32



CH.50



CH.69

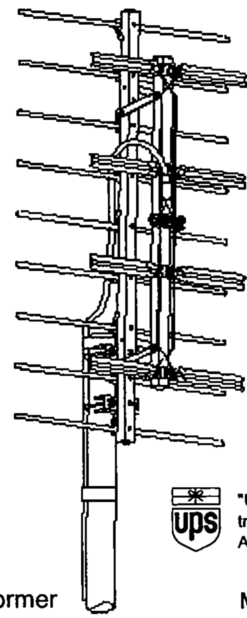
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

PROSTAR®
UHF
ANTENNA

WINEGARD®
Clearly the World's Best®

engineering specifications

Model PR-4400



Active Elements 13
Turning Radius 11.25"
Maximum Width 22"
Vertical Height 34"
Element Diameter 3/8"

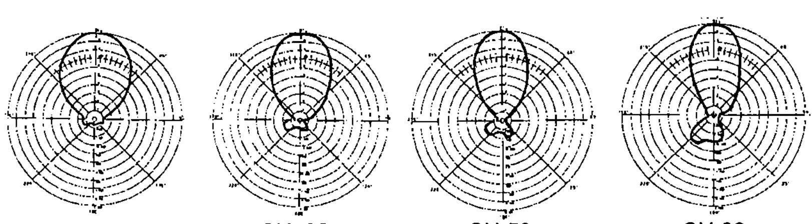
Shpg. Weight 4.64 lbs.
Carton Dimensions 6.5"x6.5"x59"

Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

Made in U.S.A.

GAIN	CH.14	CH.32	CH.50	CH.69
dB over reference dipole	9dB	10dB	10.6dB	11.6dB
beamwidth at half power points	72°	60°	46°	47°
front-to-back ratio	-17dB	-14dB	-13dB	-9dB

POLAR PATTERNS



CH.14 CH. 32 CH.50 CH.69

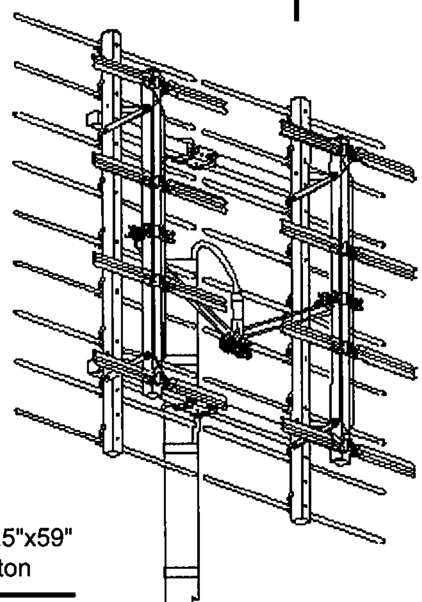
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 UHF ANTENNA

engineering specifications

Model PR-8800



Active Elements 26
Turning Radius 23"
Maximum Width 45"
Vertical Height 34"
Element Diameter 3/8"

Shpg. Weight 8 lbs.
Carton Dimensions 6.25"x6.25"x59"
1 per Carton

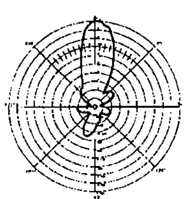
"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

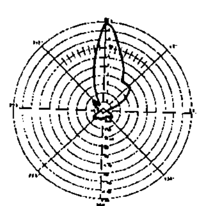
Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

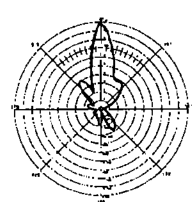
Made in U.S.A.

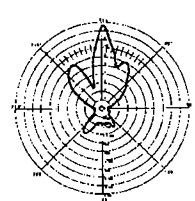
GAIN	CH.14	CH.32	CH.50	CH.69
dB over reference dipole	10.7dB	12.0dB	11.0dB	12.5dB
beamwidth at half power points	32°	23°	20°	17°
front-to-back ratio	-9dB	-17dB	-11dB	-9dB

POLAR PATTERNS


CH.14


CH. 32


CH.50


CH.69

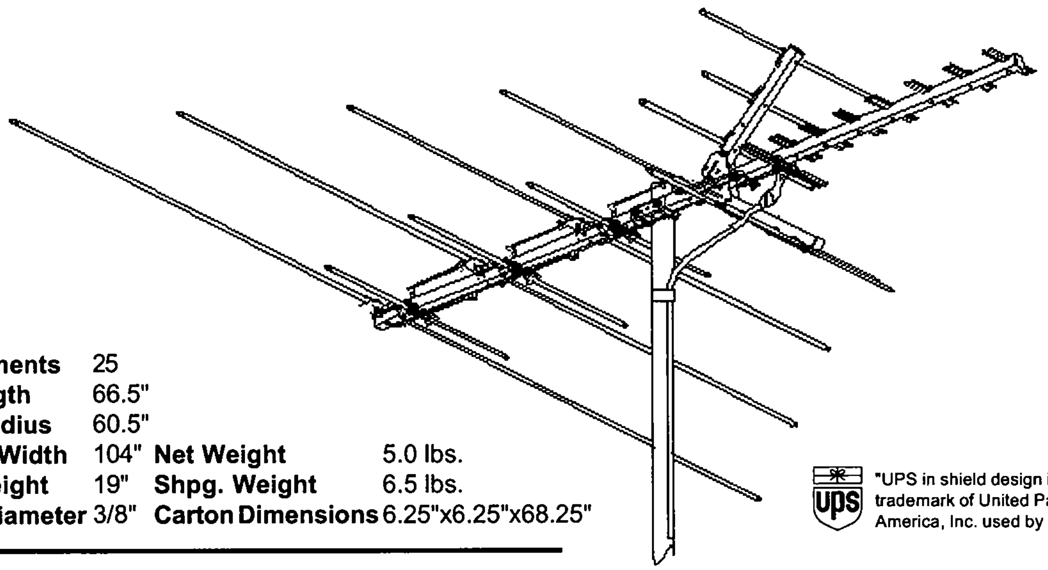
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 VHF/UHF/FM ANTENNA

engineering specifications

Model PR-5646



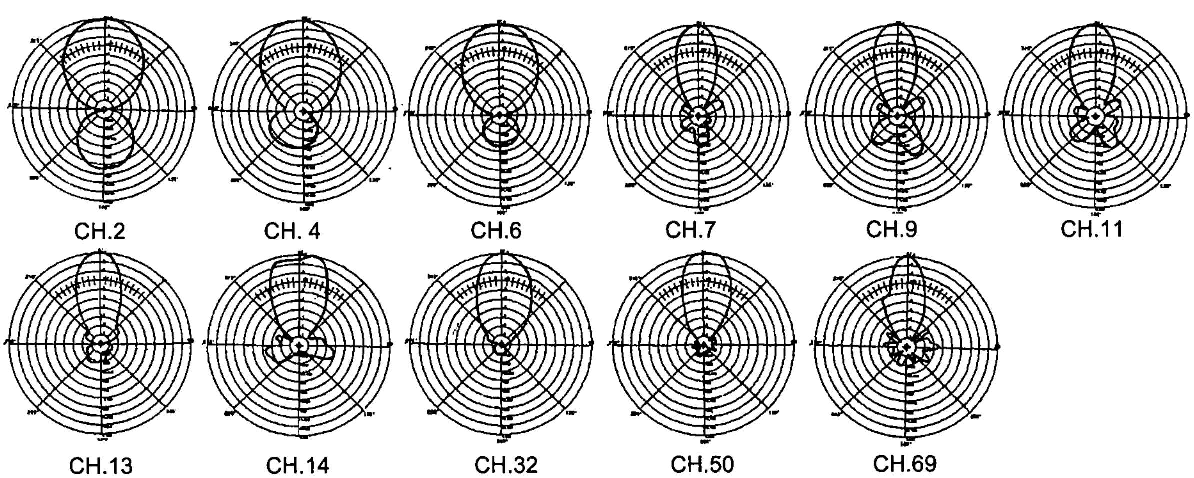
Active Elements 25
Boom Length 66.5"
Turning Radius 60.5"
Maximum Width 104" **Net Weight** 5.0 lbs.
Vertical Height 19" **Shpg. Weight** 6.5 lbs.
Element Diameter 3/8" **Carton Dimensions** 6.25"x6.25"x68.25"

Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	3.0	3.5	2.2	7.1	7.4	7.7	7.2	9.0	9.4	9.4	7.8
beamwidth at half power points	77°	76°	74°	36°	39°	40°	40°	52°	50°	46°	31°
front-to-back ratio	3.5dB	7dB	9dB	9dB	7dB	8.5dB	13dB	8dB	19dB	17dB	11dB

POLAR PATTERNS



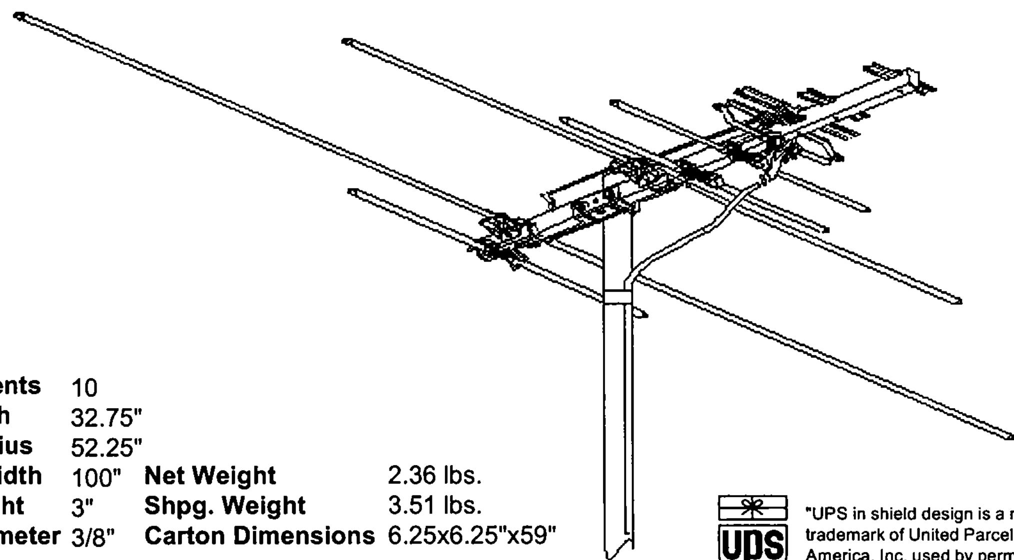
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 1/02

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 VHF/UHF/FM ANTENNA

engineering specifications

Model PR-7000



Active Elements 10
Boom Length 32.75"
Turning Radius 52.25"
Maximum Width 100"
Vertical Height 3"
Element Diameter 3/8"

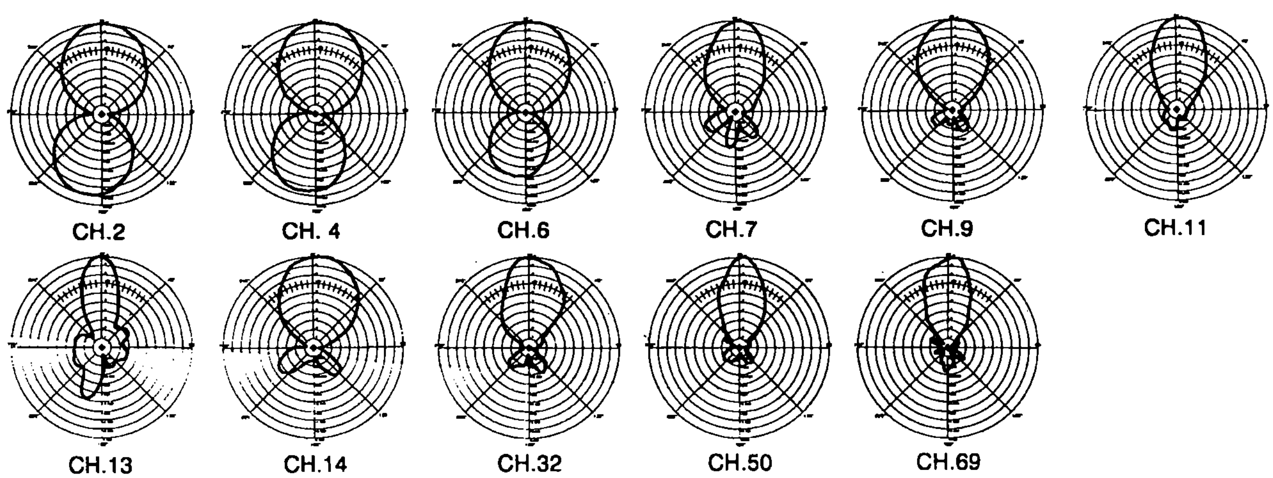
Net Weight 2.36 lbs.
Shpg. Weight 3.51 lbs.
Carton Dimensions 6.25x6.25"x59"

Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	.2	1.8	.5	5	5	5.3	4.1	3.6	5.1	6	6
beamwidth at half power points	83°	82°	78°	51°	66°	48°	33°	75°	54°	40°	43°
front-to-back ratio	1dB	1.5dB	3dB	8.5dB	12dB	12.5dB	4.5dB	7dB	10.5dB	14dB	11dB

POLAR PATTERNS



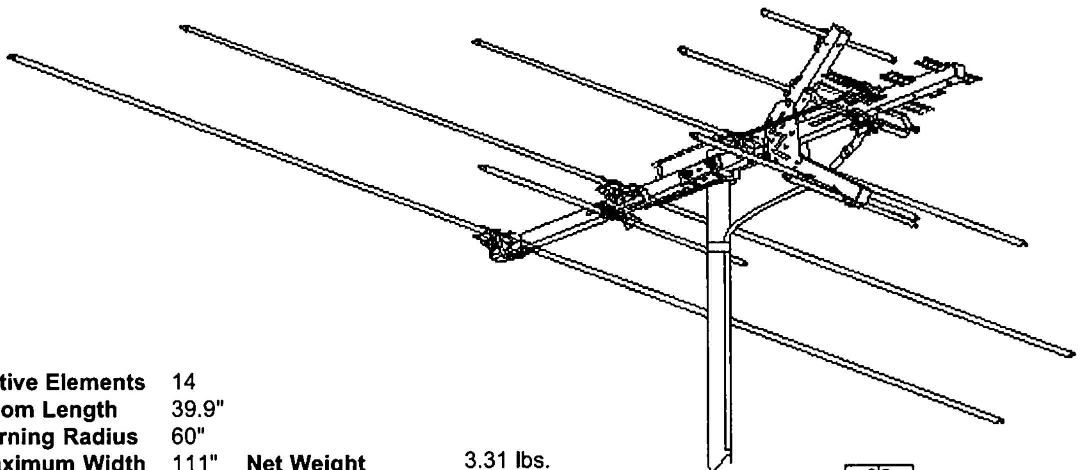
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 VHF/UHF/FM ANTENNA

engineering specifications

Model PR-7005



Active Elements	14		
Boom Length	39.9"		
Turning Radius	60"		
Maximum Width	111"	**Net Weight**	3.31 lbs.
Vertical Height	13.5"	**Shpg. Weight**	4.81 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25x6.25"x68.25"

UPS

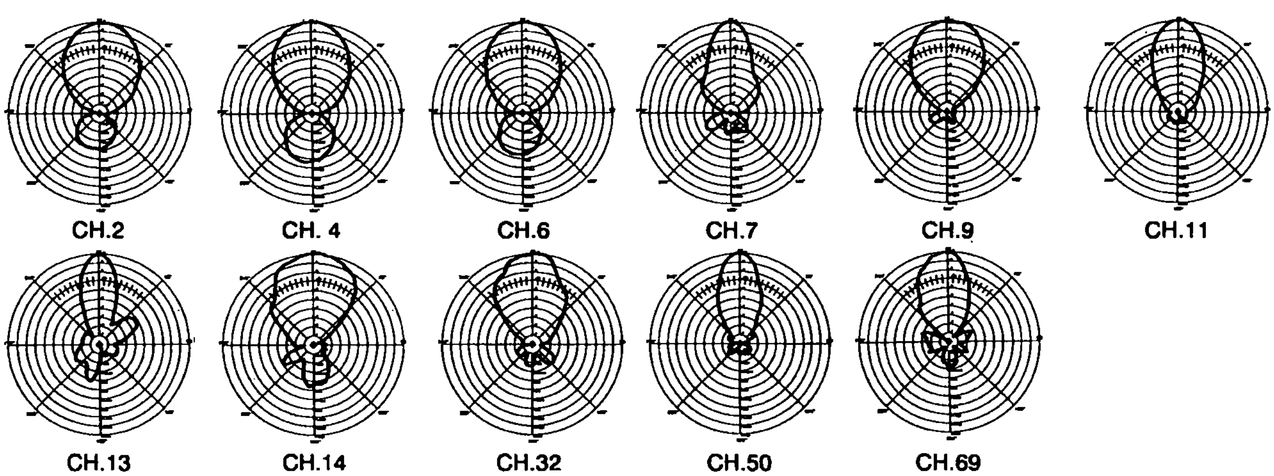
"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	.6	2.6	1.6	6.1	6.1	6.2	5.3	3.7	5.1	6	6
beamwidth at half power points	84°	75°	73°	38°	70°	48°	33°	85°	65°	32°	46°
front-to-back ratio	8dB	5dB	73dB	10.5dB	14dB	18dB	8dB	7dB	10.5dB	16dB	10.5dB

POLAR PATTERNS



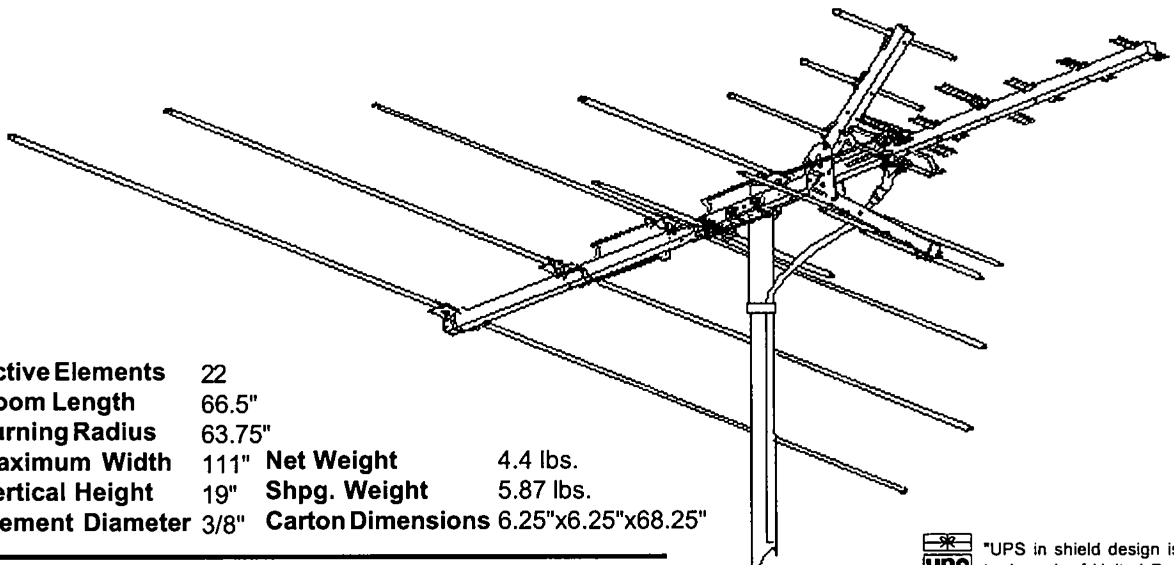
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 VHF/UHF/FM ANTENNA

engineering specifications

Model PR-7010



Active Elements	22
Boom Length	66.5"
Turning Radius	63.75"
Maximum Width	111"
Vertical Height	19"
Element Diameter	3/8"
Net Weight	4.4 lbs.
Shpg. Weight	5.87 lbs.
Carton Dimensions	6.25"x6.25"x68.25"

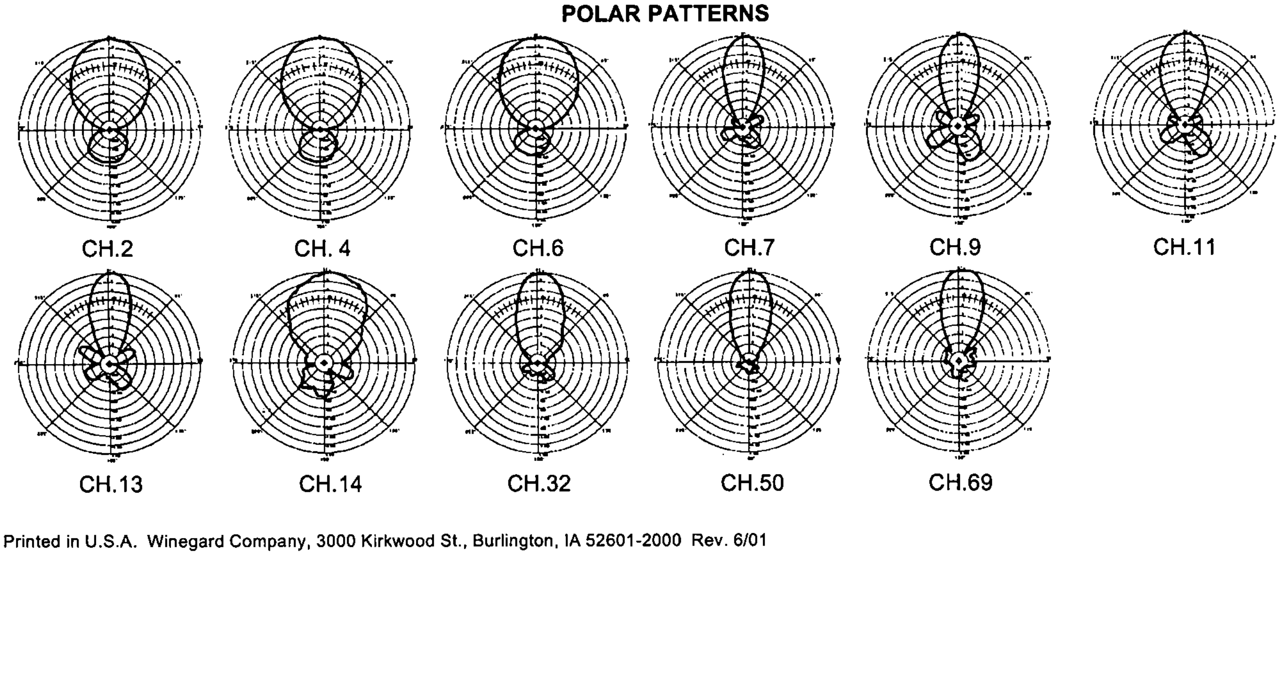
Output Impedance: 300 ohm / 75 ohm with included matching transformer
Recommended Preamp: AP Series

"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

Made in U.S.A.

CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	2.3	3.6	1.9	6.8	6.8	7.3	6.3	8.1	8	8.3	7
beamwidth at half power points	75°	77°	77°	36°	36°	43°	37°	73°	40°	37°	39°
front-to-back ratio	9dB	9dB	10.5dB	11.5dB	8dB	8dB	10dB	7dB	12.5dB	19dB	15dB

POLAR PATTERNS



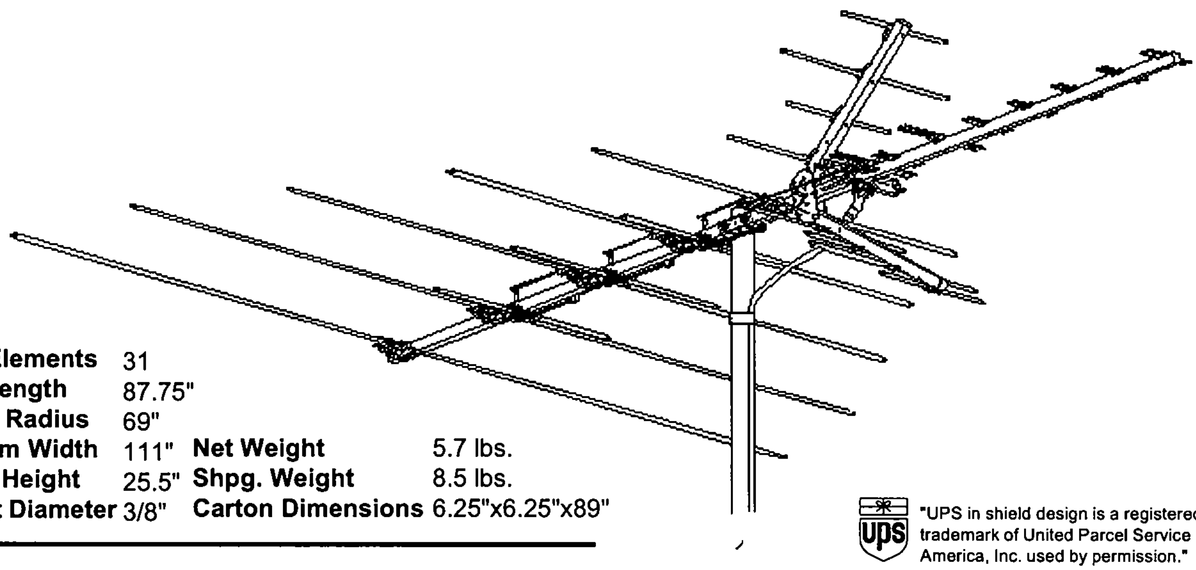
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 VHF/UHF/FM ANTENNA

engineering specifications

Model PR-7015



Active Elements 31
Boom Length 87.75"
Turning Radius 69"
Maximum Width 111"
Vertical Height 25.5"
Element Diameter 3/8"

Net Weight 5.7 lbs.
Shpg. Weight 8.5 lbs.
Carton Dimensions 6.25"x6.25"x89"

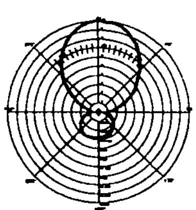
"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

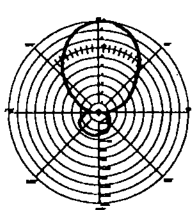
Output Impedance: 300 ohm / 75 ohm with included matching transformer
Recommended Preamp: AP Series

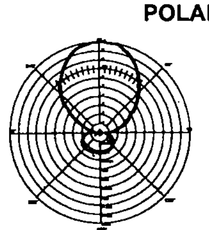
Made in U.S.A.

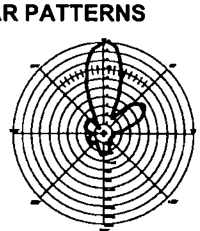
CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	3.9	4.1	2.5	7.5	7.5	8	7	9.4	9.9	9.8	8.2
beamwidth at half power points	75°	74°	77°	32°	32°	47°	40°	57°	54°	38°	25°
front-to-back ratio	10.5dB	12dB	13dB	13dB	12.5dB	8dB	14.5dB	14dB	17dB	greater than 20dB	13dB

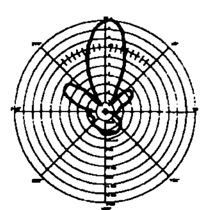
POLAR PATTERNS

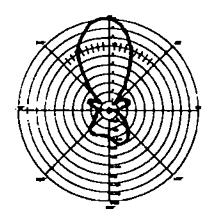

CH.2

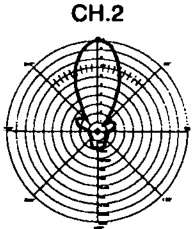

CH. 4

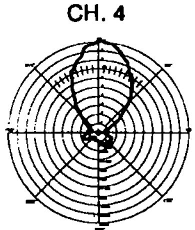

CH.6

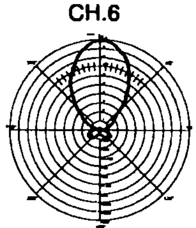

CH.7

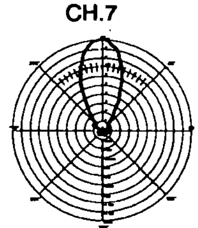

CH.9

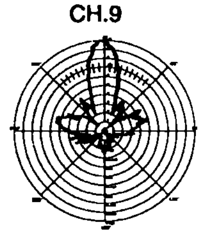

CH.11


CH.13


CH.14


CH.32


CH.50


CH.69

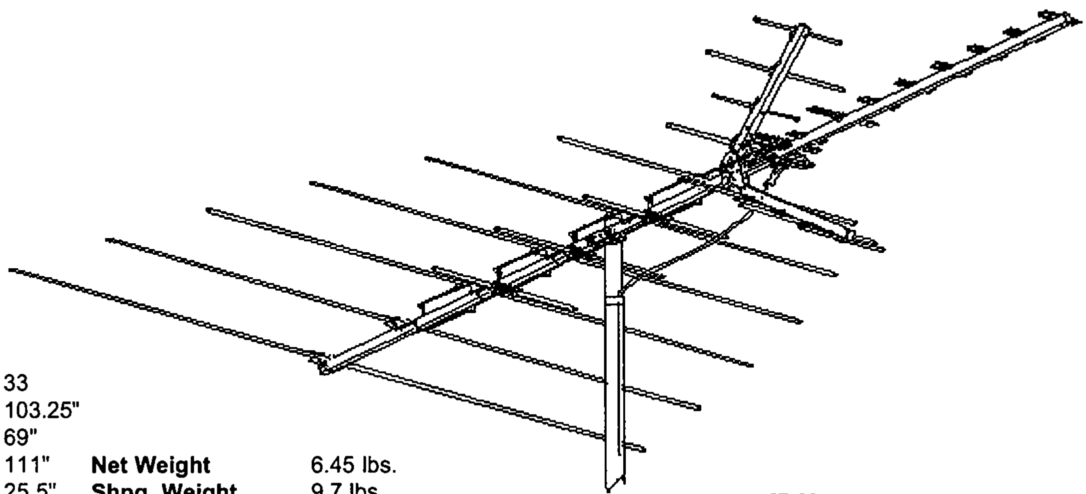
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 VHF/UHF/FM ANTENNAS

engineering specifications

Model PR-7032



Active Elements 33
Boom Length 103.25"
Turning Radius 69"
Maximum Width 111"
Vertical Height 25.5"
Element Dia. 3/8"

Net Weight 6.45 lbs.
Shpg. Weight 9.7 lbs.
Carton Dimensions 6.25"x6.25"x77"

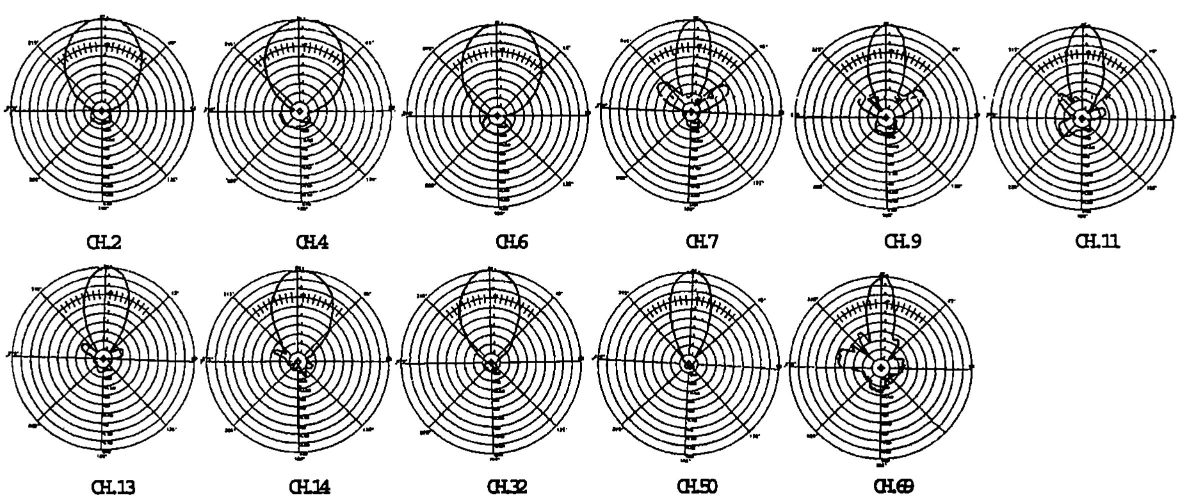
"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

Output Impedance: 300 ohm / 75 ohm with included matching transformer
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	4.6	5	3	8	7.8	8.3	7.5	9.4	10	10	8.5
beamwidth at half power points	73°	75°	77°	32°	34°	33°	40°	56°	55°	37°	27°
front-to-back ratio	18dB	13dB	14dB	16dB	15dB	11dB	17dB	17dB	20dB	greater than 20dB	17dB

POLAR PATTERNS



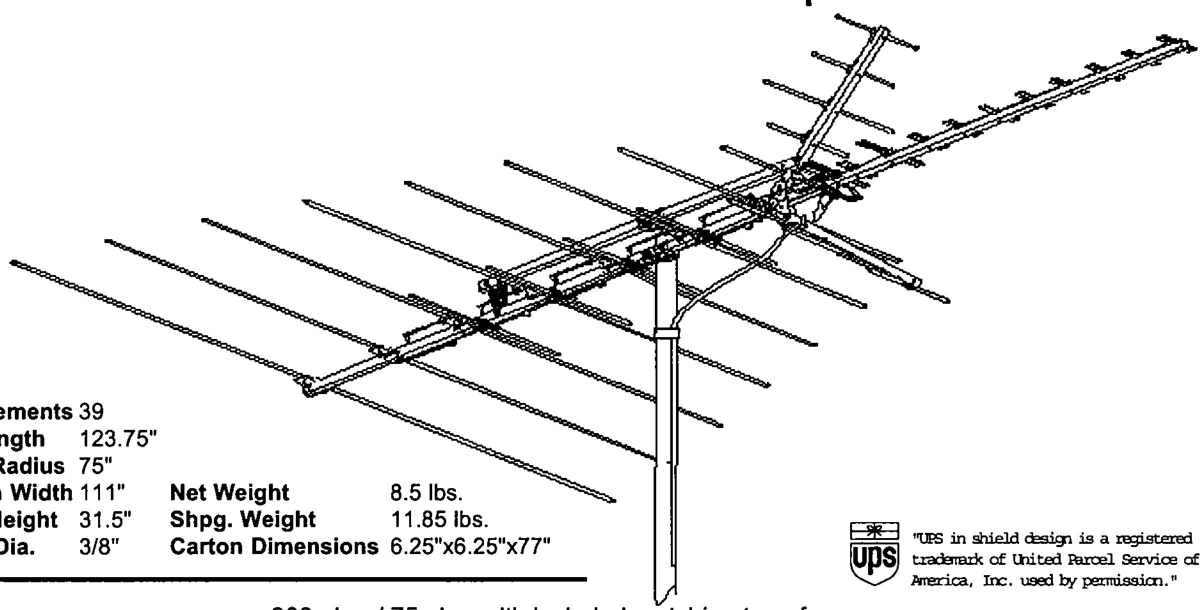
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 VHF/UHF/FM ANTENNAS

engineering specifications

Model PR-7037



Active Elements 39
Boom Length 123.75"
Turning Radius 75"
Maximum Width 111"
Vertical Height 31.5"
Element Dia. 3/8"

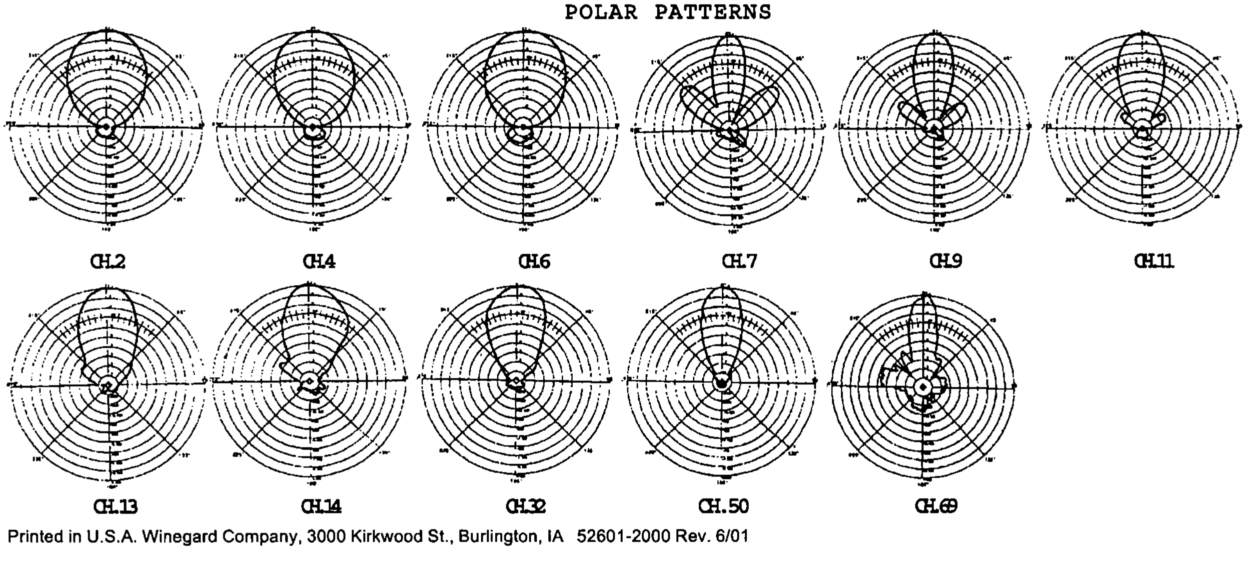
Net Weight 8.5 lbs.
Shpg. Weight 11.85 lbs.
Carton Dimensions 6.25"x6.25"x77"

Output Imdedance: 300 ohm / 75 ohm with included matching transformer
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	5.4	5.7	4.2	9.1	9.6	8.8	8.1	10.8	11.1	11.4	10.3
beamwidth at half power points	71°	72°	74°	27°	33°	39°	50°	57°	52°	34°	24°
front-to-back ratio	20dB	17dB	15dB	13dB	18dB	19dB	greater than 20dB	17dB	20dB	greater than 20dB	12dB

POLAR PATTERNS



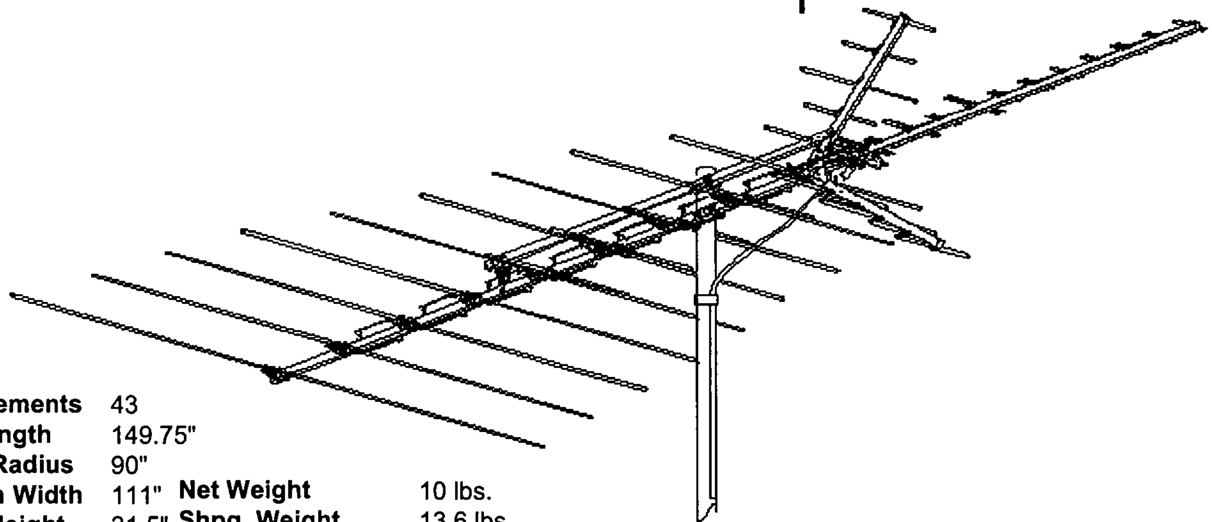
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 VHF/UHF/FM ANTENNA

engineering specifications

Model PR-7042



Active Elements 43
Boom Length 149.75"
Turning Radius 90"
Maximum Width 111"
Vertical Height 31.5"
Element Diameter 3/8"

Net Weight 10 lbs.
Shpg. Weight 13.6 lbs.
Carton Dimensions 6.75"x6.25"x104.25"

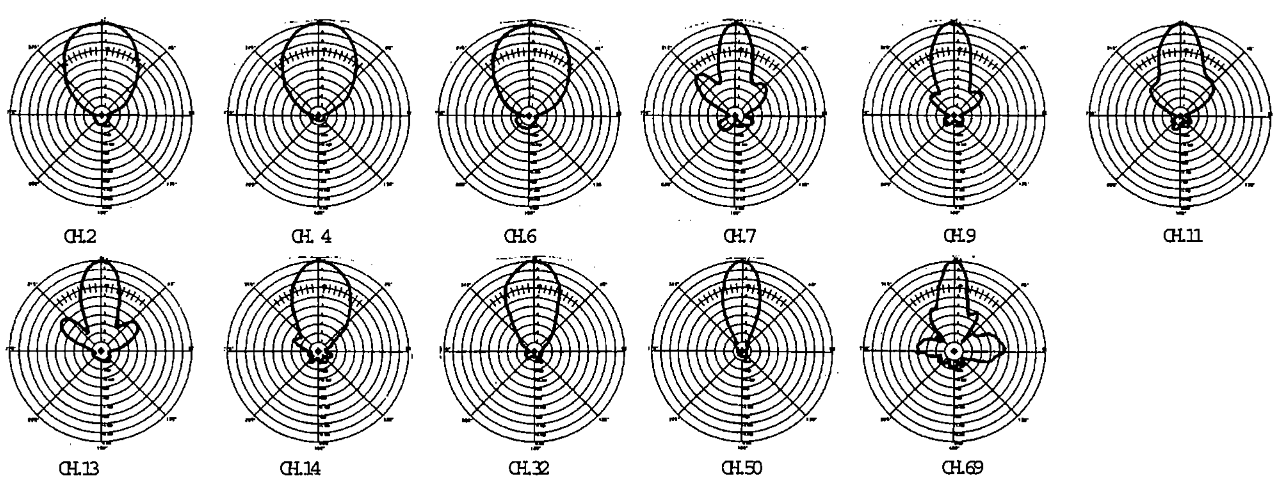
"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

Output Impedance: 300 ohm / 75 ohm with included matching transformer
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	6	6.4	5	10.2	10	9.5	9.3	10.8	11.3	11.7	10.8
beamwidth at half power points	72°	70°	73°	31°	36°	39°	33°	55°	50°	34°	24°
front-to-back ratio	20dB	greater than 20dB	17dB	14dB	18dB	17dB	19.5dB	17dB	20dB	greater than 20dB	14dB

POLAR PATTERNS



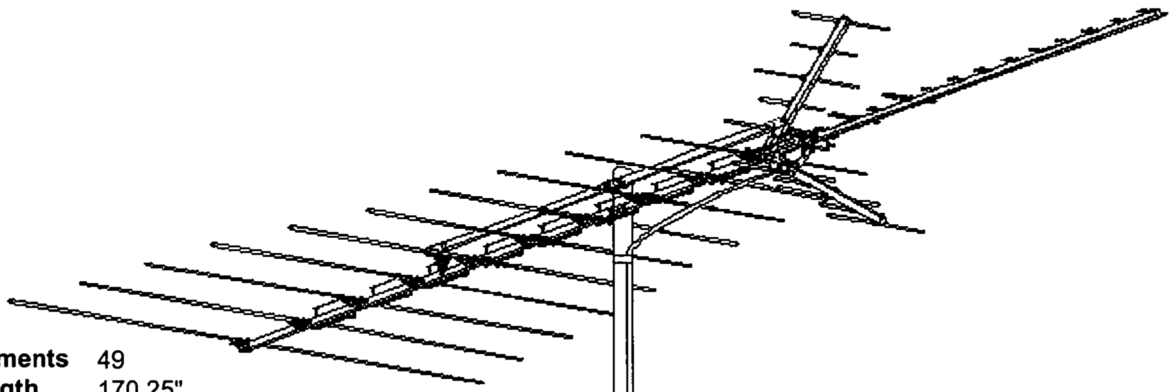
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

PROSTAR® 1000 VHF/UHF ANTENNA

WINEGARD®
Clearly the World's Best®

Model PR-7052

engineering specifications



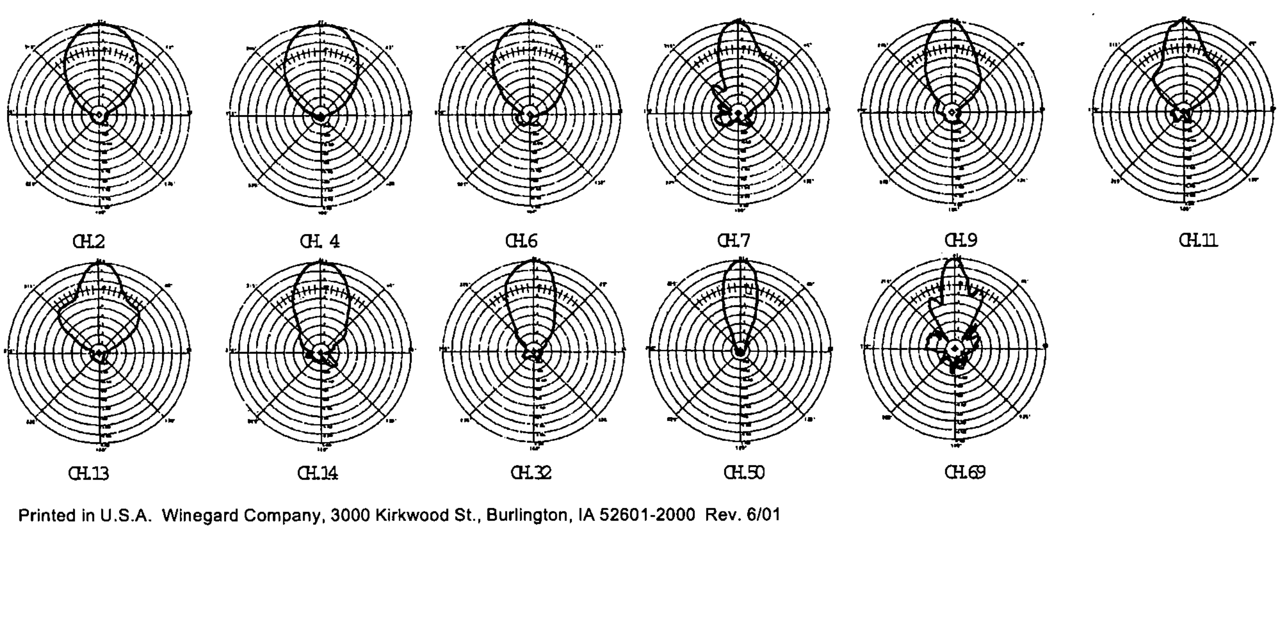
Active Elements 49
Boom Length 170.25"
Turning Radius 99.5"
Maximum Width 111" **Net Weight** 10.98 lbs.
Vertical Height 31.5" **Shpg. Weight** 14.8 lbs.
Element Diameter 3/8" **Carton Dimensions** 6.25"x6.25"x104.25"

Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13	CH.14	CH.32	CH.50	CH.69
dB gain over reference dipole	6.8	6.9	6	10.5	10.4	10	9.8	12.3	12.8	12.5	12.1
beamwidth at half power points	69°	69°	70°	35°	43°	38°	43°	51°	45°	31°	23°
front-to-back ratio	20dB	greater than 20dB	18dB	12dB	18.5dB	18dB	20dB	14dB	19dB	greater than 20dB	14dB

POLAR PATTERNS



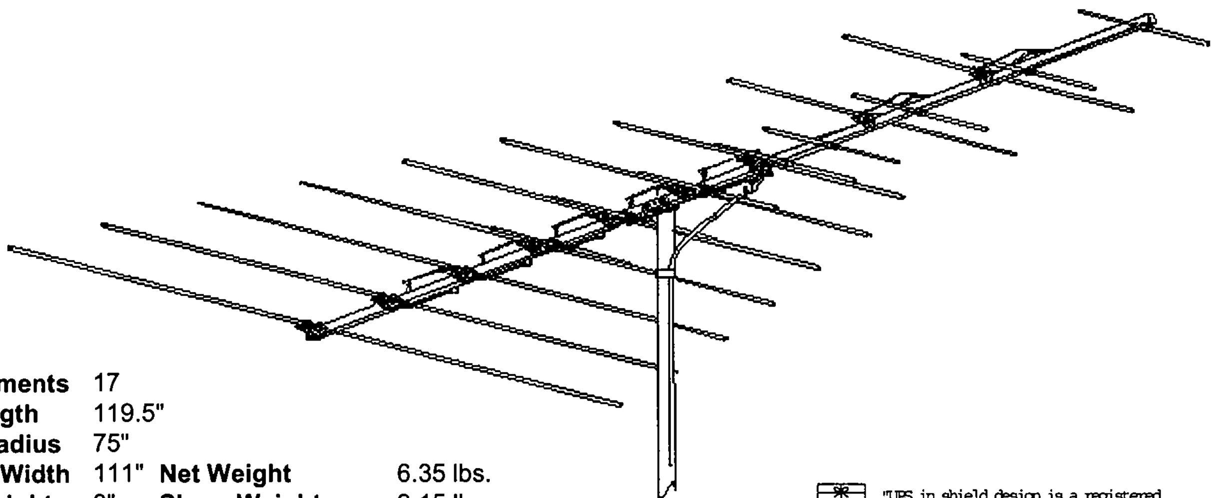
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 VHF/FM ANTENNA

engineering specifications

Model PR-5030



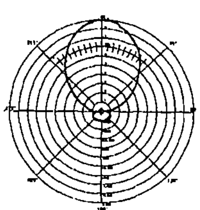
Active Elements	17		
Boom Length	119.5"		
Turning Radius	75"		
Maximum Width	111"	**Net Weight**	6.35 lbs.
Vertical Height	3"	**Shpg. Weight**	9.15 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25"x6.25"x77"

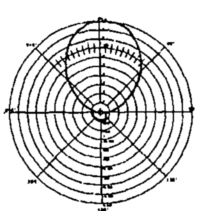
Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

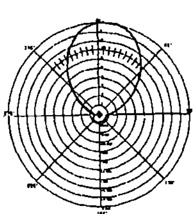
Made in U.S.A.

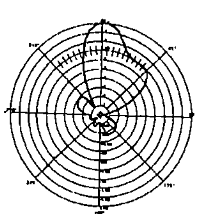
CHANNEL	CH.2	CH.4	CH.6	CH.7	CH.9	CH.11	CH.13
dB gain over reference dipole	5.1	5.0	7.0	7.5	9.5	7.7	8.2
beamwidth at half power points	68°	70°	70°	41°	36°	36°	33°
front-to-back ratio	19dB	greater than 20dB	greater than 20dB	13dB	18dB	16dB	15dB

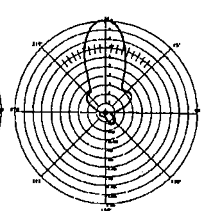
POLAR PATTERNS

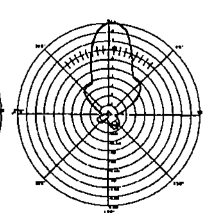

CH.2

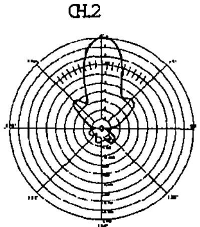

CH. 4


CH.6


CH.7


CH.9


CH.11


CH.13

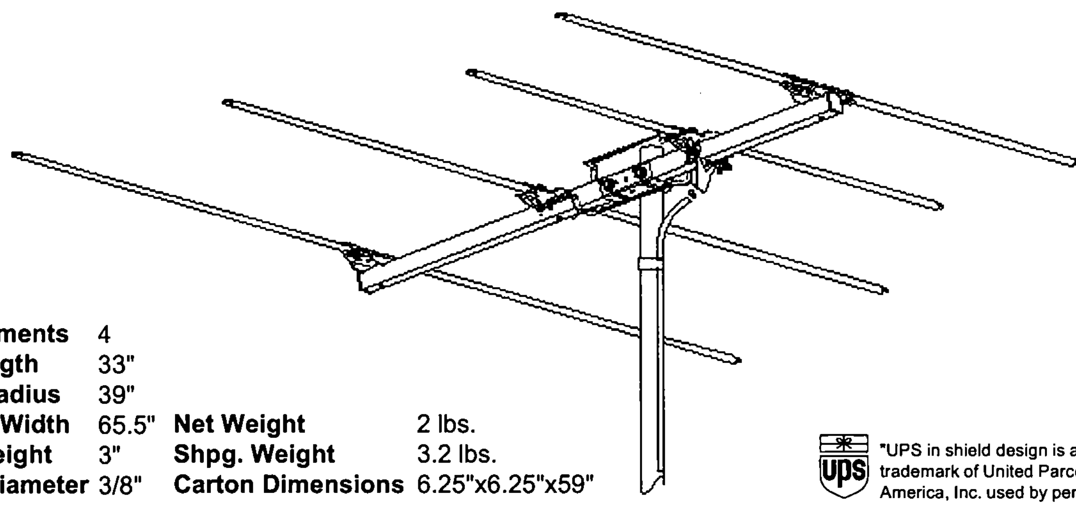
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 FM ANTENNA

engineering specifications

Model PR-6000



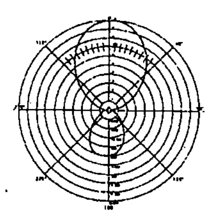
Active Elements 4
Boom Length 33"
Turning Radius 39"
Maximum Width 65.5"
Vertical Height 3"
Element Diameter 3/8"
Net Weight 2 lbs.
Shpg. Weight 3.2 lbs.
Carton Dimensions 6.25"x6.25"x59"

Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

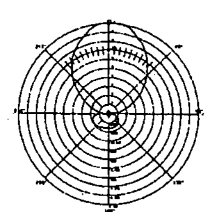
Made in U.S.A.

CHANNEL	88MHz	98MHz	108MHz
dB gain over reference dipole	5	5	5.2
beamwidth at half power points	67°	72°	71°
front-to-back ratio	6dB	14dB	16dB

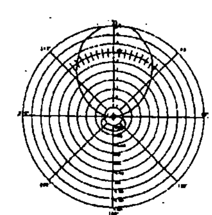
POLAR PATTERNS



88MHz



98MHz



108MHz

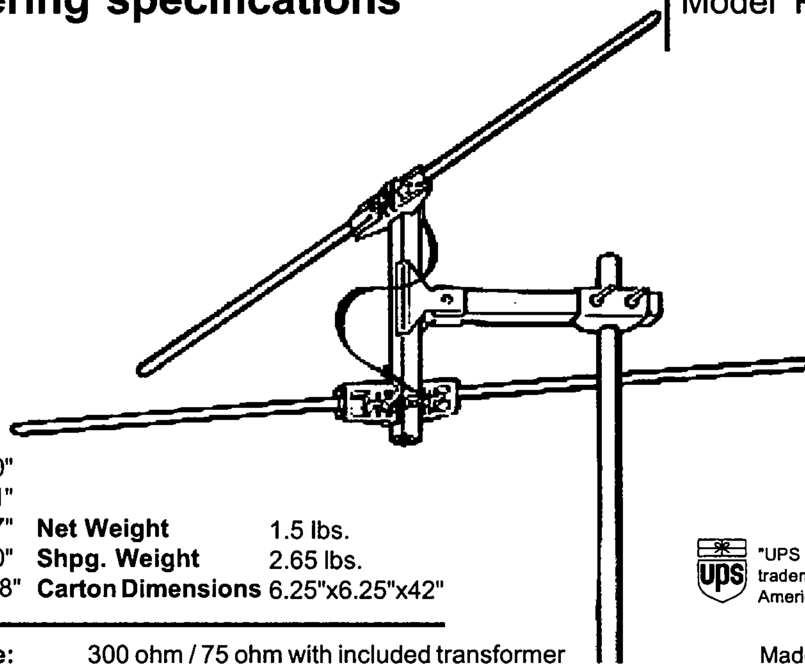
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

PROSTAR® 1000 FM ANTENNA

engineering specifications

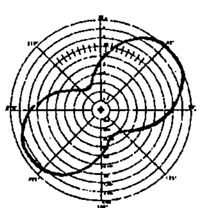
Model PR-6010



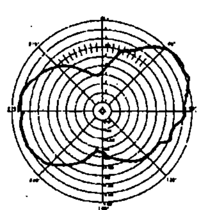
Active Elements	2		
Boom Length	10"		
Turning Radius	41"		
Maximum Width	67"	**Net Weight**	1.5 lbs.
Vertical Height	10"	**Shpg. Weight**	2.65 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25"x6.25"x42"

Output Impedance: 300 ohm / 75 ohm with included transformer
Recommended Preamp: AP Series

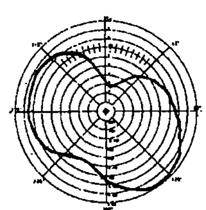
Made in U.S.A.



88MHz



98MHz



108MHz

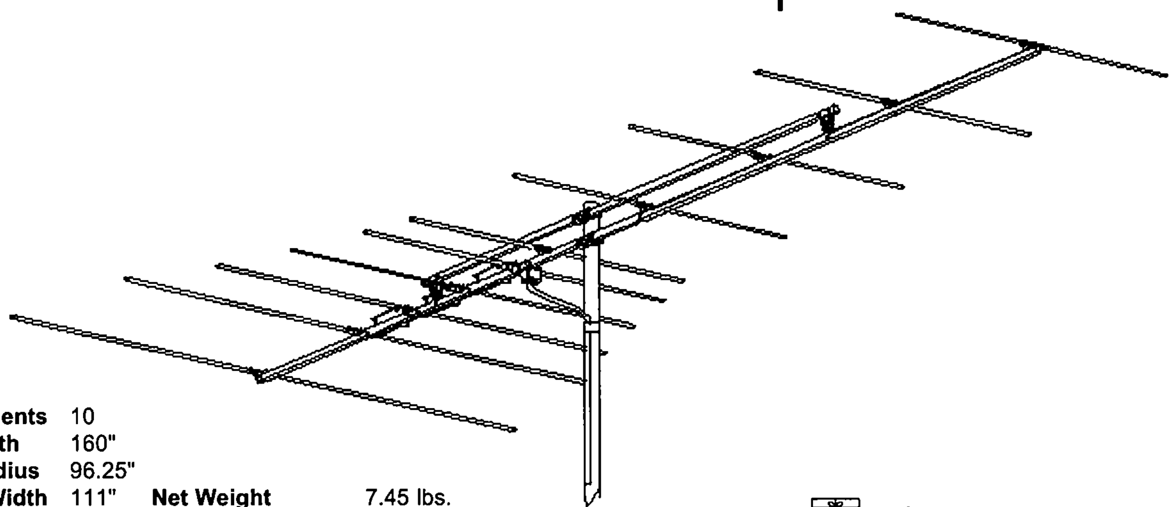
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000

WINEGARD®
Clearly the World's Best®

BROADBAND YAGI ANTENNA

engineering specifications

Model YA-1026



Active Elements	10		
Boom Length	160"		
Turning Radius	96.25"		
Maximum Width	111"	**Net Weight**	7.45 lbs.
Vertical Height	5"	**Shpg. Weight**	10.8 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25"x6.25"x89"

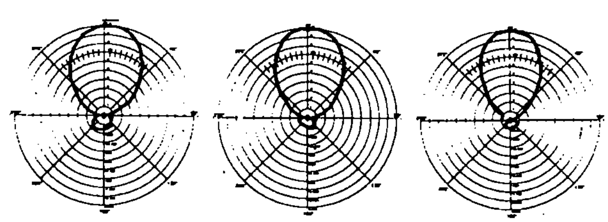
"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

Made in U.S.A.

Output Impedance: 75 ohm
Recommended Preamp: AP Series

CHANNEL	CH.2	CH.4	CH.6
dB gain over reference dipole	4.6	5.7	6.0
beamwidth at half power points	70°	66°	58°
front-to-back ratio	16dB	20dB	greater than 20 dB

POLAR PATTERNS



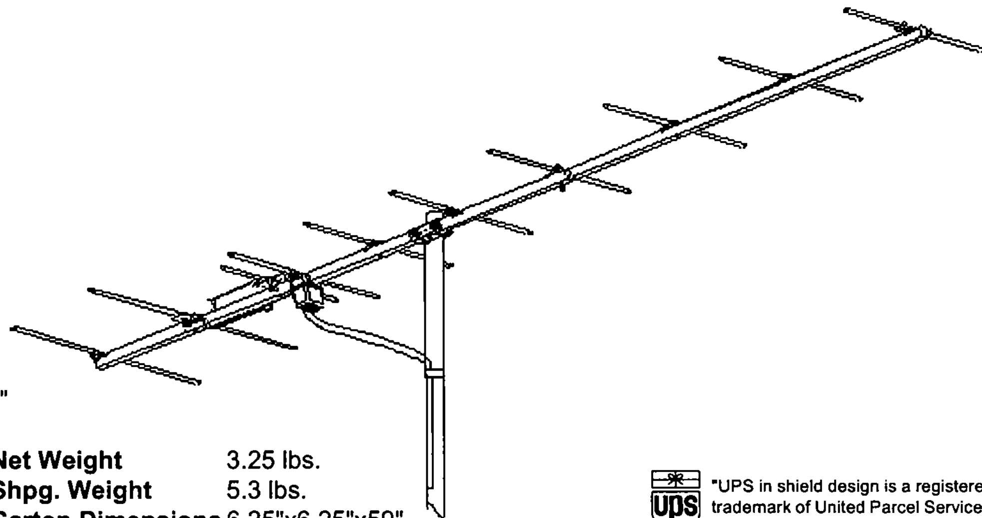
CH.2 CH.4 CH.6

WINEGARD®
Clearly the World's Best®

BROADBAND YAGI ANTENNA

engineering specifications

Model YA-1713



Active Elements 10
Boom Length 99.875"
Turning Radius 61"
Maximum Width 35"
Vertical Height 3"
Element Diameter 3/8"

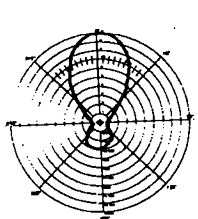
Net Weight 3.25 lbs.
Shpg. Weight 5.3 lbs.
Carton Dimensions 6.25"x6.25"x59"

Output Impedance: 75 ohm
Recommended Preamp: AP Series

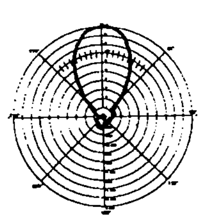
Made in U.S.A.

CHANNEL	CH.7	CH.9	CH.11	CH.13
dB gain over reference dipole	9.1	10	10	10.3
beamwidth at half power points	56°	55°	47°	40°
front-to-back ratio	10.5dB	18dB	19dB	14dB

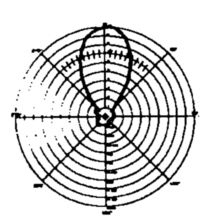
POLAR PATTERNS



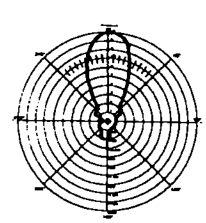
CH.7



CH.9



CH.11



CH.13

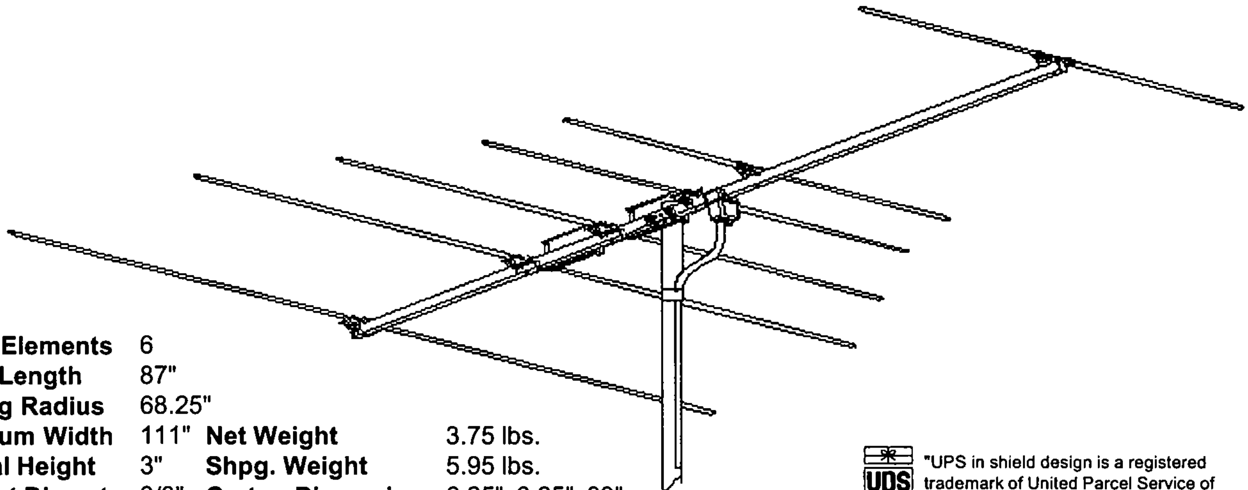
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000

WINEGARD®
Clearly the World's Best®

BROADBAND YAGI ANTENNA

engineering specifications

Model YA-6260



Active Elements	6		
Boom Length	87"		
Turning Radius	68.25"		
Maximum Width	111"	**Net Weight**	3.75 lbs.
Vertical Height	3"	**Shpg. Weight**	5.95 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25"x6.25"x89"

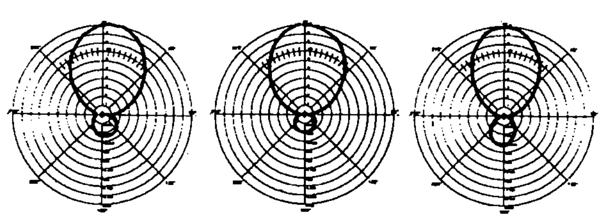
"UPS in shield design is a registered trademark of United Parcel Service of America, Inc. used by permission."

Output Impedance: 75 ohm
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.2	CH.4	CH.6
dB gain over reference dipole	3.9	4	5
beamwidth at half power points	72°	74°	64°
front-to-back ratio	12dB	14dB	9.5dB

POLAR PATTERNS



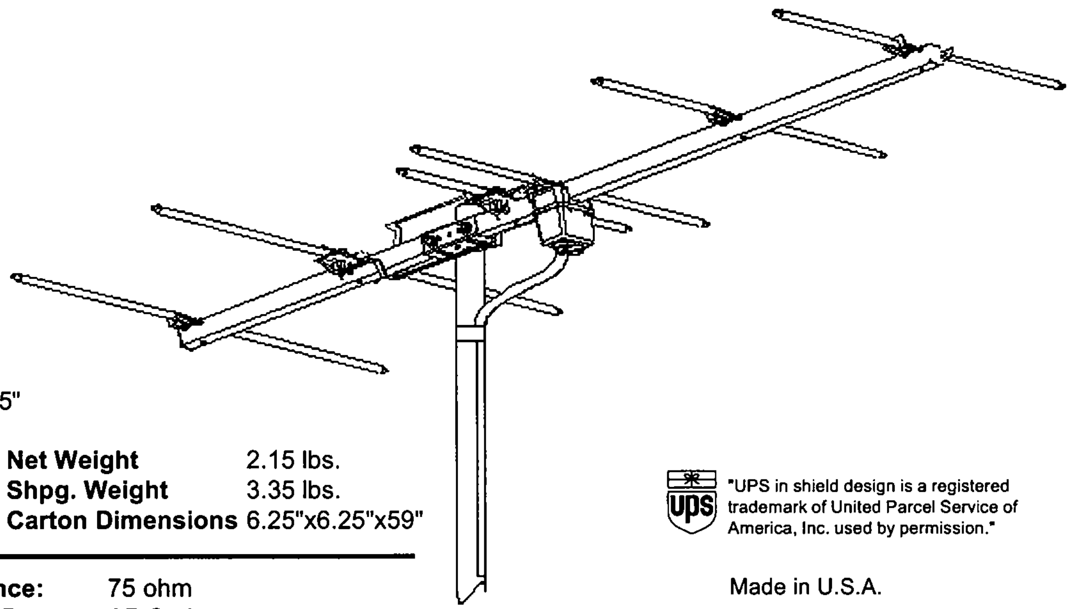
CH.2 CH.4 CH.6

BROADBAND YAGI ANTENNA

WINEGARD®
Clearly the World's Best®

engineering specifications

Model YA-6713



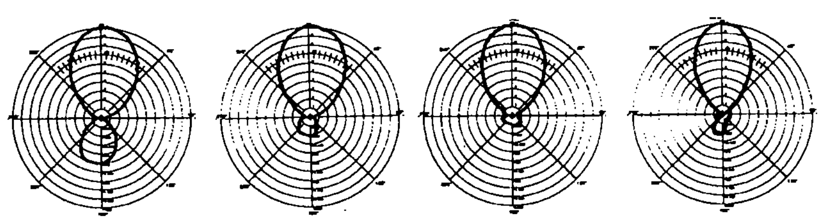
Active Elements	6		
Boom Length	49.875"		
Turning Radius	34"		
Maximum Width	35"	**Net Weight**	2.15 lbs.
Vertical Height	3"	**Shpg. Weight**	3.35 lbs.
Element Diameter	3/8"	**Carton Dimensions**	6.25"x6.25"x59"

Output Impedance: 75 ohm
Recommended Preamp: AP Series

Made in U.S.A.

CHANNEL	CH.7	CH.9	CH.11	CH.13
dB gain over reference dipole	6.8	7.3	7.2	6.8
beamwidth at half power points	64°	63°	60°	53°
front-to-back ratio	6dB	14dB	18dB	12.5dB

POLAR PATTERNS



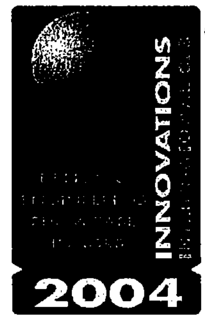
CH.7 CH.9 CH.11 CH.13

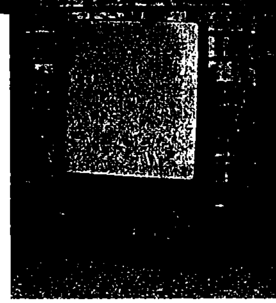
Printed in U.S.A. Winegard Company, 3000 Kirkwood St., Burlington, IA 52601-2000 Rev. 6/01

WINEGARD®
Clearly the World's Best®

HDTv2™ SquareShooter™ Antenna System

Get2 TM





Mounting options for the Square Shooter:

- Wall mount
- Roof mount
- Rail mount
- Floor

The SquareShooter™ is only 16 inches square, but receives and resonates analog and HDTV signals 40-50 miles from the transmitter, depending on the model - SS-1000 or SS-2000 (amplified).

Its small size and design allows for versatile mounting locations such as walls, roofs, patios, attics and railings. Plus, the SquareShooter™ can be mounted above a satellite dish using Winegard's DS-1000 home satellite mounting kit and diplexed with the existing satellite coax cable, incorporating both the satellite and SquareShooter™ Off-Air signals on one cable.

Both models have a very high 20 to 1 front-to-back ratios and were specifically designed for urban/metropolitan locations where line-of-sight to the transmit source is blocked. Scatter-Plane technology neutralizes reflected, out-of-phase signals arriving at the back of the antenna element. This provides the SquareShooter™ its muscle to reject multi-path signal (ghosting) and the ability to tune into the desired reflected signal for the best reception characteristics so critical for downtown urban locations.

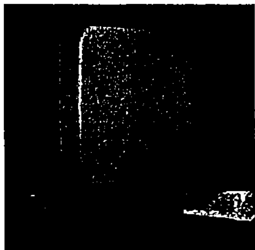
The SS-2000 is equipped with Winegard's new digital preamp specifically designed for digital reception with an input level of 300,000 mV and 12 dB flat gain across the entire bandpass. This design ensures proper digital demodulation for the Square Shooter™ antennas.

GET2 TM GETHDTv2 TM GETSquareShooter TM

Get[2]™

HDTv[2]™ SquareShooter™ Antenna System

Models SS-1000 & SS-2000



Attic Mount

Deck Rail Mount

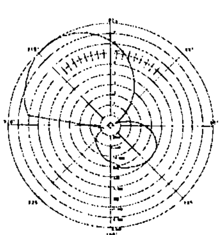
Model SS-1000/SS-2000	
Avg. beamwidth	61°
Avg. VSWR across band	1.3:1
Avg. Front to back	13 db
Avg. gain across band 470-806	4.5 db
Maximum Width Housing	16" x 16" x 4"
Preamp gain (SS-2000)	
300,000 μV Total Input	
S/N ratio	2.8 db
VHF	12 dB avg.
UHF	12 dB avg.

GENERAL RECEPTION GUIDELINES	ANALOG	DIGITAL
VHF Ch. 2-6	0-10 miles	0-15 miles
VHF Ch. 7-13	0-35 miles	0-40 miles
UHF Ch. 14-69	0-45 miles	0-50 miles

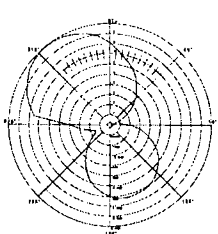
Made in U.S.A. Patent Pending Ships UPS

Channel	CH. 7	CH. 10	CH. 14	CH. 32	CH. 56	CH. 69
Frequency	175.25 MHz	193.25 MHz	471.25 MHz	579.25 MHz	723.25 MHz	805.75 MHz
Beamwidth at half power points	95°	93°	68°	67°	58°	54°
Front-to-back ratio	6.0 db	2.6 db	20db	16 db	12.5 db	12 db

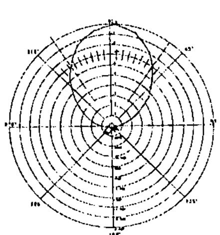
POLAR PATTERNS



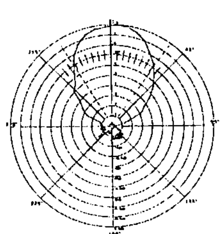
CH.7



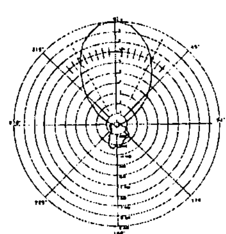
CH.10



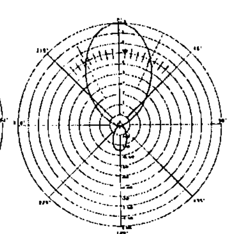
CH.14



CH.32



CH.56



CH.69

WINEGARD®
Clearly the World's Best®

Winegard Company • 3000 Kirkwood St. • Burlington, IA 52601 • 319/754-0600 • Fax 319/754-0787 • www.winegard.com WC-811 Rev. 12/16

Exhibit 2

Low Noise Amplifiers

Advanced Receiver Research LNAs

Special Frequency GaAsFET Preamplifiers

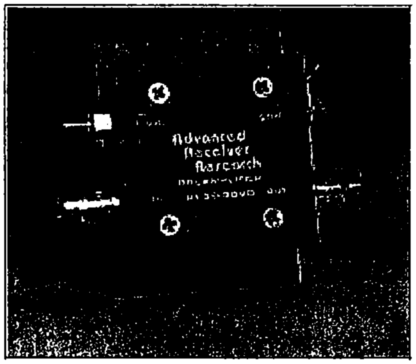
For over fifteen years, Advanced Receiver Research has produced low noise figure Gallium Arsenide amplifiers for a wide variety of frequencies and applications. Over these years we have assembled quite a "cookbook" that allows us to handle orders for these "special" frequency ranges with the same quick delivery as standard off the shelf units. We do not charge a premium for this service - custom frequency preamplifiers cost no more than our standard units! Listed below are some of the more popular "special" frequency amplifiers that we have built. If you don't see exactly what you need please call as chances are good we can supply you with a custom preamplifier.

Frequency Range	N.F	Gain	Application
1.0 - 30	2.5	20	shortwave
1.8 -2.0	0.5	26	amateur
3.3	0.5	26	nmr/mri
3.5 - 4.0	0.5	26	amateur
7.0 - 7.4	0.5	26	amateur
15	0.5	26	nmr/mri
16	0.5	26	nmr/mri
21	0.5	26	nmr/mri
21 - 21.5	0.5	26	amateur
28 - 30	0.5	26	amateur
30 - 1000	3.5	11	broadband
30 - 50 (narrow tune)	0.5	26	commercial
34	0.5	26	nmr/mri
43	0.5	26	nmr/mri
49	0.5	26	cordless telephone
50 - 54	0.5	24	amateur
51	0.5	24	nmr/mri
54 - 60	0.5	24	television
60 - 66	0.5	24	television
66 - 72	0.5	24	television
70	0.5	24	nmr/mri
72	0.5	24	remote control
72 - 76	0.5	24	paging/linking
73 - 74	0.5	24	radio astronomy
76 - 82	0.5	24	television
82 - 88	0.5	24	television
85	0.5	24	nmr/mri
88 - 108 (broad tune)	1.0	20	fm broadcast
88 - 108 (narrow tune)	0.5	24	fm broadcast
97	0.5	24	nmr/mri
108 - 136 (broad tune)	1.0	20	aircraft
108 - 136 (narrow tune)	0.5	24	aircraft
120	0.5	24	nmr/mri
128	0.5	24	nmr/mri
136 - 138	0.5	24	weather satellite
140 - 144	0.5	24	commercial
144 - 148	0.5	24	amateur
150 - 170 (broad tune)	1.0	20	commercial
150 - 170 (narrow tune)	0.5	24	commercial
170	0.5	24	nmr/mri
174 - 180	0.5	22	television
180 - 186	0.5	22	television
186 - 192	0.5	22	television
192 - 198	0.5	22	television
200	0.5	22	nmr/mri

204 - 210	0.5	20	television
210 - 216	0.5	20	television
220 - 225	0.5	20	amateur
240 - 270 (broad tune)	1.0	15	military
240 - 270 (narrow tune)	0.5	20	military
300	0.5	18	remote control
340	0.5	18	nmr/mri
400	0.5	17	nmr/mri
400 - 420	0.5	17	commercial
420 - 450	0.5	17	amateur
440	0.5	17	military radar
450 - 470 (broad tune)	1.0	15	commercial
450 - 470 (narrow tune)	0.5	17	commercial
470 - 510 (broad tune)	1.0	15	commercial
470 - 510 (narrow tune)	0.5	17	commercial
470 - 722 (narrow tune)	0.6	15	television
800 - 890 (broad tune)	1.2	15	cellular/trunking
800 - 890 (narrow tune)	0.6	19	cellular/trunking
896 - 912	0.7	18	data transfer
900 - 950 (broad tune)	1.2	15	trunking/stl
900 - 960 (narrow tune)	0.7	18	trunking/stl

about us • index • commercial products • amateur products • gunnplexer® • nmr/mri • military •
special frequency ranges • accessories • warranty • ordering information • contact us • home • top of page

High Performance
Receive Only
Broadband VHF/UHF Preamplifier



Features:

- Low noise figure
- High immunity to overload
- Completely shielded
- Suitable for mast/tower mounting
- Small size
- Rugged low profile custom enclosure

The P30-1000/11VD preamplifier has been designed for the most demanding amateur, commercial and military applications. Each model has been optimized for the lowest noise figure consistent with excellent strong signal handling capability. These preamplifiers are suitable for use in any receiver or converter/receiver system. Each preamplifier is housed in a rugged low profile custom aluminum enclosure finished with military grade black urethane enamel. Female BNC coaxial fittings are provided for the input and output connections. Other connectors or connector combinations are available. Complete rf shielding is maintained with a feedthrough capacitor for the dc power connection. Mounting holes, suitable for #4 hardware, are located at each corner of the bottom plate.

The P30-1000/11VD broadband preamplifier uses a low noise figure, high intercept point MMIC to obtain essentially flat performance characteristics across the frequency range. A +18 dBm (nearly 80 mW!), 1-dB compression specification means that overload should seldom be a problem even though the preamplifier does not employ a front-end filter. Use of a front-end filter would likely be required only in the most severe interference environments. These preamplifiers would be useful for improving receiver sensitivity throughout the vhf/uhf range. They would be particularly useful where broad vhf/uhf frequency ranges must amplified by a single preamplifier such as ahead of a broadband multicoupler, scanner receiver, spectrum analyzer, television receiver or a test receiver. In these applications single band GaAsFET preamplifiers, although lower in noise figure, may not be practical.

Extensive testing of this preamplifier on existing communications systems indicate that a signal-to-noise improvement of 6 - 14 dB can be expected. Each and every preamplifier is precision aligned on our noise figure measuring equipment and should provide long trouble free operation.

The P30-1000/11VD preamplifier is designed to be powered by a 11 - 16 volt dc source with a current consumption of 50 mA. Low power consumption along with the small size make these preamplifiers ideal for installation within existing equipment or systems, or for remote mounting at the antenna. Mounting the preamplifier at the antenna will provide the best system noise figure.

Specifications

Model	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	1 dB Bandwidth (MHz)	Device Type	Price
P30-1000/11VD	30-1000	3.5	11	+18	900	MMIC	79.95

Supply voltage: 11 - 16 Vdc
Supply current: 50 mA
Weight: 2.0 oz.
Dimensions: outline drawing

Prices shown for standard BNC connectors
For custom frequency ranges see Special Frequency Ranges or contact factory

about us • index • commercial products • amateur products • gunnplexer® • nmr/mri • military •
special frequency ranges • accessories • warranty • ordering information • contact us • home • top of page

Antennacraft LNAs

ANTENNACRAFT America's Top Producer of HDTV / VHF / UHF Antennas

ANTENNA PRODUCTS

Home Sales Support About

Antennacraft Pre-Amplifiers

Amplify digital and analog VHF/UHF signals!

New

10G201 & 10G202 Premium-Grade Pre-Amplifiers

Featuring:

Split-Band VHF-UHF design

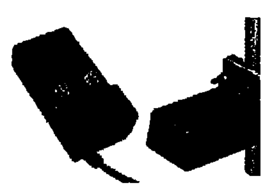
Internal RF shielding

High-quality transistors

10G201
High-Input Amplifier

10G202
High-Gain Amplifier

10G212
Adjustable-Gain Amplifier



10G201 High Input Amplifier

Best in mixed signal areas where both strong and weak transmission signals are present!

Mast mounted with indoor power supply
Avg.Gain: 16dB VHF, 22dB UHF
Noise Figure: <3.0dB VHF,< 2.6dB UHF
High input level capacity
Surface-mount design
Switchable FM trap
One combined VHF/UHF 75 ohm input/output
UL listed, AC operation
Meets CEA specs for amplifiers
List Price $54.88

10G202 High Gain Amplifier

Best in deep fringe areas where all transmissions are weak!

Avg.Gain: 29 dB UHF/VHF
Mast mounted with indoor power supply
Noise Figure: <3.0dB VHF,< 2.6dB UHF
Surface-mount design
Switchable FM trap
Power LED on power supply
One combined VHF/UHF 75 ohm input/output
UL listed, AC operation
Meets CEA specs for amplifiers
List Price $62.38

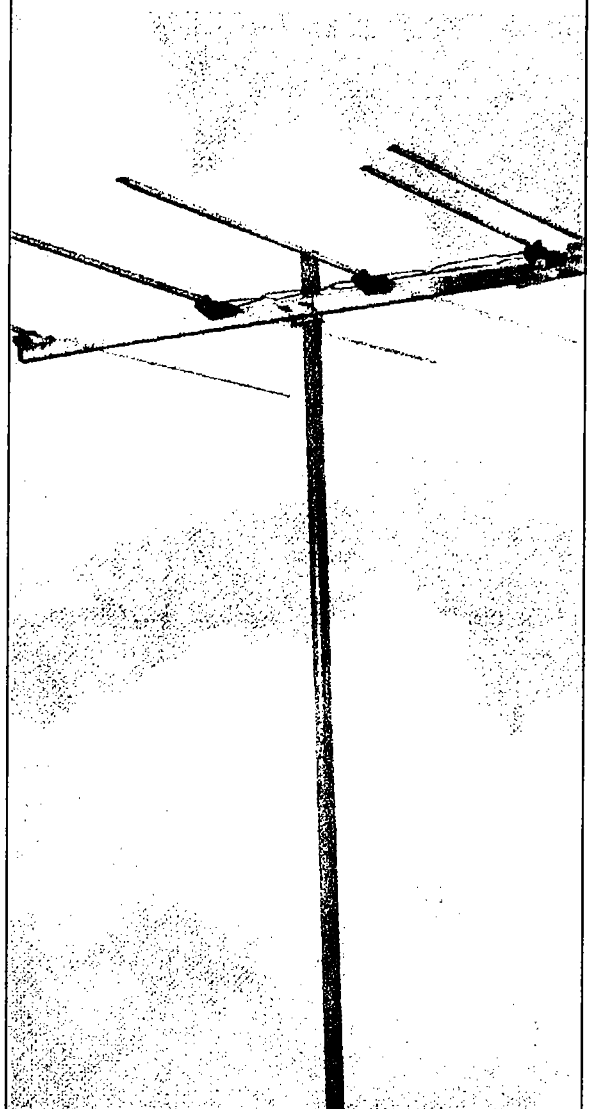
10G212 Adjustable Gain Amplifier

Allows customer the ability to adjust gain based on intended application!

Avg.Gain: 30dB UHF/VHF
Adjustable Gain Control: up to 15dB
Mast mounted with indoor power supply
Noise Figure: <4.0dB VHF,<3.5dB UHF
Remote Switchable FM trap
Surface Mount design
One combined VHF/UHF 75 ohm input/output
UL listed, AC operation
List Price $33.63

Blonder Tongue LNAs

Reception Products



BLONDER TONGUE
LABORATORIES, INC.

One Jake Brown Road, Old Bridge, NJ 08857
800-523-6049 • Toll Free Ordering Fax: 800-336-6295
www.blondertongue.com

SCMA and CMA Series

Single Channel VHF and UHF Preamplifiers

SCMA

Features & Benefits

- Low Noise Figure
- Excellent Gain and Response Flatness
- Superior Adjacent Channel Overload Rejection
- Output Test Port for Uninterrupted Service Testing
- Ideal For All BTY Series Single Channel Antennas
- SCMA Series has its Guaranteed Noise Figure Stamped on the Case

The SCMA and CMA-b Single Channel Preamplifier Series are professional quality, very low noise, single channel VHF/FM and UHF preamplifiers. Both the SCMA and CMA-b are optimized for a single VHF channel or FM Band (88-108 MHz), while the SCMA-Ub is optimized for a single UHF channel. These preamplifiers can accept a wide range of input signal levels and offer excellent gain, making these units ideal for difficult signal areas. The SCMA-Ub has an internal trap that can be factory tuned to a customer specified UHF frequency to prevent overload or intermodulation interference from strong, local channels.

The SCMA/CMA-b Single Channel Preamplifier Series are housed in a die-cast case. Input, output, and test ports are 75 ohm, type "F" female connectors. A 5/8" entry adapter is supplied on the SCMA Series (only) to allow use of a 0.500 or 0.750 aluminum cable connector. The preamplifiers mount on a 1.5 inch O.D. (max) antenna mast with the supplied mounting hardware. Blonder Tongue PS Series -21 VDC power supplies (available separately) are used to power the preamplifiers through the downleads.

Specifications

Electrical	**SCMA**	**SCMA-Ub**	**CMA-b**
Noise Figure (dB):	3.7, max (2-6) 3.0 max (FM) 2.5, max (7-13)	2.5 (14-69)	3.5 (2-6) 2.0 (FM) 2.5 max (7-13)
Trap Depth:	NA	10 dB	NA
Gain (dB):	27 (2-6), 24 (FM), 25 (7-13)	25 (14-34), 24 (35-69)	29 (2-6), 24 (FM), 26 (7-13)
Bandwidth:	6, 20 (FM)	6	6, 20 (FM)
Bandpass Flatness (dB): (FM)	±0.25 (2-13), 1.0 (FM)	±0.75	±0.25 (2-13), 1.0
Selectivity (dB):	12	12	12
Minimum Recommended Input Level (dBmV):	-10	-10.5	-10
Input Capability (dBmV):	+35	+35	+35
Impedance - All Ports) (Ohm):	75	75	75
General			
Power Requirements:	-21 VDC @ 65 mA	-21 VDC @ 29 mA	-21 VDC @ 40 mA
Recommended BT Power Supply:	PS-1536	PS-1526	PS-1526
Temperature Range (°C):	-40 to +60	-40 to +60	-40 to +60
Mechanical			
Max. Mast Diameter (O.D.) (in):	1.5	1.5	1.5
Dimensions (WxHxD in.): (WxHxD mm):	5.13 x 5.25 x 3.50 130 x 133 x 89	5.00 x 3.88 x 3.00 127 x 99 x 76	5.00 x 3.88 x 2.31 127 x 99 x 59
Weight (lbs): (kg):	1.31 0.60	1.31 0.60	1.31 0.60
Connectors (Common to All)			
Input:	"F" type, female		
Output:	"F" type, female		
Test:	"F" type, female		

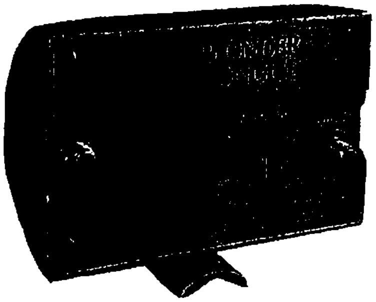
Ordering Information

Model	Stock No.	Description
SCMA	4761	Preamplifier Single Channel VHF/FM, 54-216MHz (a)
SCMA-Ub	4426	Preamplifier Single Channel UHF, 470-806MHz (a)
CMA-B	4706	Preamplifier Single Channel VHF/FM, 54-216MHz (a)
PS-1526	1526	Power Supply Single Output, -21VDC @ 48mA
PS-1536	1536	Power Supply Dual Output, -21VDC @ 100mA

(a) Specify channel when ordering

CMA Series

Broadband VHF and UHF Preamplifiers



○ Features & Benefits

- Low Noise Figure
- Output Test Port for Uninterrupted Service Testing
- High Gain and Input Capability
- Ideal For All BTY Series Broadband Antennas

The CMA Broadband Preamplifier Series includes professional quality, low noise, broadband VHF & UHF preamplifiers. CMA's are available in four different models for amplification of low band VHF, high band VHF, broadband VHF, or broadband UHF. The CMA Series are housed in a die-cast case. Input, output, and test ports are 75 ohm, type "F" female connectors. The CMA's mount on a 1.5 inch O.D. (max) antenna mast with the supplied mounting hardware. Blonder Tongue PS Series -21 VDC power supplies(available separately) are used to power the preamplifiers through the downleads.

○ Specifications

Electrical	**CMA-LB**	**CMA-HB**	**CMA-BB**	**CMA-Uc**
Frequency Range (MHz):	54-88 (2-6)	174-216 (7-13)	54-216 (2-13)	470-806 (14-69)
Noise Figure (dB):	5.0	5.0	5.0	3.0
Gain (dB):	26	26	26	20
Bandpass Flatness (dB):	±0.5	±0.5	±0.7	±1.5
Min. Recommended Input Level (dBmV):	-7	-7	-7	-9
Input Capability (dBmV):	+28	+26	+25	+26
Impedance - All Ports (Ohm):	75	75	75	75
Input Return Loss (dB):	10	12	11	-
Output Return Loss (dB):	11	9	8	-
General				
Power Requirements:	-21 VDC @ 50 mA	-21 VDC @ 50 mA	-21 VDC @ 50 mA	-21 VDC @ 29 mA
Recommended BT Power Supply:	PS-1536	PS-1536	PS-1536	PS-1526
Temperature Range (°C):	-40 to +60	-40 to +60	-40 to +60	-40 to +60
Mechanical				
Maximum Mast Diameter (O.D.) in.:	1.5	1.5	1.5	1.5
Dimensions WxHxD in:	5.13 x 5.25 x 3.50	5.13 x 5.25 x 3.50	5.13 x 5.25 x 3.50	5.00 x 3.88 x 3.00
WxHxD mm:	130 x 133 x 89	130 x 133 x 89	130 x 133 x 89	127 x 99 x 76
Weight lbs.:	1.50	1.50	1.50	1.31
mm:	0.68	0.68	0.68	0.60

Connectors (Common to All)

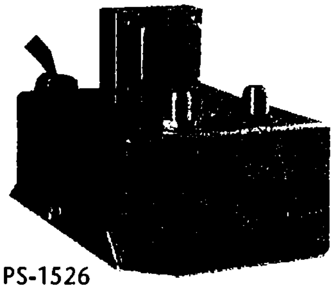
Input:	"F" type, female
Output:	"F" type, female
Test:	"F" type, female

○ Ordering Information

Model	**Stock No.**	**Description**
CMA-BB	4448 BB	Preamplifier Broadband VHF, 54-216MHz
CMA-HB	4448 HB	Preamplifier Broadband High Band VHF, 174-216MHz
CMA-LB	4448 LB	Preamplifier Broadband Low Band VHF, 54-88MHz
CMA-UC	1264	Preamplifier Broadband UHF, 470-806MHz
PS-1526	1526	Power Supply Single Output, -21VDC @ 48mA
PS-1536	1536	Power Supply Dual Output, -21VDC @ 100mA

PS Series

Preamplifier Power Supplies



PS-1526

PS-1536

Features & Benefits

- Single Output, 40mA Capacity
- Regulated and Surge Protected
- Auxiliary AC Receptacle

The PS-1526 and PS-1536 are professional quality, DC power supplies designed to power SCMA and CMA Series antenna preamplifiers. Both units provide -21 VDC and allow for a combined VHF and UHF feed to be diplexed with the power feed. The PS-1536 has a dual output for powering two loads, with a maximum current rating of 100 mA. The PS-1526 has a single output for powering one load, with a maximum current rating of 40 mA.

The PS-1526 and PS-1536 are housed in an aluminum case with an auxiliary AC receptacle. Both units offer regulated and surge-protected power. The PS-1536 has a panel mounted fuse, provides an additional level of short circuit protection on the regulator and a clamped output voltage to protect connected loads.

Specifications

PS-1536

RF

Thru-Line Insertion Loss
- VHF (10-300 MHz): 0.2 dB
- UHF (470-806 MHz): 0.2 dB

Thru-Line Return Loss
- VHF (10-300 MHz): 20 dB
- UHF (470-890 MHz): 20 dB

Isolation Between Outputs:
- 10-700 MHz: 50 dB
- 700-806 MHz: 35 dB

Impedance: 75 Ω

Electrical

Output Voltage: -21 VDC

Current @ 105 VAC Input: 100 ma

General

Power Requirements:
117 VAC, ±10 %,
60 Hz, 0.11 A

Temperature Range: 0 to +50 °C

Mechanical

Dimensions (WxHxD):
8.25 x 3.50 x 2.25 in.
210 x 89 x 57 mm

Weight: 2.00 lbs, 0.91 kg

Connectors

Input: "F" type, female

Output + DC: "F" type, female

PS-1526

RF

Thru-Line Insertion Loss
- VHF (10-300 MHz): 0.3 dB
- UHF (470-806 MHz): 0.5 dB

Thru-Line Return Loss
- VHF (10-300 MHz): 26 dB
- UHF (470-890 MHz): 22 dB

Impedance: 75 Ω

Electrical

Output Voltage: -21 VDC

Current @ 105 VAC Input: 40 ma

General

Power Requirements:
117 VAC, ±10 %,
60 Hz, 0.07 A

Temperature Range: 0 to +50 °C

Mechanical

Dimensions (WxHxD):
4.75 x 3.25 x 2.75 in.
121 x 83 x 70 mm

Weight: 1.25 lbs, 0.57 kg

Connectors

Input: F" type, female

Output + DC: "F" type, female

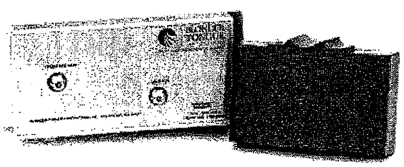
Ordering Information

Model	Stock No.	Description
PS-1526	1526	Power Supply Single Output, -21VDC @ 40mA
PS-1536	1536	Power Supply Dual Output, -21VDC @ 100mA

Galaxy III and Galaxy III Plus

Consumer Broadband Preamplifiers

GALAXY III Series



GALAXY III Plus Series

Features & Benefits

- UHF/VHF and UHF Models
- Low Noise Figure
- Split Band Amplification for Maximum Dynamic Range and Overload Protection
- Dual Output Port Models with Built-in Splitter For Two Set Hookups
- Single or Dual Input Models for Combined or Separate UHF and VHF Antenna Installations
- Lightning and Surge Protected
- High Impact Plastic Enclosure

The GALAXY III Series are quality broadband antenna preamplifiers designed for residential consumer applications. The preamplifier's case is designed to mount on the antenna mast in close proximity to the receiving antenna for best performance. A compact indoor transformer and power adder are included with all models. The GALAXY III Series features lightning and surge protection and a high impact polypropylene case for long service life. Many UHF and UHF/VHF models are available, including units with 300 or 75 ohm, single or dual outputs. Each preamplifier is individually packaged in a display box and includes complete mast mounting hardware.

Specifications

	Input Impedance (ohm)	Output Impedance (ohm)	Frequency Band (dB)	Amplifier Gain (dB)	Noise Figure
VHF					
HORIZON III	1-300	1-300	LB (2-6) HB (7-13)	14 14	5.0 4.0
SKYLINER III PLUS	1-300	1-75	LB (2-6) HB (7-13)	31 31	5.0 4.0
UHF					
ABLE U2 III	1-300	1-300	UHF (14-69)	19	3.3
ABLE U2 III 75	1-300	1-75	UHF (14-69)	20	3.5
ABLE U2 III 75-75	1-75	1-75	UHF (14-69)	20	3.5
UHF/VHF					
CROSS COUNTRY III	1-300	1-300	LB (2-6) HB (7-13) UHF (14-69)	14 14 19	5.0 5.0 3.5
SUBURBAN III	1-300	1-75	LB (2-6) HB (7-13) UHF (14-69)	15 15 19	5.0 5.0 4.0
SUBURBAN III PLUS	1-300	1-75	LB (2-6) HB (7-13) UHF (14-69)	31 31 37	5.0 5.0 5.0
VOYAGER III	1-300	1-300	LB (2-6) HB (7-13) UHF (14-69)	14 16 18	5.0 5.0 3.3
VOYAGER III DUAL	1-300	2-300	LB (2-6) HB (7-13) UHF (14-69)	14 16 18	5.0 5.0 3.3
VAULTER III	1-300	1-75	LB (2-6) HB (7-13) UHF (14-69)	15 15 20	5.0 5.0 3.5
VAULTER III DUAL	1-300	2-75	LB (2-6) HB (7-13) UHF (14-69)	14 16 18	5.0 5.0 3.3
VAULTER III PLUS	1-300	1-75	LB (2-6) HB (7-13) UHF (14-69)	31 31 38	4.5 4.5 4.5

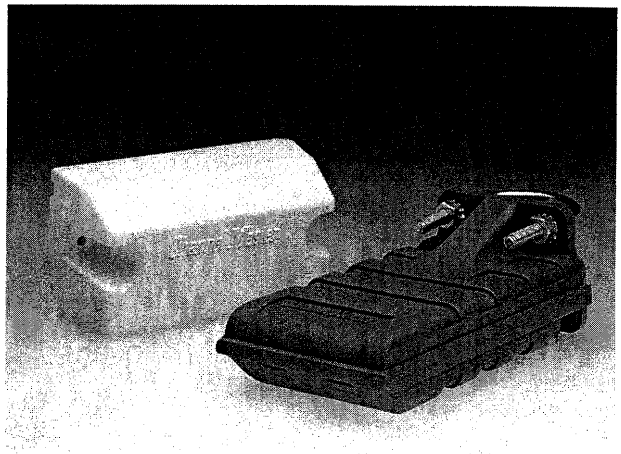
Ordering Information

Model	Stock No.	Description
ABLE U2 III	5118	Consumer Broadband UHF Preamplifier 1-300 Ohm Output
ABLE U2 III 75	5119	Consumer Broadband UHF Preamplifier 1-75 Ohm Output
ABLE U2 III 75-75	5219	Consumer Broadband UHF Preamplifier 1-75 Ohm Output
SUBURBAN III	5123	Consumer Broadband VHF/UHF Preamplifier 1-75 Ohm Output
VAULTER III	5124	Consumer Broadband VHF/UHF Preamplifier 1-75 Ohm Output
VAULTER III DUAL	5125	Consumer Broadband VHF/UHF Preamplifier 2-75 Ohm Outputs
VOYAGER III	5122	Consumer Broadband VHF/UHF Preamplifier 1-300 Ohm Output

Channel Master LNAs

Spartan 3™

Mast Mounted Preamplifiers



- Surface-mounted components for automated production and consistent high performance
- Attractive, modern design for both outdoor unit and power supply
- Easiest installation in the industry
- High gain and ultra low noise figure from the latest generation transistors gives optimum sensitivity
- Separate VHF and UHF amplification plus the use of ultra linear transistors improve output capability for optimum signal handling
- Switchable and tunable FM traps provide full FM control where needed
- Uninterrupted operation even under the harshest environmental conditions
- Full lightning and surge protection
- Cool running, redesigned 117 VAC power supply, Model 0747 is included with each model except Models 0065DSB and 0265DSB. Output voltage is +18 VDC. UL and cUL listed. (Power supply is also available as a separate model.)
- Models 0065 DSB and 0265 DSB are satellite receiver LNB voltage compatible. (+12 to +22 VDC)

SPECIFICATIONS

				VHF			UHF			FM Control		
Model	Inputs	Input Impedance Ohms	Output Impedance/ Downlead Ohms	Gain dB	Noise Figure dB	Output Capability dBmV*	Gain dB	Noise Figure dB	Output Capability dBmV*	Switchable Trap	Tunable Trap	Power Supply
0064 DSB	1 (VHF/UHF)	300	75	16	3.0	56	23	2.2	50	Yes	Yes	0747 Incl.
3041 DSB	1 (VHF/UHF)	300	75	16	3.0	56	23	2.2	50	Yes	No	0747 Incl.
0264 DSB	2 (VHF & UHF)	300	75	16	3.0	56	23	2.2	50	Yes	Yes	0747 Incl.
0068 DSB	1 (VHF/UHF)	75	75	16	3.0	56	23	2.2	50	Yes	Yes	0747 Incl.
0065 DSB	1 (VHF/UHF)	300	75	16	3.0	56	23	2.2	50	Yes	Yes	Not Incl.**
0265 DSB	2 (VHF & UHF)	300	75	16	3.0	56	23	2.2	50	Yes	Yes	Not Incl.**

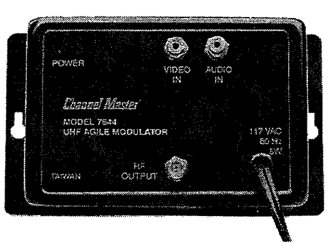
**Output capability is quoted for 2 channels at -46 dB cross modulation. Derate by 5 or 9 dB for 4 or 8 channels per band. Maximum input is output capability minus gain.*
***Ensure the 100 mA current draw will not overload the satellite receiver. See Titan™ Model 7778 for Spartan 3™ features in the Titan™ die-cast housing.*

UHF Agile Modulator

MODEL 7644

- PLL frequency synthesized
- Set channel with DIP Switches
- Ideal for DBS satellite receivers, security cameras
- Output frequency may be set in 1 MHz increments, allowing CATV as well as off-air channel plans.

FCC Certified

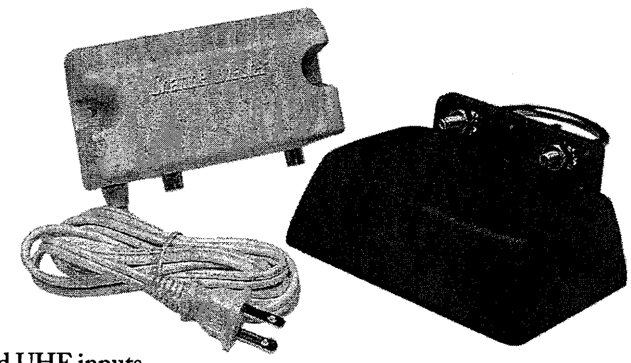


SPECIFICATIONS

RF:	
UHF Channel Range	14-50
Frequency Range	471.25 to 687.25 MHz
Output Level	+14 dBmV
Modulation Type	NTSC Double Sideband AM
Output Impedance/Connector	75 ohms, Type "F"
VIDEO:	
Input Level	1V± 3 dB
Input Impedance	75 ohms
Frequency Response	30 Hz - 4.2 MHz
Input Connector	RCA Phono
AUDIO:	
Input Level	200 mV rms
Input Impedance	10 k ohms
Frequency Response	50 Hz to 15 kHz
Subcarrier Frequency	4.5 MHz
Subcarrier Level	Video-15 dB
Input Connector	RCA Phono
POWER:	117 VAC, 60 Hz, 5W

TITAN 2™

MATV Mast Mounted Preamplifiers



Three models available:

MODEL 7775

- UHF only

Models 7777 and 7778

- VHF and UHF bands with separate amplification in each band for maximum signal handling
- May be configured for either separate or combined VHF and UHF inputs
- Includes a switchable FM trap
- Model 7778 offers Spartan 3™ specifications in the die-cast Titan™ housing

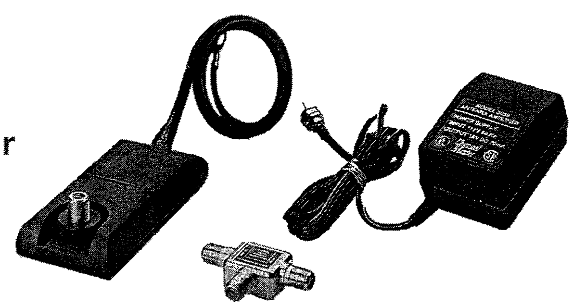
SPECIFICATIONS

MODEL	7775	7777	7778
Number of Inputs*	1(UHF)	1/2(VHF & UHF)	1/2(VHF & UHF)
Input and Output Impedance	75	75	75ohms
Input and Output Connectors	Type F	Type F	Type F
VHF Gain	N/A	23	16dB
VHF Noise Figure	N/A	2.8	3.0dB
VHF Output Capability**	N/A	57	56dBmV
Switchable FM Trap	N/A	Yes	Yes
UHF Gain	26	26	23dB
UHF Noise Figure	2.0	2.0	2.2dB
UHF Output Capability**	51	51	50dBmV

** On Models 7777 and 7778, an internal switch selects either separate or combined VHF and UHF inputs.*
*** Output capability is quoted for 2 channels at -46 dB cross modulation.*
Derate by 5 or 9 dB for 4 or 8 channels per band. Maximum input is output capability minus gain.

*Channel***Max**®

UHF/VHF Outdoor Antenna Amplifier



MODEL 3039

- Amplifies weak UHF/VHF television signals
- Increases incoming signal by 20 times
- Consists of antenna boom mounted amplifier, UL/cUL listed power supply, 6' RG59 coaxial cable, weather boot, and tie wrap
- Packaged in a clear, clam shell blister pack for optimum consumer appeal

SPECIFICATIONS

Frequency Range	54-88 MHz 174-806 MHz
Impedance	300 ohm (in), 75 ohm (out)
Gain	13 dB
Noise Figure	3.5 dB
Power Required	117VAC
Output Capability	45 dBmV per ch.(8 chs.)

Winegard LNAs

MODEL	INPUT			OUTPUT	AVERAGE GAIN		AVERAGE NOISE		MAXIMUM TOTAL INPUT# (MICROVOLTS)	
	VHF	UHF	82 CH.		VHF	UHF	VHF	UHF	VHF	UHF
AP-2870	75	75		75	17 dB	19 dB	2.9 dB	2.9 dB	10,000 µV	93,000 µV
AP-2880	75	75		75	29 dB	19 dB	2.9 dB	2.9 dB	29,000 µV	93,000 µV
AP-3700	75	or	75	75	17 dB	By-Passed	2.6 dB	N/A	110,000 µV	N/A
AP-3800	75	or	75	75	29 dB	By-Passed	2.9 dB	N/A	29,000 µV	N/A
AP-4700		75 or	75	75	By-Passed	19dB	NA	2.9dB	N/A	93,000 µV
AP-4800		75 or	75	75	By-Passed	28 dB	N/A	2.7 dB	N/A	30,000µV
AP-8275			75	75	29 dB	28 dB	2.9 dB	2.8 dB	29,000 µV	30,000 µVV
AP-8283			300	75	29 dB	28 dB	2.9 dB	2.8 dB	29,000 µV	30,000 µV
AP-8700			75	75	17 dB	19 dB	2.8 dB	2.8 dB	110,000 µV	93,000 µV
AP-8703			300	75	17 dB	19 dB	3.9 dB	3.9 dB	110,000 µV	93,000 µV
AP-8733	300	300		75	17 dB	19 dB	3.9 dB	3.9 dB	110,000 µV	93,000 µV
AP-8780			75	75	17 dB	28 dB	2.9 dB	2.7 dB	110,000 µV	30,000 µV
AP-8783			300	75	17 dB	28 dB	3.9 dB	3.9 dB	110,000 µV	30,000 µV
AP-8800			75	75	29 dB	19 dB	2.7 dB	2.8 dB	29,000 µV	93,000 µV
AP-8803			300	75	29 dB	19 dB	3.9 dB	3.9 dB	29,000 µV	93,000 µV
AP-8833	300	300		75	29 dB	19 dB	3.9 dB	3.9 dB	29,000 µV	93,000 µV

Exhibit 3

Rotors

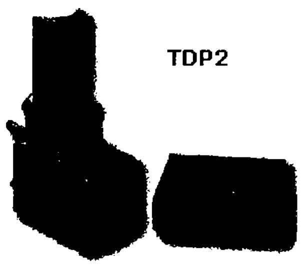
ANTENNACRAFT America's Top Producer of HDTV / VHF / UHF Antennas

ANTENNA PRODUCTS

Home Sales Support About

TDP2 TV/FM Antenna Rotator

Dependable and reliable, this is the standard the TV industry goes by! For traditionalists everywhere, the TDP2 simplified multi-channel reception.



TDP2

Fully Automatic, heavy-duty motor handles large antenna with plenty of torque to break thru heavy ice loads

Strong, machine-cut gears that won't bind

Brake pads hold firm to prevent high wind damage (tested to 70 mph)

2 synchronized motors give exact degree of station location

One piece high alloy aluminum construction assures total weather protection

Gold, corrosion-resistant coated

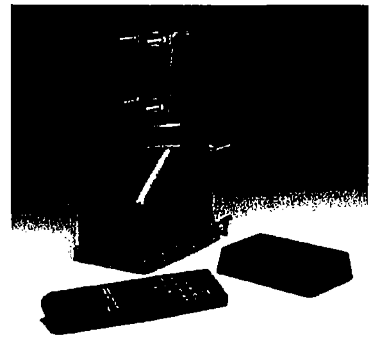
Holds masts up to 2" diameter

Requires 3-wire rotator cable

UL listed, AC operation

List Price $94.88

Antenna Rotators



A Rotor or Rotator is a mast-mounted, motor-driven device that permits the TV viewer to conveniently rotate (orient) the outdoor antenna in any direction to optimize reception of a desired TV channel. A rotor should be considered when TV signals are being broadcast from towers in different directions and a single antenna can not accommodate all locations.

A rotator consists of two parts: 1) an indoor control unit, and 2) an outdoor drive unit. The two are connected via a 3-conductor wire that carries the voltage and control signals from the indoor unit to the outdoor drive unit.

Channel Master manufactures a remote control unit, model 9521A. A separate indoor controller, model 9537 is also available and is compatible with the following rotator systems: 9500, 9510, 9510A, 9512, 9513, 9515, 9515A, and Radio Shack 15-1225. Model 9537 is the indoor controller and handheld remote control. This model may be added to an existing manual rotator system and instantly upgrades the system to the remote control version.

Antenna Rotator Controller with Infra-Red Remote Control

The Complete System
Model 9521A —*Controller, Handheld, and Drive Unit*

Handheld Unit and Controller Only
Model 9537 —*Instantly upgrade a manual system to remote by simply replacing current manual controller with Model 9537. Model 9537 is a perfect upgrade for Models 9500, 9510(A), 9512, 9513, 0515(A), and Radio Shack 15-1225.*

Control Unit Features

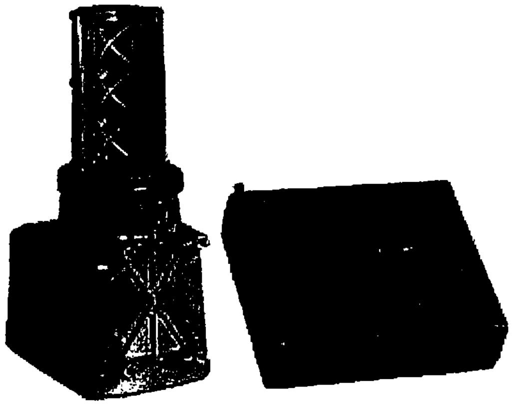
- Compatible with Most Universal Remote Controls (Including Satellite)
- 69 Channel Programmable Memory
- Non-Volatile Memory — Holds Locations during Power Failures
- Automatic Synchronization Ensures Pinpoint Accuracy
- Direct Access via TV Channel Number or Digital Compass Location
- Unobtrusive Control Blends with any Décor

Drive Unit Features

- One-Piece Cast Aluminum Housing
- Heavy Duty Rotator Motor
- Wind-Tested Brake Pads
- Durable Powder-Coat Paint Finish
- Precision-Cut Gear System
- Built-In Steel Thrust Bearings

SPECIFICATIONS
Rotation 1RPM
Gear Ratio 3200 to 1
Max. Masting 2"
Max. Vertical Load 250 lbs.
Max. Balanced Windload Area 3 sq. ft.

117V 60 Hz Rotator and Control Unit
(230V 50 Hz Units: 9521EU and 9537EU)



360° Outdoor Antenna Rotator

$74.99
Catalog #: **15-1245**

Brand: **RadioShack**
Model: **15-1245**

FREE SHIPPING

Protect Your Investment
Learn How

Availability	On-line: In-stock	In Store: Check availability
	Phone: In-stock 1-800-THE-SHACK (1-800-843-7422)	

(Pricing and availability may vary outside the contiguous 48 United States.)

With the Outdoor Antenna Rotator you can accurately position your antenna for the best possible TV and FM reception–perfect for suburban and rural areas. It automatically turns your antenna to the direction you dial in on the control panel, and then shuts off when it reaches the desired position.

PRODUCT FEATURES
• The heavy-duty construction handles large antennas and masts from 1-1/3 to 1-3/4 inches in diameter
• The Outdoor Antenna Rotator is also ideal for Ham and other amateur radio antennas
• For use with 3-wire rotator cable (#15-1150)
• Includes mounting hardware
• Includes channel labels for marking the best reception points for each channel
• Handles masts from 1-1/3 to 1-3/4 inches in diameter
• Rotation time 360°: 65 (± 5) seconds (at 60Hz)
• Rotation torque: 160 inch-pounds
• Vertical load: 99 pounds maximum
• Thrust bearing: Handles loads up to 250 pounds maximum
• Gear ratio: 3100 (± 100) to 1
• Wind load braking system: Up to 70mph
• Power source: 120VAC, 62W, 60Hz, 0.52A
• Motor: 18VAC (2.35A)
• UL Listed

Need Related Products?
Check the products that you would like added to the cart and then click the Add to Cart or Update Cart button.

100-Ft. Rotator Control Cable
15-1150
$14.99

Monday, June 13, 2005 5:45:40 PM

Remote Rotator Controller with Infrared Signal

$54.99
Catalog #: **15-1213**

FREE SHIPPING

Protect Your Investment
Learn How

Availability	On-line: Out of Stock	In Store: Check availability
	Phone: Out-of-stock 1-800-THE-SHACK (1-800-843-7422)	

(Pricing and availability may vary outside the contiguous 48 United States.)

PRODUCT FEATURES
• Indicator on the remote displays antenna direction
• Remote rotator controller with infrared signal
• Includes handheld unit and controller; rotator not included

Monday, June 13, 2005 5:48:18 PM

Before the
Federal Communications Commission
Washington, D.C. 20554

DRAFT

In the matter of	)	
	)	
Re Technical Standards for Determining	)	ET Docket No. 05-182
Eligibility for Satellite-Delivered Network	)	
Signals Pursuant to the Satellite Home	)	
Viewer Extension and Reauthorization Act	)	

To: The Commission

COMMENTS OF
THE ASSOCIATION FOR MAXIMUM SERVICE TELEVISION, INC.

The Association for Maximum Service Television, Inc. ("MSTV")[1] files these comments and the corresponding Engineering Statement[2] to address some of the important issues raised by the Commission's Notice of Inquiry (the "NOI") for determining eligibility for satellite-delivered network signals pursuant the Satellite Home Viewer Extension and Reauthorization Act (SHVERA).[3]

The NOI is seeking comments on the adequacy of the digital signal strength standard and testing procedures used to determine whether households are eligible to

---

[1] MSTV represents nearly 500 local television stations on technology and spectrum policy issues relating to analog and digital television services.
[2] *Infra,* Ex.1*,* du Treil, Lundin & Rackely, Inc., *Engineering Statement in Support of Comments of the Association for Maximum Service Television, Inc., in Response to the Notice of Inquiry in the Matter of Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act. ET Docket No. 05-182.*
[3] Notice of Inquiry, *In re Technical Standards for Determining Eligibility for Determining Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act (SHVERA)*, ET Docket 05-182, FCC 05-1794 (rel. May 18, 2005).

receive distant digital television (DTV) network signals from satellite communication providers. Specifically, the Commission is seeking comments and information on whether the signal strength standards of 47 CFR 73.622(e) and the measurement procedures of 47 CFR 73.686(d) should be amended for the purpose of identifying if a household is underserved by a digital television signal and thus eligible for reception of a retransmitted distant network signal.

MSTV urges the Commission to reaffirm the digital signal strength standards listed in Section 73.622(e) of the rules for determining service availability for DTV and thus identifying underserved households eligible for SHVERA. These standards -- grounded on sound engineering principles, are based on a set of planning factors recommended by the FCC Advisory Committee Television Services and subsequently adopted by the Commission.[4] These factors have been in use for almost a decade and have been proven in the field to be appropriate for determining service availability for DTV. Moreover, the attached Engineering Statement prepared by the firm of du Treil, Lundin and Rackley, Inc. have re-examined the premise for these planning factors and provided further evidence to demonstrate that the planning factors established a decade ago are achievable and are an appropriate metric for predicting DTV service under the terms of SHVERA.

---

[4] From The Sixth Report and Order, Appendix A, *Advanced Television Systems and their Impact upon the Existing Television Broadcast Service,* MM Docket No. 87-268, FCC 97-115.

CONCLUSION

For the reasons explained above, the Commission should not change the strength standards listed in Section 73.622(e) of the rules for determining service availability for DTV and use these standards to identify underserved households eligible for SHVERA.

Respectfully submitted,

ASSOCIATION FOR MAXIMUM SERVICE TELEVISION, INC.

/s/David Donovan_
David L. Donovan
Victor Tawil
ASSOCIATION FOR MAXIMUM
SERVICE TELEVISION, INC.
P.O. Box 9897
4100 Wisconsin Avenue, NW
Washington, D.C. 20016
202-966-1956 (tel.)
202-966-9617 (fax)

June 17, 2005

ENGINEERING STATEMENT
IN SUPPORT OF COMMENTS OF THE
ASSOCIATION FOR MAXIMUM SERVICE TELEVISION
IN RESPONSE TO THE NOTICE OF INQUIRY IN THE MATTER OF
TECHNICAL STANDARDS FOR DETERMINING ELIGIBILITY FOR
SATELLITE-DELIVERED NETWORK SIGNALS PURSUANT TO THE SATELLITE
HOME VIEWER EXTENSION AND REAUTHORIZATION ACT
ET DOCKET NO. 05-182

1. Introduction

This engineering statement was prepared on behalf the Association for Maximum Service Television ("MSTV") in support of its comments in response to the FCC's Notice of Inquiry ("NOI") in the matter of *Technical Standards for Determining Eligibility For Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act* ("SHVERA"), ET Docket No. 05-182. In the NOI, the Commission sought comments and information on whether the signals strength standards of 47 CFR 73.622(e) and the measurement procedures of 47 CFR 73.686(d) should be amended for the purpose of identifying if a household is unserved by a digital television signal and thus eligible for reception of a retransmitted distant network signal.

For the purposes of predicting whether a household is unserved by a DTV signal, MSTV believes that the Commission should not change the signal strength standards of 47 CFR 73.622(e). These standards were established in the Sixth Report and Order in MM Docket No. 87-268, Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service, FCC 97-115 (herein "DTV Sixth R&O"), and incorporated into Rule Section 73.622(e). As the NOI indicates, the signal strengths specified in Section 73.622(e) are expressed as the electric field strengths necessary at a receiving antenna to provide a signal sufficient to overcome the thermal and receiver noise present within the 6 MHz DTV channel to provide an acceptable picture on a DTV receiver, and thus they are termed the "noise-limited field strengths."

The noise limited field strength values listed in Section 73.622(e) are based on a set of planning factors recommended by FCC Advisory Committee on Advanced Television Service and are listed in Appendix A of the DTV Sixth R&O. This engineering statement reviews the bases for these planning factors and provides examples of specifications for available equipment demonstrating that the planning factors remain an appropriate means of defining digital television service availability.

2. DTV Planning Factors

The DTV planning factors, as listed in the DTV Sixth R&O, are provided in Table 1 below. Following the table are detailed descriptions of each factor including a summary of the parameters upon which each factor is based.

Table 1 – DTV Planning Factors[1]

Planning Factor	Low VHF Ch. 2-6	High VHF Ch. 7-13	UHF Ch. 14-69	Units
Geometric Mean Frequency	69	194	615	MHz
Dipole Factor (dBm-dBu)	-111.8	-120.8	-130.8	dB
Thermal Noise	-106.2	-106.2	-106.2	dBm
Antenna Gain	4	6	10	dBd
Downlead Line Loss	1	2	4	dB
Antenna front-to-back ratio	10	12	14	dB
Receiver Noise Figure	10	10	7	dB
Time Probability Factor (90% Availability)	0	0	0	dB
Location Probability Factor (50% Availability)	0	0	0	dB
C/N Ratio	15.2	15.2	15.2	dB
Noise-Limited Field Strength	28	36	41	dBuV/m, f(50,90)

The DTV planning factors were listed in an alternate form in the Satellite Home Viewer Improvement Act (SHVIA) proceedings[2]. So that there is no confusion, where appropriate we provide an explanation of the differences in form. No matter which form

[1] From Sixth Report and Order, Appendix A, *Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service*, MM Docket No. 87-268, FCC 97-115.
[2] See Report, *Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Improvement Act*, ET Docket No. 00-90, FCC 00-416.

is used to express the DTV planning factors, the noise-limited field strengths calculated from them are the same.

2.1 Use of Geometric Mean Frequency

For DTV planning purposes, a frequency dependent dipole factor was calculated for the three television bands (Low VHF, High VHF and UHF) based on the geometric mean of the frequencies at the upper and lower edges of each band. The geometric mean frequency was then used to calculate a single dipole factor for each of the three television bands, thus simplifying the planning process by eliminating the need to separately calculate a dipole factor for each DTV channel. Absent this policy, the calculated noise-limited signal strengths would vary in a frequency-dependent manner from channel to channel across the entire band. The use of the geometric mean frequency is reasonable for planning purposes as differences between the dipole factor as calculated based on the geometric mean frequency and that calculated based on the center frequency of the actual channels are small (1 to 2 dB, depending on band).

2.2 Dipole Factor

The dipole factor expresses the quantitative relationship between the power or voltage present at the terminals of a half-wave dipole antenna which is immersed in an electric field of known strength. The DTV Sixth R&O expresses the dipole factor in logarithmic form as the relationship between electric field strength and power. The SHVIA Report expresses the dipole factor in logarithmic form as the relationship between electric field strength and voltage. Both the DTV Sixth R&O and the SHVIA Report assume a 75-ohm load. It is important to note that no substantive differences arise from the variation in the form of expressing the dipole factor.

2.3 Thermal Noise

For the DTV planning factors, thermal noise is calculated based on a 6 MHz-wide channel and assumed temperature of 290K. The DTV Sixth R&O expresses it in logarithmic terms as power in decibels relative to a milliwatt. The SHVIA Report expresses it in logarithmic terms as voltage in decibels relative to a microvolt, assuming a 75-ohm impedance.

We note that the DTV Sixth R&O correctly reports the thermal noise at -106.2 dBm. When expressed in terms of voltage in units of dB/1μV for a 75-ohm impedance the value is 2.56 dB/1μV. It is not known why the thermal noise is reported as 1.75 dB/1μV in the SHVIA Report. The 0.81 dB of difference does not result in a change in the noise-limited field strengths in the SHVIA Report due to the fact that the SHVIA Report adjusts the Carrier-to-Noise ratio by 0.8 dB (15.2 to 16 dB) from that used in the DTV planning factors in the DTV Sixth R&O. This compensates for the difference in the reported thermal noise figure.

2.4 Antenna Gain and Downlead Line Loss

In both the DTV Sixth R&O and the SHVIA Report, the presumed antenna gains are expressed in decibels relative to a half-wave dipole and the downlead line losses are expressed based on assumed use of 50 feet of typical 75-ohm coaxial cable.

2.5 Antenna Front-to-Back Ratio

The antenna front-to-back ratio, which is listed in the DTV Sixth R&O (but is not listed in the SHVIA Report) does not enter into the calculations of the noise limited field strengths. It is, however, pertinent to issues of interference from undesired signals, and it is used in the process of allotting DTV channels. The antenna front-to-back ratio expresses the assumed difference between the maximum antenna gain (for an antenna properly oriented toward a desired station) and the gain for the antenna in the opposite direction (180°) to its maximum gain.

2.6 Receiver Noise Figure

The receiver noise figure expresses, in logarithmic terms, the increase in overall noise (above thermal noise) due to internal receiver circuitry. The figures are based on tests conducted on the Grand Alliance system (the 8-VSB system adopted by the FCC for US digital television) at the Advanced Television Test Center and are reported in the "Final Technical Report" of the Technical Subgroup of the FCC Advisory Committee on Advanced Television Service, October 30, 1995.

2.7 Time and Location Probability Factors

For the purpose of predicting the limit of DTV service, the time and location probability factors that were adopted are the same as the planning factors used for the Grade B analog (NTSC) television signal, namely a signal predicted to be received at 50 percent of the locations, 90 percent of the time. Unlike the analog Grade B planning factors, however, no adjustment was made to the DTV noise limited field strengths in terms of a median field (50 percent of the locations, 50 percent of the time) as was done with the Grade B field strength. Rather, the noise limited field strengths for DTV service are expressed as fields received at 50 percent of the locations, 90 percent of the time.

When predicting DTV service based on the noise limited field strength, the prediction model takes into account both the time and location probability factors. Therefore, the values of both factors are 0 dB when predicting the field strengths.

2.8 Carrier-to-Noise (C/N) Ratio

The carrier-to-noise (C/N) ratio is also based on testing done on the Grand Alliance system at the Advanced Television Test Center. The 15.2 dB figure listed in the DTV Sixth R&O expresses the minimum ratio of the desired carrier power to noise power necessary to produce an acceptable DTV picture. In the SHVIA Report, this figure is listed as 16 dB. However, since the SHVIA Report understates the thermal noise by 0.81 dB (see Section 2.3), the net result is no change in the noise-limited field strengths.

3. Applicability of Planning Factors to Equipment Available for Purchase and Installation

For the purpose of evaluating whether the noise limited field strengths, developed based on the DTV planning factors, are still valid based on performance of available receiving equipment, we provide the following information comparing the applicable DTV planning factor values to the values of those factors as specified by manufacturers for equipment that is presently available for purchase and installation.

3.1 Antenna Gain and Front-to-Back Ratio

The planning factors for antenna gain and front-to-back ratio were for outdoor antennas. A search of web sites for suppliers and manufacturers of outdoor antennas reveals the following partial list of antennas (see Table 2) that meet or exceed the antenna gain and front-to-back ratio values contained in the DTV planning factors. The gain and front to back ratios shown in Table 2 were obtained from information produced by the manufacturers and/or equipment suppliers.

Table 2 – Specifications from Manufacturers of Outdoor Receiving Antennas				
Frequency Band	Manufacturer	Antenna Model	Antenna Gain (dBd)	Antenna Front-to-Back Ratio (dB)
Low VHF	Antennacraft	CS-1100	6.9	19.4
	Channel Master (Andrew)	Crossfire Model 3671	5.6 (Band Average) 4.9 (min. Ch 2) 6.2 (max. Chs 5,6)	24 (minimum across band)
	Winegard	Prostar 1000 Model PR-5030	5.0 (min. Ch 4) 7.0 (max. Ch 6)	19 (min. Ch 2)
High VHF	Antennacraft	CS-1100	9.6	17.6
	Channel Master (Andrew)	Crossfire Model 3671	10.9 (Band Average) 9.5 (min. Ch13) 11.5 (max. Ch 8)	14 (minimum across band)
	Winegard	Prostar 1000 Model PR-5030	7.5 (min. Ch 7) 9.5 (max. Ch 9)	13 (min. Ch 7) >20 (max. Ch 4,6)
UHF (Channels 14 –51)	Antennacraft	MXU-59	10.7	17.0
	Channel Master (Andrew)	UHF Model 4228	10.8 (min. Ch 14) 12.7 (max. Ch. 43)	19 (min. Ch 35) 24 (max. Ch. 43)
	Winegard	Prostar 1000 Model 9032	14.9 (min. Ch 14) 16.3 (max. Ch 32)	14 (min. Ch 14) 20 (max. Ch 32,50)

As can be seen in Table 2, with respect to both the antenna gain and antenna front-to-back ratio, the data indicate that there are a number of receiving antennas available on the market that exceed the DTV planning factors.

As an aide in reception, mast-mounted, low-noise pre-amplifiers are available which can further enhance system gain. For reference, relevant specifications for three models are listed in Table 3.

Table 3 – Specifications from Manufacturers of Mast-Mounted Preamps				
Frequency Band	Manufacturer	Amplifier Model	Amplifier Gain (dB)	Amplifier Noise Figure (dB)
VHF	Antennacraft	10G202	29 (avg VHF/UHF)	<3.0 (VHF)
	Channel Master (Andrew)	Titan 2 Model 7777	23	2.8
	Winegard	Chromstar 2000 Model AP-2880	29	2.9

Table 3 – Specifications from Manufacturers of Mast-Mounted Preamps				
UHF	Antennacraft	10G202	29 (avg VHF/UHF)	<2.6 (UHF)
	Channel Master (Andrew)	Titan 2 Model 7777	26	2.0
	Winegard	Chromstar 2000 Model AP-2880	19	2.9

When the improvements in system noise figure (see Section 3.3 below) resulting from implementation of a mast-mounted preamplifier are taken into account, it is possible to meet the planning factor gain figures even when using antennas with passive gains less than the planning factor values.

3.2 Downlead Line Loss

The line loss values contained in the DTV planning factors are based on 50 feet of 75-ohm coaxial cable. The planning factor values appear reasonable based on the published attenuation values for 75-ohm RG-6 coaxial cable. Table 4 provides specifications from three different coaxial cable manufacturers. In all three cases, the attenuation values assumed in the DTV planning factors exceed that of available products. In other words, the DTV planning factors use conservative estimates of transmission loss.

Table 4 – Specifications from Manufacturers of Coaxial Cable (75 ohm)				
Frequency	Manufacturer	Cable Type and Model	Attenuation (dB/100 ft)	Attenuation (50 feet of cable)
69 MHz (Low VHF)	Belden	RG 6/U Model 9116	1.71	0.86
	Channel Master	RG6 9533-500	1.79	0.90
	Coleman	RG 6/U Model 992127	1.9	0.95
194 MHz (High VHF)	Belden	RG 6/U Model 9116	2.73	1.37
	Channel Master	RG6 9533-500	2.89	1.45
	Coleman	RG 6/U Model 992127	3.2	1.6
615 MHz (UHF)	Belden	RG 6/U Model 9116	5.00	2.50
	Channel Master	RG6 9533-500	5.57	2.79

Table 4 – Specifications from Manufacturers of Coaxial Cable (75 ohm)				
	Coleman	RG 6/U Model 992127	6.2	3.1

3.3 Receiver Noise Figure

The receiver noise figures used in the planning factors are 10 dB for low-band VHF, 10 dB for high-band VHF and 7 dB for UHF, based upon test data from the Advanced Television Test Center. We have not independently tested a representative sample of DTV receivers, and since the Commission has stated in the NOI that it intends to conduct measurements on DTV receivers, we assume that the Commission will be drawing conclusions regarding the appropriate noise figure values for the purposes of the SHVERA. We note that analog (NTSC) UHF receivers have achieved noise figures in the range of 7 to 8 dB.

It is noted that the overall system noise figure can be significantly reduced with the use of a high-gain, low-noise, mast-mounted pre-amplifier. For example, assuming a mast-mounted, pre-amplifier gain of 19 dB with noise figure of 2.9 dB at UHF frequencies (based on values contained in Table 3), and assuming a downlead line loss of 4 dB and receiver noise figure of 7 dB per the DTV UHF planning factors, there is a calculated improvement in the overall system noise figure of 7.8 dB.

3.4 Receiver C/N Ratio

Laboratory measurements on various DTV receivers were reported by Bouchard, et al. of the Communications Research Center Canada (CRC) in late 2000.[3] These measurements demonstrated C/N levels consistent with the FCC planning factor of 15.2 dB. The measurements were conducted on six DTV receivers manufactured in the period of 1999-2000. For a weak desired signal level, the results demonstrated a C/N range of 15.3 dB to 17.8 dB, with a median C/N of 15.6 dB. The five best out of the six had a C/N of 15.3 dB to 16.7 dB, with a median C/N of 15.4 dB. The worst performing receiver was the oldest of the population measured.

Recent laboratory measurements on a "fifth generation" DTV receiver also show C/N measurement results consistent with the FCC planning factor. Laboratory measurements were conducted by the CRC on the latest Zenith receiver in September

[3] See Bouchard, Pierre, et al., "Digital Television Test Results – Phase 1", Communications Research Center (Ottawa, Canada), *CRC Report No. CRC-RP-2000-11*, November 2000.

2003.[4] These results showed a measured C/N of 15.9 dB in the presence of a weak signal level. This is within 0.7 dB of the planning factor figure and indicates that the latest generation of DTV receivers will perform in line with those of earlier manufacture.

3.5 Antenna Orientation

The DTV planning factors assume that the receiving antenna is properly oriented toward the desired station. In the SHVIA proceeding, the Commission affirmed the validity of this assumption with respect to reception of an analog TV signal. Channel Master (now owned by Andrew), Winegard and Delhi (formerly Jerrold) all manufacture antenna rotators for outdoor mast-mounted home antennas. All have control systems that may be operated inside the home to remotely actuate the rotator. The same assumption of proper antenna orientation, as affirmed in the SHVIA proceeding, is also valid for reception of DTV signals, and is therefore consistent with the DTV planning factors.

4. Other DTV Receiver Performance Factors

The NOI requests information on DTV receiver performance as it may be affected by conditions not addressed by the planning factors. Among these conditions is performance in the presence of multipath. With regard to multipath conditions, we note that recent studies on “fifth generation”, 8-VSB receivers have shown significant improvement over the performance of earlier receivers.[5]

In Laud’s paper, he reports laboratory tests demonstrating fifth generation receiver equalizer capability to handle up to 50-µs pre- and post-ghosts. He also indicates significant improvement in ghost-canceling capability of fifth generation receiver equalizers, with a capable of handling ghost ensembles with up to 100 percent ghosts. His paper also reports on field tests on fifth-generation receivers in Washington, DC; Ottawa, Canada; and Baltimore, MD where significant improvement in performance of fifth generation receivers at known “difficult” locations was demonstrated. In these field tests, fifth generation receivers showed improvements ranging from an elimination to near elimination of failures (in the Ottawa and Baltimore tests) to a reduction in failures by a factor of three (in the Washington tests).

---

[4] See “Results of the Laboratory Evaluation of Zenith 5th Generation VSB Television Receiver for Terrestrial Broadcasting”, Report Version 1.1, Communications Reseach Centre Canada, September 2003.
[5] See Tim Laud, et. al., “Performance of 5th Generation 8-VSB Receivers”, IEEE Transactions of Consumer Electronics, Vol. 50, No. 4, Nov. 2004. Also Yiyan Wu, et. al., “An ATSC DTV Receiver With Improved Robustness to Multipath and Distributed Transmission Environments”, IEEE Transactions on Broadcasting, Vol. 50, No. 1, March 2004.

5. Conclusion

In light of the foregoing information on performance of DTV reception equipment, we conclude that equipment is available that will permit DTV reception in the presence of a signal equaling or exceeding that based on the DTV planning factors. Therefore, use of the DTV noise-limited signal strengths, developed based on those planning factors and contained in the DTV Sixth R&O, is an appropriate metric for predicting DTV service under the terms of the SHVERA.

This statement was prepared by me or under my direction and it is true and correct to the best of my knowledge and belief.

Louis Robert du Treil, Jr., P.E.

du Treil, Lundin & Rackley, Inc.
201 Fletcher Ave.
Sarasota, Florida 34237

June 17, 2005

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Technical Standards for Determining Eligibility	)	
For Satellite-Delivered Network Signals Pursuant	)	ET Docket No. 05-182
To the Satellite Home Viewer Extension and	)	
Reauthorization Act	)	
	)	

To: Office of the Secretary
Attn: The Commission

COMMENTS OF ATI TECHNOLOGIES, INC.

ATI Technologies, Inc. ("ATI"), by its attorneys, hereby submits these Comments in response to the Commission's *Notice of Inquiry* in the above-captioned proceeding.[1] In the NOI, the Commission requested comment on a number of issues related to the determination of eligibility to receive distant broadcast digital television ("DTV") signals from direct-to-home satellite operators. As the industry leader in the design and production of DTV receiver chips, ATI respectfully submits these Comments to provide the Commission with timely and accurate information about the performance of DTV receivers and associated equipment that now is or soon will be available to end-user consumers.

---

[1] Technical Standards for Determining Eligibility For Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act, ET Docket No. 05-182, *Notice of Inquiry*, FCC 05-94 (rel. May 3, 2005) ("*NOI*").

Introduction

Founded in Toronto, Canada in 1985, ATI designs, produces and markets graphics, video, and multimedia processors for use in personal computers including both PCs and Macs; video game consoles such as the X-Box; and consumer electronics devices, including mobile phones, personal digital assistants, and DTV receivers and set-top boxes ("STBs"). In 2004, when ATI garnered US $2 billion in revenue, NASDAQ added ATI to its NASDAQ-100 Index.[2]

In 2004, ATI shipped more than five million DTV chips for use in high definition televisions and STBs. ATI supplies leading manufacturers of HD TVs and HD STBs including but not limited to Funai, Hitachi, JVC, Mitsubishi, Matsushita (Panasonic), Philips, Scientific-Atlanta, Samsung, Sharp, Sony, TiVo, Toshiba, Thomson, TTE (RCA), and others. ATI holds an 85 percent share of the market for Integrated HDTV Digital Cable Ready (DCR) and DTV off-air VSB demodulators. In short, ATI has the most fielded VSB receiver chips, in the largest variety of consumer branded equipment, of any chip supplier in the world.

As such, ATI is uniquely positioned to comment on DTV receiver technology.[3] ATI therefore offers the following:

(1) The Commission should adopt the cross-industry receiver performance guidelines set forth in ATSC's "A/74 Recommended Practice;"

(2) The performance measurement factors known as A/74 Field Ensemble testing indicate actual receiver performance more accurately than do the A/74 Laboratory Ensembles and in fact provide the most reliable and accurate method of evaluating DTV receiver performance;

---

[2] Launched in January 1985, the NASDAQ-100 Index represents the largest non-financial domestic and international issues listed on The NASDAQ Stock Market based on market capitalization. *See* http://dynamic.nasdaq.com/dynamic/nasdaq100_activity.stm.

[3] Attachment A diagrams the components of a typical DTV receiver.

(3) The current DTV receiver marketplace offers end-users superior performance that is highly affordable, and market trends project increasing affordability and performance as equipment manufacturers integrate the latest generations of DTV receiver chips; and

(4) Neither price nor brand name indicate to consumers the performance of DTV receivers and using the best chips does not necessarily cost more. As a result, consumers lack sufficient information for purchasing products based on DTV receiver performance.

I. The ATSC "A/74 Recommended Practice: Receiver Performance Guidelines" Best Characterizes DTV Receiver Performance.

A. The A/74 Receiver Performance Guidelines Provide an Appropriate Set of DTV Receiver Performance Benchmarks.

The *NOI* seeks comment on the appropriate parameters for testing the performance of DTV receivers and the interference rejection capability of these receivers.[4] ATI recommends that the Commission in this proceeding adopt the "A/74 Recommended Practice: Receiver Performance Guidelines" as published by the Advanced Television Systems Committee, Inc. ("ATSC").[5] In 2003, the Commission requested ATSC's assistance in developing standards for DTV receiver performance.[6] The Commission specifically suggested an approach whereby "industry parties representing broadcasters, consumer electronics manufacturers, consumers, and others as appropriate, would identify the relevant DTV receiver performance parameters,

---

4 *NOI* at ¶ 17.

5 As the Commission is aware, ATSC is a cross-industry association comprised of approximately 140 member companies and organizations that participate in developing Standards and Recommended Practices for the DTV industry.

6 *Notice of Inquiry* in ET Docket No. 03-65; MM Docket No. 00-39, *Interference Immunity Performance Specifications for Radio Receivers; Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television*, March 2003.

develop appropriate minimum performance specifications for those parameters, and publish them."[7]

In response, ATSC formed the Specialist Group on Receivers, commonly known as T3/S10, comprised of representatives from across the range of industries and parties interested in DTV receiver performance. ATSC established this group specifically to develop performance guidelines and recommendations suited to represent accurately the demands of all interested parties. Working together, this cross-industry effort reached consensus on DTV receiver performance guidelines and created the "A/74 Recommended Practice." ATI recommends that the Commission adopt the "A/74 Recommend Practice" because it reflects this cross-industry agreement and provides the most appropriate and accepted parameters for evaluating receiver performance.

B. A/74 Field Ensemble Testing is the Best Available Indicator of Actual Receiver Performance.

The A/74 Recommended Practice identifies two groups of performance vectors known as Laboratory Ensembles[8] and Field Ensembles.[9] ATI has found that testing to the A/74's Laboratory Ensembles assists in demodulator characterization. Nevertheless, Laboratory Ensembles do not provide an adequate prediction of how well a receiver will perform in the field. In ATI's experience, demodulators optimized for performance on these Laboratory Ensembles often suffer from degraded performance.

---

7 *Id*. at ¶ ¶ 34-36.

8 A/74 Recommended Practice, Section 4.5.3.

9 A/74 Recommended Practice, Section 4.5.2. Sections 4.1 through 4.4 of the A/74 Recommended Practice also include RF measurement and pass/fail thresholds for receiver RF parameters. ATI also has found that receivers that do not reach these thresholds are unlikely to deliver a satisfactory end-user experience.

On the other hand, in ATI's extensive experience, the fifty performance vectors known as Field Ensembles provide a comparatively better indicator of actual receiver performance than do Laboratory Ensembles. As described below, the A/74 Field Ensembles in fact provide the best available indicator of actual receiver performance. As such, A/74 Field Ensembles best satisfy the Commission's need for guidelines to evaluate DTV receiver performance accurately.

While the A/74 Field Ensembles identify the parameters for evaluating DTV receiver performance, they do not specify a detailed test procedure or grading system with which to evaluate a receiver's performance quantitatively. ATI, in cooperation with its customers in all affected industries, developed a robust test procedure and grading system based on the A/74 Field Ensembles. Attachment B details this procedure. Applying this procedure in conjunction with the A/74 Field Ensembles, ATI conducted performance tests on VSB demodulator chips used in two high performing and two lower performing HDTV sets and STBs available at retail today. The VSB chips included in these DTV receivers incorporated "state of the art" technology as of 2003 and 2004. Figure 1 below indicates the results of ATI's Field Ensemble tests on these four receivers.

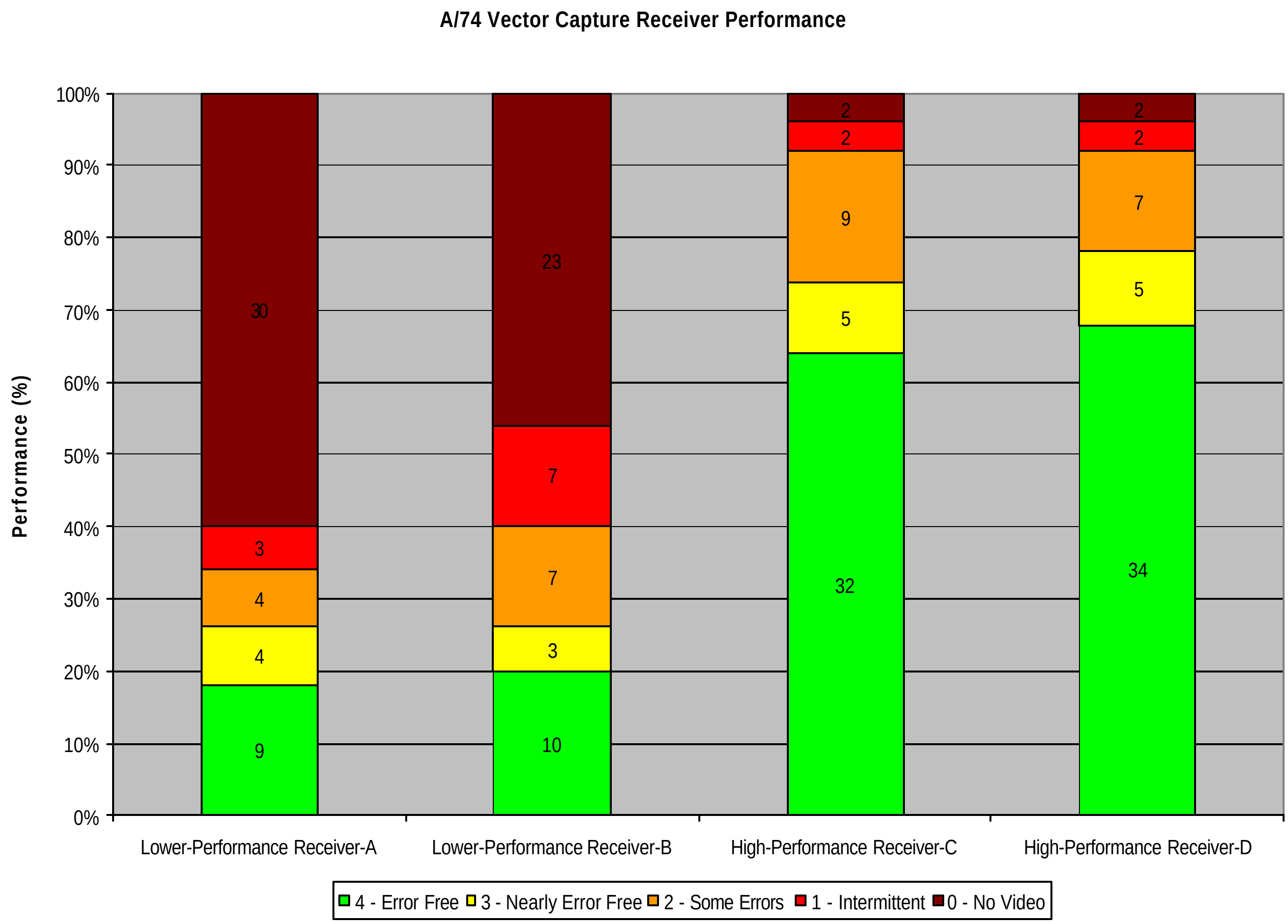


Figure 1

As shown in Figure 1, Receivers C and D clearly demonstrate superior performance on the A/74 Field Ensemble testing. All comprehensive independent field testing known to ATI also confirms that A/74 Field Ensemble is the best available indicator of actual DTV receiver performance. Likewise, ATI's own independent field testing and analysis verifies that receivers such as Receivers C and D that show superior performance on the A/74 Field Ensembles tend to perform better in the field. In addition, ATI's customers also report that Receiver D (the highest-performance receiver based on A/74 Field Ensemble tests) outperforms all other DTV receivers available today in their own (proprietary) independent field tests. Indeed, VSB demodulators of the type included in Receiver D are the best-selling demodulators on the market.[10] Consequently, ATI's own field tests, independent field tests conducted by DTV manufacturers, and the marketplace itself therefore confirm A/74 Field Ensemble-based testing and grading procedures as the best currently available indicator of DTV receiver performance. Because A/74 Field Ensemble testing provides the best available information regarding the relative performance of DTV receivers and demodulators, the Commission should endorse Field Ensemble testing as developed by ATSC in the cross-industry A/74 Recommended Practice.

II. Equipment Available in All Price Ranges Provides Exceptional DTV Receiver Performance, and Differences In Receiver Performance Do Not Appreciably Affect the Price of Equipment to the End-User.

The *NOI* also requested comment on whether a wide variation in the performance of reasonably priced DTV receivers exists, whether increases in the price of DTV sets correlate with improvements in receiver performance, and whether consumers are aware of the performance differences between DTV receivers such that they can take these differences into account when purchasing DTV equipment.[11] Based on ATI's expertise and extensive experience in the DTV industry, ATI concludes that (1) exceptional DTV receiver performance is available in all price ranges; (2) the use of the highest quality receiver chipsets does not appreciably affect the cost to the end-user of such equipment; and (3) consumers lack sufficient information for purchasing products based on receiver performance.

---

[10] DTV manufacturers may require up to twelve months or more to develop a new product and deliver that product to market. Thus, even though the vast majority of ATI's customers adopted the more advanced technology found in Receiver D in the second half of 2004, consumer products containing this improved technology are only now beginning to be shipped to market. ATI's research also indicates that some manufacturers are still introducing new DTV receivers incorporating lower performing VSB technology. These receivers continue to perform at a level roughly equivalent to that of Receivers A and B in Figure 1.

The VSB technology used in a DTV receiver substantially impacts the performance of that receiver. As VSB technology continues to advance, the price of high-performing VSB demodulators decreases, and consequently, the end-user pays the same or less for relatively higher performing DTV equipment than previously available. As Chart A demonstrates, the price differences to equipment manufacturers between higher performing and lower performing VSB demodulator technology continually diminishes and may well disappear in the near term.

VSB RF to Bits Price to CE Manufacturers (Million Units)

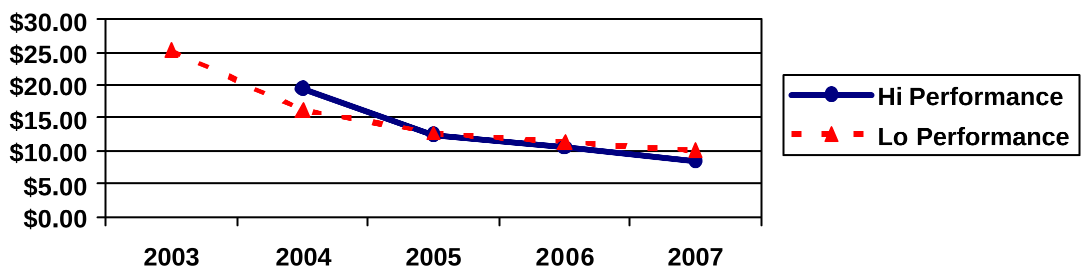


Chart A[12]

In 2004, the price difference between a higher performing and lower performing VSB demodulator was approximately $3.30. Currently, the prices are nearly identical. Based on historical price reductions and anticipated manufacturing volumes, ATI projects that high performance VSB demodulators will be available in 2006 for less than the price today for lower performance VSB demodulators.

---

11 See *NOI* at ¶ 17.

12 Chart A includes the price of the Tuner/IF and demodulator functions in high volumes (>250K). It excludes the cost of license fees paid by receiver manufacturers.

Current DTV receivers demonstrate this increased performance across a wide range of reception conditions, including less than ideal conditions, as a result of advances in the embedded VSB demodulator chips. Interference rejection capabilities have shown great increases, and prices for units with these capabilities have fallen.

In short, the performance of reasonably priced DTV receivers has drastically improved in recent years as manufacturers have transitioned to the newest VSB demodulator technology. ATI anticipates that this trend will continue, as improved performance becomes increasingly affordable. Even low priced DTV sets and receivers today often have excellent reception capabilities, and, soon, all DTV sets and receivers should perform at least as well as the most advanced equipment available today.

Consumers cannot purchase DTV sets based on receiver performance because consumers do not have ready access to information specifying the quality of the chips inside the DTV sets. Even ATI is unable to predict receiver performance of end-user products because ATI cannot determine which chips are embedded in which units based on the material available at retail outlets. After ATI sells demodulator and/or processor chips to its customers, those customers manufacture DTV sets with these chips and re-sell the finished products to wholesalers, retailers, or end-user customers without reporting back to ATI or disclosing to end-users which products include which chips. Brand names do not convey to consumers the quality of embedded chips, as the same manufacturer may use VSB demodulator chips from different suppliers in units offered under the same brand name. Indeed, field tests have shown that even some lower priced DTV receivers outperform higher priced DTV receivers produced by the same manufacturer due to the use of different VSB demodulator chips in the tested equipment that are not readily apparent to end-users.

Because neither price nor brand name is predictive of performance, consumers consequently lack sufficient information for purchasing products based on the likely performance level of DTV receivers.

CONCLUSION

ATI recommends that the Commission utilize the ATSC's A/74 Field Ensembles as appropriate parameters for testing the performance of DTV receivers. ATI's own analysis and independent field tests demonstrate that the A/74 Field Ensembles are the best available indicator of actual receiver performance.

As a market leader in the design and production of DTV receiver chips, ATI also submits that superior DTV receiver performance is available to consumers in equipment in all price ranges. As equipment manufacturers have transitioned to the newest generations of receiver chip technology, DTV sets with greatly improved performance are increasingly available at lower prices. The trends of increases in performance and affordability with simultaneous decreases in its costs will continue, leading to more widespread availability of affordable DTV equipment capable of excellent reception in even adverse conditions.

Respectfully submitted,
ATI TECHNOLOGIES, INC.

By: /S/ David Kleiman
David Kleiman

ATI TECHNOLOGIES, INC.
1 Commerce Valley Drive East
Markham, Ontario
Canada L3T 7X6
(905) 882-2600

By: /S/ James M. Burger
James M. Burger
Kevin P. Latek

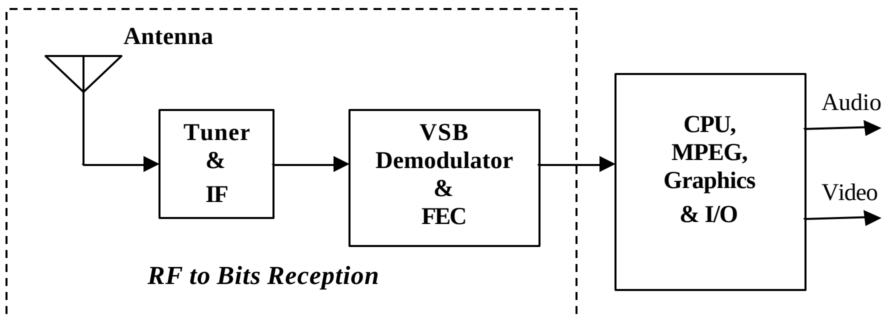
DOW, LOHNES & ALBERTSON, PLLC
1200 New Hampshire Avenue, N.W.
Washington, D.C. 20036
(202) 776-2000

Its Attorneys

Dated: June 17, 2005

ATTACHMENT A

A typical DTV receiver is comprised of four primary elements: the antenna, the Tuner/IF, the Demodulation/FEC (referred to commonly as the demodulator), and the CPU/MPEG Processor. ATI sells the demodulator under the NXT and THEATER brand names and the CPU/MPEG/Graphics/I/O Processor under the XILLEON brand. Some of ATI's XILLEON devices include THEATER technology. Tuners and antennas are available from various vendors.



ATTACHMENT B

ATI Research Inc.
White Paper

Recommended Testing Procedure for the Evaluation of ATSC A/74 Vector Capture VSB Receiver Performance

June 2005

Introduction. **ATSC A/74, 18 June 2004, Recommended Practice: Receiver Performance Guidelines [1],** recommends 50 RF vector captures or field ensembles which can be used in the evaluation of DTV receiver performance. In order to properly characterize receiver performance against these 50 vector captures, a method was developed that standardizes the testing procedure. The evaluation of the receiver performance with any vector capture is subjective. The goal of this white paper is to document a standard testing procedure that creates consistent receiver performance results. This procedure can be used in the receiver evaluation of any RF vector capture data set and not specifically ATSC A/74 vector captures.

Vector Captures. The best metric of receiver performance is real-world field testing. Although laboratory testing with multi-path scenarios has some merit, on-site field testing is the absolute final measure of receiver performance. Subjecting multiple receivers to different locations around the country and varied changing environments can reliably determine ranking of receiver performance and coverage. Unfortunately, this can be an expensive time consuming process with the exact signal conditions varying over time. If a snap-shot of the RF signal could be taken, then these unique signal conditions could be repeated in a lab environment any time on any receiver. This is the exact purpose of RF vector capture testing.

A/74 Vector Captures. 50 RF vector captures cited in A/74 Annex A are indoor and outdoor field ensembles from the New York City and Washington, D.C. area. The A/74 Annex A, vector captures are approximately 24.4 seconds in length. The capture details and format are described in reference [1]. Overall the quality of these RF vector captures is good, but 9 of the 50 vectors have dropped samples and 3 of the 50 vectors have gray-screen video. Extreme care is needed in the evaluation of these particular vector captures.

RF Playback Equipment. A Sencore RFP910 or compatible RF playback device is required for real-time playback and receiver evaluation of the vector captures. In addition to a 44 MHz output, the RFP910 can provide an RF output on terrestrial channels 2 through 69. The RFP910 has the capability of continually looping the vector captures which allows multiple evaluations of the same vector capture to measure subtle performance differences When using the RFP910, it is recommended to allow several loopings (i.e. at least 3 loopings) of the vector capture before any performance measurements are recorded to ensure stability of the playback device.

Vector Capture Performance Criteria. Each vector capture is looped on the Sencore RFP910 and a 5-grade performance metric is assessed for each receiver. The vector capture is looped at least 3 times before any reception grade is assessed. Each receiver is then evaluated over a number of vector capture loops. Very often a vector capture exhibits slightly different performance grades. In this case, the higher grade score is assessed. If dramatically different grades are observed on each loop, then the lower grade is recorded. To help evaluate closely performing receivers, notes can be added to help assess some of the lower grades.

A pictorial representation of the receiver video performance criteria is shown in Figure 1.

Figure 1. Receiver Video Performance Criteria

The following five performance grades are applied to a receiver per vector capture:

4 – Error Free. The receiver does not exhibit any visible reception problems. Note that errors may occur in the video but some of these errors can be virtually unseen by the observer due to MPEG decoder error concealment. Careful observation is required to identify these visual errors. Audio content can be used to identify reception issues. The home viewer would not notice reception issues.

3 – Mostly Error Free. The receiver is near perfect except for up to two visible video defects or events over the 24 second loop period. Note that depending on the quality of the MPEG decoder, error concealment versus receiver performance should be differentiated. With this grade, the home viewer would most likely continue watching the program but with noticeable occasional reception issues.

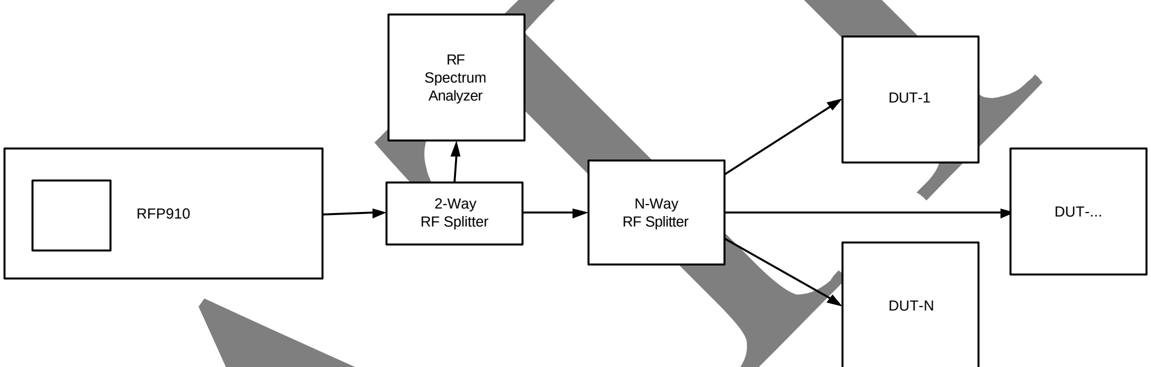
2 – Some Errors. The receiver exhibits some errors, but more than ½ of the video is error free. The receiver has marginal reception for this vector capture. With this grade, although very annoying, the home viewer may watch a high demand content such as a World Cup soccer match.

1 – Many Errors. The receiver exhibit many errors, with less than ½ of the video as error free. The receiver has marginal reception on the vector capture. With this grade, the content is marginally watch-able to totally un-watch-able by a viewer.

0 – Little or No Video. The receiver exhibits constant errors, with 0% clear error-free video or no video. The receiver essentially has no reception. With this grade, the content is unwatchable by a home viewer.

Test Procedure. The following is a step-by-step procedure for testing the vector captures. A block diagram of the test setup is shown in Figure 2.

Figure 2. Vector Capture Test Set-up



1) Load a clean reference vector capture on a RFP910 such as Hawaii_ReferenceA provided with the RFP910.

2) Set the RFP910 to Channel 26 (545 MHz).

3) Set the RFP910 is setup to playback at 21.52 MS/s

4) Set the RFP910 to max power output.

5) Using an RF-splitter, equally split the RF signal from the RFP910 to the multiple devices under test (DUTs). It is recommended that an RF spectrum analyzer be connected to one of the split outputs to monitor the signal during playback.

6) Tune the DUTs and ensure reception of the clean test signal. All the DUTs should score a "4 – Error Free" on this reference vector capture.

7) Load and play any of the A/74 vector captures on RFP910.

8) Ensure the DUTs are properly tuned to Physical Channel 26. Some receivers may have problems with the switch of content from one vector to another. In this case, a channel re-scan or re-tune may be required. Careful effort is required to ensure that "no-video" on a DUT is due to a reception issue and not a program identification issue.

9) Allow at least 3 loops of the vector capture on the RFP910.

10) Evaluate all the DUTs over multiple loops of the RFP910 until a consistent and repeatable score can be determined. This may take a couple of loops for obvious grade scores to many loops and careful evaluation for non-obvious grade scores. If multiple DUTs have identical scores for the same vector capture, but there is a clear difference in performance, then this should be noted in the comments for the test.

11) The vector capture should be scored per DUT according to the guidelines discussed above.

12) Steps 7 through 11 should be repeated for all vector captures of interest.

A/74 Vector Capture Limitations. 9 of the 50 A/74 field ensembles or vector captures have physical defects in the original data collections. This is a known issue and great care is needed to separate "real" receiver reception problems versus "non-real" problems caused from the physical defects of the vector captures. Additionally, the vector capture looping on the RFP910 causes a non-real event on the transition from the end of the video file to the start of the video file. This is a limitation of this type of evaluation method. These non-real events are ignored for this evaluation process.

The following A/74 vectors have 48 dropped samples:
Vector Capture 32 of 50, WAS-038/34/01 Indoor @ 14.9905 sec
Vector Capture 33 of 50, WAS-038/34/01 Outdoor @ 15.07375 sec
Vector Capture 34 of 50, WAS-038/36/01 Indoor @ 22.2029 sec
Vector Capture 35 of 50, WAS-047/48/01 Indoor @ 13.773 sec
Vector Capture 36 of 50, WAS-049/34/01 Indoor possible dropped symbol not specified
Vector Capture 37 of 50, WAS-049/39/01 Indoor @ 24.855 sec
Vector Capture 46 of 50, WAS-082/35/01 Indoor @17.1644 sec
Vector Capture 47 of 50, WAS-083/36/01 Indoor @ 14.8805 sec
Vector Capture 48 of 50, WAS-083/39/01 Indoor @ 12.1696 sec

3 of the 50 vectors have a gray, white or blank video content. Determining receiver performance on these vectors can be difficult if internal receiver metrics can not be accessed. If internal metrics indicate no reception issues for these blank-content vector captures, then these vector captures are not included in the performance estimation.

The following A/74 vectors have no content video (gray, white or black screen):
Vector Capture 22 of 50, WAS-003/35/01 Outdoor
Vector Capture 24 of 50, WAS-311/35/01 Outdoor

Vector Capture 44 of 50, WAS-080/35/01 Indoor

Conclusion. The A/74 vector captures are an excellent tool for determination of receiver reception performance in the field. Careful evaluation and testing procedure of the vector captures is required to ensure consistent receiver performance results.

References. **[1] ATSC Recommended Practice: Receiver Performance Guidelines**, Doc. A/74, 18 June 2004, (www.atsc.org/standards/a_74.pdf).

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of Technical Standards for Determining Eligibility For Satellite-Delivered Network Signals Pursuant To the Satellite Home Viewer Extension and Reauthorization Act	)))))	ET Docket No. 05-182

To: The Commission

COMMENTS OF THE
CONSUMER ELECTRONICS ASSOCIATION

The Consumer Electronics Association ("CEA"), respectfully files these Comments in response to the Commission's Notice of Inquiry ("NOI") in the above-captioned proceeding.[1] CEA does not at this time wish to recommend specific rules changes related to determining whether a household is unserved by a DTV signal. However, CEA appreciates the FCC's consideration of this important subject and makes the following general comments.

It is beneficial to consumers, broadcasters, and direct broadcast satellite (DBS) service providers to make the determination of whether a household is unserved by an adequate digital TV signal as simple and consistent as possible. The goal of this proceeding should be to find an agreeable method of making this determination that relies first on prediction or modeling and does not require in-situ field testing. To that end, CEA is supportive of the FCC's current reliance on the modified Longley-Rice model for evaluating the field strength of a particular DTV station at a specific location.

Whatever the result of this inquiry, it is imperative that the FCC have a single, consistent definition of the service area for each analog and digital TV station. Those definitions today are

[1] *In the Matter of Technical Standards for Determining Eligibility For Satellite-Delivered Network Signals Pursuant To the Satellite Home Viewer Extension and Reauthorization Act*, Notice of Inquiry, ET Docket No. 05-182, FCC 05-94 (rel. May 3, 2005) ("NOI").

the Grade B contour and the DTV noise-limited service contour, respectively. In its Notice of Proposed Rulemaking on Unlicensed Operation in the Broadcast TV Bands[2], the FCC chose to use the Grade B contour as a precise demarcation of which channels should be considered unoccupied for the purpose of allowing unlicensed devices to operate in TV bands. Broadcast television viewers have a right to a consistent definition of whether their household is considered serve by a television station. That definition should not differ based on whether the reason for the question is determining if an unlicensed device can occupy that channel or if a DBS provider can deliver that channel as part of its service. In fact, it is entirely logical that if a station is weak enough to be considered an unoccupied channel, one should expect to receive that station by DBS service. The FCC must be careful not to end up with two regimes such that a household might be told that they can receive a weak local station (based on field measurement) and, therefore, are not eligible to receive that station by satellite and yet that same broadcast channel could be occupied by a nearby unlicensed transmitter (based on Grade B contour) and, therefore, rendered unusable.

Both receivers and the DTV receiving environment are extremely complex. It seems impractical and counterproductive to even attempt to factor in all the options that are available to consumers for determining whether an adequate DTV signal exists. Even if all receivers were found to perform very nearly the same, each installation is entirely different, both in the ambient RF environment and the antenna used to extract energy from that environment. The questions raised by this inquiry, although directed by Congress, can distract from the basic goal. The issue of DTV reception is tremendously complicated in an engineering sense, but the Government's involvement should be limited and specific so as to let the marketplace deliver the best solutions. The FCC should be wary of starting down a path of determining how much effort a consumer should put into broadcast DTV reception.

---

[2] *In the Matter of Unlicensed Operation in the Broadcast TV Bands*, Notice of Proposed Rulemaking, ET Docket No. 04-186, FCC 04-113 (rel. May 25, 2004) ("NPRM").

Comments on Specific Factors Raised by this Inquiry

The Notice provides six factors that are specified by the Satellite Home Viewer Extension and Reauthorization Act of 2004 (SHVERA)[3] to be considered by the FCC in this inquiry regarding whether rules should be revised for determining if a household is unserved by a DTV station. These factors are repeated here with brief comments as to their relevance for any rule changes.

- whether to account for the fact that an antenna can be mounted on a roof or placed in a home and can be fixed or capable of rotating;

Although antenna type and placement is indeed a critical factor in DTV reception, it is not appropriate for the FCC to consider these details for the rules in question. It is necessary and sufficient for the FCC to state that a given field strength, predicted or measured, at a known height above the location determines whether the household is served.

- whether Section 73.686(d) of title 47, Code of Federal Regulations, should be amended to create different procedures for determining if the requisite digital signal strength is present than for determining if the requisite analog signal strength is present;

The FCC rightfully points out the fundamental differences between analog and digital TV signals and the need for adapting measurement details to the particulars of DTV signals. CEA has not taken a position on the correct intermediate frequency (i.f.) bandwidth or tuning location to use for DTV signal strength measurement.

- whether a standard should be used other than the presence of a signal of a certain strength to ensure that a household can receive a high-quality picture using antennas of reasonable cost and ease of installation;

[3] *The Satellite Home Viewer Extension and Reauthorization Act of 2004*, Pub. L. No. 108-447, § 207, 118 Stat 2809, 3393 (2004) (to be codified at 47 U.S.C. § 325), § 204(b).

Again, CEA believes that determining the presence of a signal of a certain strength is the right level of involvement for the FCC. Going beyond that invites the quagmire of assessing reasonableness, cost effectiveness, and ease of installation.

- whether to develop a predictive methodology for determining whether a household is unserved by an adequate digital signal under section 119(d)(10) of title 17, United States Code;

CEA is supportive of using a predictive methodology for the benefit of all parties involved and to reduce the burden of determining whether a household is unserved. Our own efforts to help consumers select the best antenna for DTV reception[4] indicate that predictive modeling of reception at a given location is a tall challenge. However, the Longley-Rice model is a very good tool with years of engineering development. CEA is not aware of any industry discussion regarding a better model that might be used for the same purpose.

- whether there is a wide variation in the ability of reasonably priced consumer digital television sets to receive over-the-air signals, such that at a given signal strength some may be able to display high-quality pictures while others cannot, whether such variation is related to the price of the television set, and whether such variation should be factored into setting a standard for determining whether a household is unserved by an adequate digital signal;

Within the ATSC's work on A/74, *ATSC Recommended Practice: Receiver Performance Guidelines*, the tradeoffs involved in receiver design have been discussed in some detail among broadcasters and TV manufacturers. In a market guided by competition and not Government intervention, it should be expected to have products that optimize for different parameters. These variations are relatively small, as every

[4] See www.antennaweb.org.

manufacturer is motivated by competition to build good receivers, but these variations still serve the market. A DTV that has relatively poor weak signal reception as compared to every other receiver in the market, might have excellent selectivity and prove to be the ideal receiver for a particular location with closely packed channels. Conversely, suppose the FCC determines that there is very little variation in the ability of existing DTVs to receive over-the-air signals. Those same DTVs when connected to the many available antennas and placed in the infinitely complex RF environment will certainly demonstrate a wide variation in reception capability.

- whether to account for factors such as building loss, external interference sources, or undesired signals from both digital television and analog television stations using either the same or adjacent channels in nearby markets, foliage, and man-made clutter.

Again, CEA asserts that there is only so much that the FCC can factor into its determination of served households. Broadcasters, manufacturers, and retailers are all highly motivated to make broadcast television consumers successful in their quest to receive pristine HDTV signals. And yet, in the fringe areas that are the subject of this inquiry, there is no perfect predictor or guarantee of reception. The FCC should not attempt to account for the listed environmental factors beyond the degree to which they are accounted for today.

Conclusion

For the reasons expressed herein, CEA recommends that the FCC focus its attention on a consistent definition of served households based on field strength at the location, improvement of the Longley-Rice model if needed, and refinement of measurement procedures to accommodate the specific nature of DTV signals. The FCC should not attempt to account for the myriad other factors that make up the DTV receiving system unique to every installation.

Respectfully submitted,

Michael D. Petricone, Esq.
Vice President, Technology Policy
Brian E. Markwalter
Vice President, Technology
CONSUMER ELECTRONICS ASSOCIATION
2500 Wilson Boulevard
Arlington, VA 22201
Tel: (703) 907-7644

June 17, 2005

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of: Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act	ET Docket No. 05-182

COMMENTS OF DIRECTV, INC.

Viewers want their local broadcast signals. DIRECTV, Inc. ("DIRECTV") has found that viewers prefer – by substantial margins – their local broadcast signals to similar out-of-town signals.[1] This is why DIRECTV has made delivery of local signals such a high priority. DIRECTV now retransmits local analog signals in over 130 markets, representing 93 percent of U.S. television households. And it recently announced plans to offer as many as 1500 local digital signals by 2007. From DIRECTV's perspective, the future is local.

The point of this proceeding is to begin developing a methodology for determining when viewers are eligible for distant digital signals.[2] By the time any such methodology is finalized, however, it will be irrelevant to many DIRECTV subscribers

---

1 Indeed, as DIRECTV has launched local markets, it has seen a marked *decrease* in distant signal subscribership. In each of 2003 and 2004, DIRECTV experienced a net loss of around 170,000 distant network subscribers. Put another way, in early 2002, approximately 16 percent of DIRECTV customers subscribed to at least one distant network signal feed – now the number is under 9 percent.

2 *Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act*, Notice of Inquiry, 20 FCC Rcd. 9349 (2005) ("*Notice*").

because subscribers to whom DIRECTV provides local digital signals cannot sign up for distant digital signals.[3] The methodology developed in this proceeding will thus be used less frequently than the existing methodology.[4] But to viewers who rely on it, the methodology developed for digital signals will be no less important.

For this reason, DIRECTV urges Congress and the Commission to heed perhaps the most important lesson from the last decade of distant network signal qualification – ***predictive modeling is better than on-site testing.*** On-site tests frustrate and inconvenience subscribers, cost far more money than they are worth, and should be used – if at all – only as a last resort. The primary goal of this proceeding should be to create an accurate, reliable model to predict over-the-air digital reception.

DISCUSSION

On-site testing is far from the norm today. In the last five years or so, only about 3,200 DIRECTV customers – or only 0.3 percent of those requesting distant network signals – asked for an on-site test. Only about 1,400 of these actually received an on-site test. At Congress's direction,[5] however, the Commission has requested comments about predictive modeling as only one among many topics – most of which concern on-site

3 *See* 47 U.S.C. § 339(a)(2)(D)(iv) (providing that, "[a]fter the date on which a satellite carrier makes available the digital signal of a local network station, the carrier may not offer the distant digital signal of a network station affiliated with the same television network to any new subscriber to such distant digital signal after such date, except that such distant digital signal may be provided to a new subscriber who cannot be reached by the satellite transmission of the local digital signal").

4 *See Satellite Delivery of Network Signals to Unserved Households for Purposes of the Satellite Home Viewer Act*, Report and Order, 14 FCC Rcd. 2654, 2689, 2890 (1999) ("*SHVA Report and Order*") (endorsing method for predicting signal strength at individual locations); 47 C.F.R. § 73.686(d) (setting forth testing procedures).

5 47 U.S.C. § 338(a)(4); Satellite Home Viewer Extension and Reauthorization Act of 2004 ("SHVERA"), Pub. L. No. 108-447 § 204, 118 Stat. 2809, 3428-29 (2004).

testing.[6] The implication, perhaps, is that on-site testing should be the norm for digital signals. But testing is frustrating to subscribers and costly to satellite operators and consumers (and, presumably, local broadcast stations, who must pay for testing when customers qualify for distant network signals).[7] It thus deserves an even smaller role in the digital world than it has today, not a bigger one.

To begin with, on-site testing is extraordinarily time consuming for subscribers. In order to seek on-site testing, subscribers must wait at least thirty days after they have received the results of the predictive model for broadcasters to decide whether to grant waiver(s).[8] Then, they must wait until an independent,[9] qualified tester can be identified in their area. Once DIRECTV places an order for the test, the customer must wait for the tester (not DIRECTV) to arrange the appointment. While DIRECTV often tries to expedite this process, tests must often be delayed because of scheduling issues or bad weather (particularly in the winter months).[10] Moreover, in many areas there are very few independent entities available to conduct such tests – extending the wait time even longer through no fault of DIRECTV. Thus, even if every subscriber to get an on-site test ultimately were to receive all channels requested, many would still be unhappy as a result of the delay.

Subscribers are also frustrated by the testing process. Viewers unfamiliar with section 76.686(d) of the Commission's rules might reasonably think that an on-site test

---

6 *See Notice*, 20 FCC Rcd. at 9356, 9357.

7 *See* 47 U.S.C. § 339(a)(4)(B) (allocating cost for on-site testing).

8 47 U.S.C. § 339(c)(4)(A) (providing for testing only "[i]f a subscriber's request for a waiver . . . is rejected and the subscriber submits to the subscriber's satellite carrier a request for a test").

9 *See id*. (requiring selection of "a qualified and independent person" to conduct testing).

10 *See* 47 C.F.R. § 76.686(d)(2)(ii) (instructing testers to "not take measurements in inclement weather or when major weather fronts are moving through the measurement area").

involves somebody looking at their television to determine whether or not they receive an adequate signal. Most are not expecting what actually happens:

- Assuming good weather, the tester raises a "test antenna" to twenty feet above ground level for a single story house (or thirty feet for a two story house), and orients the antenna in the direction of maximum signal strength on each channel.
- The tester takes a "cluster measurement" consisting of five readings in four corners of a three-meter square and one reading in the center of the square.
- The tester ranks the cluster measurement results in order to determine the median number.
- The tester adjusts the figures for line loss and antenna factors, and converts them to dBu.
- After the signal test is complete, the tester sends a form back to DIRECTV, which processes the test within several days.

In DIRECTV's experience, those denied their requested distant signals based on such a process end up angry at DIRECTV, at their local broadcast stations, and at the FCC as well.

Even setting aside customer relations, on-site testing is a losing economic proposition. Over the last five years, the average cost of an on-site test has been around $150, although in some areas it can now cost as much as $450. DIRECTV estimates that it would take at least five years to recoup this cost from revenues generated by providing distant signals to those tested eligible for such signals – a time frame unlikely to be realized given churn rates for distant signals.[11] Based on these figures, DIRECTV has a difficult time imagining that on-site testing makes economic sense for broadcasters, either.

[11] *See* footnote 1, above (discussing churn rate for distant signals in areas where local signals are offered).

Analog on-site testing, then, frustrates and inconveniences subscribers and costs money that DIRECTV is unlikely to recoup. Digital on-site testing will be worse on both scores (especially if it becomes the norm) because there are far fewer "independent" entities qualified to conduct on-site tests for digital signals than there are for analog signals and because equipment is in shorter supply. This means that wait times will increase – making viewers even more frustrated than they are now. And it means that costs will increase – making on-site testing an even less attractive economic proposition than it is now.

DIRECTV can think of no reason why federal policy should encourage such a result. It thus urges the Commission and Congress to develop an accurate and reliable predictive model for digital signals rather than relying on on-site testing. If on-site testing is to continue to be part of the methodology for digital signals at all, it must remain strictly at the satellite operator's option, to be used only in close cases.[12]

* * *

12 *See* 47 U.S.C. § 339(c)(4)(E) ("A satellite carrier may refuse to engage in the testing process. If the carrier does so refuse, a subscriber in a local market in which a satellite carrier does not offer the signals of local broadcast stations under section 338 may, at his or her own expense, authorize a signal intensity test to be performed pursuant to the procedures specified by the Commission in section 73.686(d) of title 47, Code of Federal Regulations, by a tester who is approved by the satellite carrier and by each affected network station, or who has been previously approved by the satellite carrier and by each affected network station but not previously disapproved.").

Congress and the Commission should not create a distant digital signal methodology that gives prominence to on-site testing. They should, instead, devote their energies toward developing a digital predictive model that is as accurate as possible. DIRECTV looks forward to assisting Congress and the Commission in this endeavor.

Respectfully Submitted,

/s/______________________________
Susan Eid
Vice President, Government Affairs
Stacy R. Fuller
Vice President, Regulatory Affairs
DIRECTV, INC.
444 North Capitol Street, NW, Suite 728
Washington, DC 20001
(202) 715-2330

William M. Wiltshire
Michael Nilsson
HARRIS, WILTSHIRE & GRANNIS LLP
1200 Eighteenth Street, NW
Washington, DC 20036
(202) 730-1300

Counsel for DIRECTV, Inc.

June 17, 2005

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Technical Standards for Determining	)	
Eligibility For Satellite-Delivered Network	)	ET Docket No. 05-182
Pursuant To the Satellite Home Viewer	)	
Extension and Reauthorization Act	)	
Reauthorization Act of 2004	)	

COMMENTS OF ECHOSTAR SATELLITE L.L.C.

David K. Moskowitz
Executive Vice President and General Counsel
ECHOSTAR SATELLITE L.L.C.
9601 South Meridian Boulevard
Englewood, CO 80112
(303) 723-1000

Karen Watson
Ross Lieberman
ECHOSTAR SATELLITE L.L.C.
1233 20th Street, N.W.
Washington, D.C. 20036-2396

Pantelis Michalopoulos
Chung Hsiang Mah
STEPTOE & JOHNSON LLP
1330 Connecticut Avenue, NW
Washington, D.C. 20036
(202) 429-3000

Counsel for EchoStar Satellite L.L.C.

June 17, 2005

TABLE OF CONTENTS

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Technical Standards for Determining	)	
Eligibility For Satellite-Delivered Network	)	ET Docket No. 05-182
Pursuant To the Satellite Home Viewer	)	
Extension and Reauthorization Act	)	
Reauthorization Act of 2004	)	

COMMENTS OF ECHOSTAR SATELLITE L.L.C.

EchoStar Satellite L.L.C. ("EchoStar") hereby submits its comments on the Notice of Inquiry released by the Commission on May 3, 2005 ("NOI") seeking comment on the adequacy of the digital signal strength standard and testing procedures used to determine whether households are eligible to receive distant digital television ("DTV") network signals from satellite carriers.[1]

Section 204(b) of the Satellite Home Viewer Extension and Reauthorization Act of 2004 ("SHVERA") substituted a new Section 339(c)(1) of the Communications Act, 47 U.S.C. § 339(c)(1), directing the Commission to complete, not later than one year after SHVERA's enactment, "an inquiry regarding whether, for purposes of identifying if a household is unserved by an adequate digital signal under [17 U.S.C. § 119(d)(10)], the digital signal strength standard in [47 C.F.R. § 73.622(e)(1)], or the testing procedures in [47 C.F.R. § 73.686(d)], such statutes or regulations should be revised" to take into account various statutory

[1] *Technical Standards for Determining Eligibility For Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act*, FCC 05-94, Notice of Inquiry, ET Docket No. 05-182 (rel. May 3, 2005), published 70 Fed. Reg. 28503 (2005) ("NOI").

factors affecting signal strength and reception.[2] SHVERA also directed the Commission to consider whether a predictive methodology should be developed for determining whether a household is unserved.[3] The Commission is required to submit a report to the House and Senate Commerce Committees containing the results of its inquiry and recommendations for changes, if any, to the statutes and regulations in question.[4]

The issues raised in the NOI are vital to the DTV transition and to Congress's intent to provide households unserved by an adequate digital signal from their local network station with the option of obtaining a distant digital station affiliated with the same network from their satellite carrier. The issue is more stark for digital than for analog signals. More often than with analog signals, reception problems for DTV are more dramatic, meaning that the picture cannot be received at all. At the same time, the Commission should not ignore lesser problems such as tiling or other digital artifacts – consumers have higher DTV picture quality expectations and should not be expected to tolerate reception of such quality. In addition, reception problems that are not associated with inadequate signal strength (*e.g.*, the multipath phenomenon) still have to be taken into account. In the case of DTV reception, multipath problems do not result in a "ghosted" image as in the case of analog reception. Rather, as the Commission itself has recognized, "[t]hese signals, although they originate from the same transmitting source, are out of phase *and can cause severe interference that can result in the complete loss of the digital service*."[5]

---

[2] *See* 47 U.S.C. §§ 339(c)(1)(A) and (B).

[3] 47 U.S.C. § 339(c)(1)(B)(iv).

[4] 47 U.S.C. § 339(c)(1)(C).

[5] NOI at ¶ 20 (emphasis added).

For these reasons, it is important to ensure that the digital signal strength standard, the testing procedures, and any predictive model used to determine whether a household is unserved, take into account all factors that affect whether an artifact-free DTV *picture* can actually be received, and not merely whether the DTV signal is strong enough at the location in question. To this end, EchoStar commissioned an engineering study by Hammett & Edison, Inc. ("H&E") (see Attachment A). The results of that study suggest a number of changes to the Commission's rules are necessary to make the digital signal standard and testing procedures more accurate. In short:

- The Commission should revise upwards its DTV signal strength standard.
- The Commission should revise its testing rules to take account of multipath interference. Static multipath corresponds to a measurable signal strength penalty. The Commission should make allowance for this penalty.
- The Commission should also revise its testing to reflect the fact that the vast majority of DTV households have either indoor antennas or imperfectly pointed outdoor antennas. The Commission should prescribe indoor testing, preferably by use of typical indoor antennas, and allow for an appropriate adjustment if perfectly pointed professional equipment is used.
- The Commission should revise the measurement rules to take account of the significant time variability of DTV signals.
- The Commission should recommend to Congress the adoption of a predictive model with an improved time variability factor and improvements to account for DTV signal loss due to building penetration, land use and land cover variations, as well as certain other adjustments.

EchoStar also notes that with the exception of the DTV predictive model, the Commission today has the authority to promulgate rules that implement these recommendations and should commence a rulemaking proceeding to that end.

I. THE DIGITAL STRENGTH STANDARD SHOULD BE REVISED TO ACCOUNT FOR DTV RECEIVER PERFORMANCE AND MAN-MADE NOISE

H&E points to two reasons why the digital strength standard may be inadequate. First, H&E tested five commercially available DTV receivers – four consumer receivers and one professional receiver – and found that the signal sensitivities of the current generation consumer DTV receivers can be significantly worse than the signal sensitivities assumed in the Commission's DTV planning factors for the digital signal strength for VHF and UHF DTV channels.[6] As a result, many consumer DTV sets may not be able to display a DTV picture even when the strength of the digital signal meets the Commission's standards. Accordingly, the digital strength standard should be revised upwards to take into account these marketplace realities.

Another reason is man-made noise, which particularly affects signal levels at low-band VHF channels (2-6).[7] As more fully explained in the H&E study, man-made (or impulse) noise was not adequately taken into account in the Commission's DTV planning factors, particularly at low-band VHF frequencies (TV Channels 2-6). As a result, the Commission did not build in a sufficient margin for noise when it set the signal strength standard for those channels. H&E cites studies that found that median noise levels in Boulder, Colorado approached 20 dB at 137 MHz, which implies a median value approaching 30 dB at 54 MHz. As H&E concludes, "[i]f 20 or 30 dB of man-made noise is added to the thermal noise floor, certainly, some viewers in urban areas will be unable to receive low-band DTV signals due to

---

[6] H&E at 12-13.

[7] H&E at 9-11.

excessive man-made noise."[8] H&E concludes that the signal strength standard for the low-band VHF signals should be increased by 12-30 dB to account for such noise.

II. DIGITAL SIGNAL TESTING SHOULD INCLUDE TESTING FOR MULTIPATH INTERFERENCE PROBLEMS

Multipath interference in the analog context results in "ghosted" images that are of poor quality, but that are typically still viewable unless the problem is severe. In contrast, as the Commission has recognized, multipath interference is an even more acute problem for DTV reception: "[t]hese signals, although they originate from the same transmitting source, are out of phase *and can cause severe interference that can result in the complete loss of the digital service*."[9] Moreover, multipath interference can be static (caused by signal reflections off fixed structures) or dynamic (caused by signal reflections off moving objects, e.g. airplanes or cars).

While dynamic multipath interference is difficult to account for, the H&E study shows that static multipath interference can be measured and its severity can be expressed as a signal strength penalty caused by the equalizer on the DTV receiver attempting to compensate for the multipath "echoes."[10] This penalty should be subtracted from the measured digital signal strength before it is compared against the Commission's digital strength standard. Given the acuteness of multipath interference for DTV reception, the Commission should change its testing rules accordingly to incorporate the methodology described in the H&E study for taking such problems into account.

---

[8] *Id*. at 10.

[9] NOI at ¶ 20 (emphasis added).

[10] H&E at 8-9.

III. THE SIGNAL STRENGTH AND TESTING PROCEDURES SHOULD TAKE INTO ACCOUNT INDOOR ANTENNA USE AND THE LACK OF ROTATION IN OUTDOOR ANTENNAS

As the H&E study points out, the testing procedures assume an outdoor antenna that can be accurately pointed so as to receive the strongest possible signal.[11] However, an outdoor antenna is not practicable for many households, particularly people who live in apartment buildings. Moreover, even households that have outdoor antennas often do not have rotating antennas or have a practicable means of re-pointing their antennas "on the fly" to achieve optimum reception for every broadcast station in the market. These realities need to be taken into account.

A. Indoor Antennas

With respect to indoor vs. outdoor antennas, the Commission has recognized that "because structures located within the line of sight between the transmitter and the receiving antenna can block or weaken the strength of received signals, an outdoor antenna installation . . . will generally allow a stronger signal to be received by the antenna than will an indoor antenna installation. Thus, households in which the antenna is placed indoors *will generally need an antenna with greater gain* than will a household in which the antenna is placed outdoors."[12]

However, as the H&E study shows, "[b]ecause of limitations on the physical dimensions of indoor antennas, they have always had *less* gain than typical outdoor antennas."[13] Indeed, H&E's review of the existing literature published as recently as 2005 and as far back as 1959 show that indoor antennas consistently have gains of about 9 dB below those for outdoor

---

[11] H&E at 2. *See also* 47 C.F.R. § 73.686(d)(2)(iv) (requiring the testing antenna to be oriented in the direction which maximizes the value of field strength).

[12] NOI at ¶ 9 (emphasis added).

[13] H&E at 4.

antennas. Moreover, the problem of the reduced gain of indoor antennas is exacerbated by building penetration losses. As the H&E study shows, because the signal has to penetrate the roof and walls of the building before it can be received by the low-gain indoor antenna, the signal strength loss can be as great as 30 dB for VHF in a high clutter area like New York City, but can vary depending on which floor of a building the indoor antenna is placed.

Because the signal testing procedures require an outdoor test with professional equipment, those procedures penalize the many apartment dwellers and others that cannot practically install and make use of an outdoor antenna. Perhaps in recognition of this, the Commission sought comment on whether and when indoor testing should be performed.[14] Indoor testing should be required. Moreover, the test should ideally be conducted using a typical indoor antenna. However, if a professional antenna were to be used instead then the signal test result should be reduced by 9 dB (at the very least) to account for the lower gain of indoor antennas.

B. Lack of Rotation and Antenna Pointing Error

Because the signal strength testing procedure requires the testing antenna to be oriented so as to maximize signal strength, it implicitly assumes that every household has a rotating antenna that can be re-pointed to optimize reception for each local station. This is an unrealistic assumption. Indeed, in some markets, not all of the network stations may be transmitting from the same site, so there may be no single "optimal" orientation. Even households with antennas capable of rotating generally do not have the ability to adjust the orientation of the antenna "on the fly" so that, for most intents and purposes, the antenna is a non-rotating antenna.

---

[14] NOI at ¶ 13.

While the H&E study does not provide an average signal loss from mispointing, it does note a worse case loss scenario of 14 dB for a high performance antenna at UHF.[15] This suggests that the signal strength loss from the lack of rotating antenna can be significant and should therefore be taken into account. One way to do so would be to conduct further study to determine the "average" signal loss caused by the lack of a rotating antenna and to subtract that from the measured signal strength before comparing it against the Commission's signal strength standard.

IV. DIGITAL SIGNAL STRENGTH TESTING SHOULD BE CONDUCTED OVER A REASONABLE PERIOD OF TIME TO ACCOUNT FOR TEMPORAL VARIATIONS IN SIGNAL STRENGTH

Current digital signal strength testing procedures involve the taking of essentially instantaneous signal strength measurements. However, the H&E study shows that digital signal strength is characterized by significant variability over time, usually caused by atmospheric conditions.[16] Indeed, as H&E point out, the Longley-Rice propagation model is based on empirical data about time variability. It would be strange for a predictive model to incorporate time variability but for actual testing to ignore it completely.

Accordingly, the Commission's signal strength testing procedures should be modified to take into account this variability in signal strength over time. This could be achieved by taking the cluster measurement as the assumed median and applying a correction factor so that the 90% time reliability is achieved. The correction factor can be derived from the F(50,50) (median) and F(50,90) values used by the Commission for contour projection. As more fully described in the H&E study, the difference in decibels between the two values at any given

---

[15] H&E at 3.

[16] *Id*. at 4-6.

distance from the transmitter could serve as an appropriate correction factor to adjust for time variability.[17]

V. THE INDIVIDUAL LOCATION LONGLEY-RICE PREDICTIVE MODEL MUST BE IMPROVED BEFORE IT IS USED TO DETERMINE WHEN A HOUSEHOLD IS UNSERVED BY A LOCAL DIGITAL STATION

Finally, the H&E study suggests changes to the current Individual Location Longley-Rice ("ILLR") predictive model if it were to be used to determine when a household is digitally unserved, including an improved time variability factor and incorporating more realistic values for system noise, building penetration, and land cover and clutter.

A. Improved Time Variability Factor

As H&E points out, The ILLR model developed to predict analog signal strength is based on a time variability factor of 50%, which implies that a household predicted to be served may not actually have an adequate signal 50% of the time.[18] For DTV reception purposes, this likely means inability to receive a DTV picture for 50% of the time, which is clearly unacceptable. Even improving time reliability factor in the model to 90% would help but would still mean that households predicted to be served may not actually have digital service for up to five weeks of the year. Consequently, H&E suggests that "[a]n increase in temporal reliability to 99% (or better) seems prudent until there is greater experience with consumer reception of DTV signals, although this represents still 3.65 days a year without a usable signal."[19]

---

[17] *Id*.

[18] *Id*. at 11.

[19] *Id*. at 7. *See also id.* at 11.

B. System Noise

With respect to system noise, H&E notes that while the FCC planning factors for DTV receivers did include a system noise figure, it assumed a conjugate-impedance match between the receiver and antenna. This is rarely the case. H&E's calculations based on the characteristics of more typical antennas suggest that the predictive model should take into account an effective system noise figure increased by 3 dB to correct for the inaccuracy in the FCC planning factors.

C. Building Penetration

As noted earlier, the H&E study shows that signal strength loss due to building penetration can be as great as 30 dB for VHF in a high clutter area like New York City, but that such values will vary depending on which floor of a building the indoor antenna is placed.[20] The typical loss figures reported by H&E are preliminary, but clearly illustrate the existence of the building penetration loss phenomenon. Further study may yield a more complete set of figures for incorporation into the ILLR predictive model, especially as applied to apartment dwellers using indoor antennas.

D. Land Use and Land Cover

With respect to land cover and clutter, the Commission has repeatedly recognized that incorporation of such factors into the ILLR model would improve its accuracy.[21] However, while the Commission in the NOI claims that the ILLR currently takes into account land use and

---

[20] *Id*. at 13-14.

[21] *Establishment of an Improved Model for Predicting the Broadcast Television Field Strength Received at Individual Locations*, Report and Order, 15 FCC Rcd 12118, 12121 (2000) ("assignment of clutter loss values based on LULC categories would enhance the accuracy of predictions made with the ILLR model.") ("*ILLR Order*"); *Satellite Delivery of Network Signals to Unserved Households For Purposes of the Satellite Home Viewer Act*, Order on Reconsideration, 14 FCC Rcd 17373, 17377 ¶ 8 (1999) ("We believe that consumers will benefit when the effects of trees and buildings are included in the ILLR prediction model.").

land cover,[22] the Commission has in fact set almost all of the clutter-loss values for the VHF channels at zero for every land use/land cover category in the model -- which means that the signal loss from land use and land cover will be the same in the urban canyons in New York City as in the plains of Kansas.[23] EchoStar has challenged this approach in the analog context, but incorporation of more realistic values for land use and land cover is even more important for DTV reception than for analog reception. As noted earlier, while analog signal strength and quality problems may lead to deterioration in picture quality, digital signal problems can lead to not just a degraded picture with tiling and digital artifacts, but also an abrupt and total loss of digital service.

VI. CONCLUSION

EchoStar urges the Commission to take the above comments and the H&E study into account in formulating its report and recommendations to Congress.

Respectfully submitted,

/s/

Pantelis Michalopoulos
Chung Hsiang Mah
STEPTOE & JOHNSON LLP
1330 Connecticut Avenue, NW
Washington, D.C. 20036
(202) 429-3000

Counsel for EchoStar Satellite L.L.C.

David K. Moskowitz
Executive Vice President and General Counsel
ECHOSTAR SATELLITE L.L.C.
9601 South Meridian Boulevard
Englewood, CO 80112
(303) 723-1000

Karen Watson
Ross Lieberman
ECHOSTAR SATELLITE L.L.C.
1233 20th Street, N.W.
Washington, D.C. 20036-2396

June 17, 2005

[22] NOI at ¶ 15.

[23] *See ILLR Order* at 12127 ¶ 15, *aff'd on recon.* 19 FCC Rcd 9964 (2004).

ATTACHMENT A

Statement of Hammett & Edison, Inc.

Consulting Engineers

Before the
Federal Communications Commission
Washington, D.C. 20554

In Re Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act	))))	**ET Docket No. 05-182**

COMMENTS OF THE NATIONAL ASSOCIATION OF BROADCASTERS

Marsha J. MacBride
Benjamin F.P. Ivins
Kelly Williams
NATIONAL ASSOCIATION OF BROADCASTERS
1771 N Street, N.W.
Washington, D.C. 20036

June 17, 2005

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The philosophy behind the latest revision of the original SHVA – the Satellite Home Viewer Extension and Reauthorization Act of 2004 ("SHVERA") – is captured in Section 204, which is entitled "Replacement of Distant Signals with Local Signals." That provision reiterates Congress' strong preference for local over distant signals in a variety of ways, including through implementation of the "if local, no distant" principle.

That simple – and sensible – policy is at the heart of SHVERA. Because local-to-local service is the *desirable* way to deliver network affiliates to satellite subscribers, and because distant network station signals are at best a *necessary evil*, the SHVERA pushes the DBS industry towards the former and away from the latter.

While recognizing the overwhelming desirability of local-to-local over distant network signals, Congress also decided to create a narrowly-limited new right to transmit distant signals based on the unavailability of an over-the-air *digital* signal. 47 U.S.C. § 339(a)(2)(D)(i)(III). This new method of qualifying subscribers to receive distant signals will not go into effect until April 30, 2006, and even then it will apply only to a limited number of stations in the top 100 markets. (Other stations will be subject to this new rule in 2007 or later.)

While the Senate Commerce Committee approved a bill in 2004 that would have enabled DBS companies to use a digital *predictive* model to sign up new subscribers for distant digital signals, Congress as a whole ultimately rejected that approach. As enacted, therefore, the SHVERA allows a satellite carrier to sign up a subscriber claiming unavailability of an over-the-air digital signal *only* based on the results of an actual field measurement. 47 U.S.C. §§ 339(a)(2)(D)(i)(III), 339 (a)(2)(D)(vi). It would take an act of Congress for a DBS firm to be able to rely on a digital predictive model to sign up a subscriber for a distant digital signal.

The Commission's current Inquiry concerns the extent to which the DBS companies will be authorized to use the SHVERA compulsory license to retransmit the HD signals of New York or Los Angeles stations to customers in Glendive, Montana, Presque Isle, Maine, Dayton, Ohio and more than 200 other markets across the United States. In preparing its recommendations, the Commission should ensure that no DBS company can use the distant digital compulsory license as an inexpensive, large-scale *substitute* for digital local-to-local. Broadcasters, Congress, and the Commission all remember well what it was like in the 1990's when the DBS industry massively abused the *analog* distant-signal compulsory license, illegally "hooking" millions of ineligible customers on distant signals. The Commission's recommendations should be carefully designed to ensure that this sordid history does not repeat itself.

The following is a brief summary of NAB's comments in response to the specific questions that the Commission has asked about technical issues:

- **Type of antenna**: The Commission should continue to assume use of a properly-oriented directional rooftop antenna with substantial gain. Antennas of that kind, which fully satisfy (or exceed) the Commission's DTV planning factors, are readily available at low cost.

It would be difficult to overstate the unfairness of assuming that viewers will use only indoor (or low-quality outdoor) antennas. *Satellite* antennas (dishes) do not work when they are placed indoors, or pointed the wrong way, and it would be arbitrary and capricious to force *over-the-air* antennas to overcome these severe obstacles to successful reception. It would also violate one of the most fundamental assumptions of the Commission's entire DTV planning process, leaving broadcasters in the position of having built a system to Commission specifications that the Commission would now condemn as inadequate (because it is not designed for indoor or low-quality outdoor antennas).

- **Signal strength measurements**: The Commission's existing procedures for measuring signal strength at individual locations will work well, with minor modifications, for measuring digital signal strength.

- **Objective vs. subjective test for which households are "unserved"**: If a location has objective signal strength above the minimums specified for digital (*e.g.*, 41 dBu for UHF), field tests show it is overwhelmingly likely that a high-quality picture can be received at that location. The Commission's existing DTV minimum signal strengths are therefore an excellent metric for determining which households are "served" by digital signals. Use of a subjective standard would be a disaster, just as it was when the DBS industry (illegally) implemented such a standard a few years ago. Application of such a standard would be arbitrary and capricious.

- **Development of a predictive model**: When given the ultimate test -- being compared to the results of actual measurements -- the Longley-Rice model does exceptionally well at predicting whether or not particular locations will receive a signal above the DTV minimums. Longley-Rice makes correct predictions 95% of the time about digital signals, and the model's errors are divided roughly evenly between over- and underpredictions. Thus, if and when a predictive model is needed for over-the-air digital signals, Longley-Rice is the right choice.

In the short run, however, there are very serious practical problems with using the results of a digital Longley-Rice model as a basis for signing up subscribers. First, certain stations can be evaluated starting in April 2006; many others not until July 2007; and still others at a variety of different (currently unknown) dates thereafter. Keeping track of all of this in a predictive model would be daunting, to say the least. Second, the channels on which particular stations will broadcast in digital are still -- and will remain for some time -- in flux. Third, the Commission would need to design a hybrid digital/analog predictive model to take into account those stations (such as translators) that are not expected to broadcast in digital until some future date. Finally, if this complex, changing, hybrid digital/analog Longley-Rice model were being run internally by EchoStar, still another layer of concern would arise, since a federal judge found that EchoStar illegally manipulated the *analog* ILLR model in three different ways (behind the scenes) to sign up ineligible subscribers. *See CBS Broadcasting Inc.*, 265 F. Supp. 2d 1237, 1248-50 (S.D. Fla. 2003).

Because of these many concerns, implementing a "digital ILLR" model in the near term is fraught with difficulties. To the extent that the DBS companies do not offer digital local-to-local in every market at the end of the transition, however, there may be a need then for a digital predictive model to be applied to individual households. The Commission should endorse Longley-Rice for that long-term purpose.

Variations in DTV receivers. Since one can obtain a high-quality picture from an above-minimum strength signal almost all the time using even early-generation DTV receivers, differences in quality among receivers are not material to an objective signal strength test. In any event, the most recent round of receivers -- the fifth generation -- does vastly better than older receivers at achieving reception in difficult environments, such as multipath. As these (and future, still further-improved generations of) receiver chips are incorporated into set-top boxes, the already strong connection between signal strength and picture quality will become even more robust.

Additional clutter factor. Longley-Rice already reflects environmental "clutter" -- trees and buildings -- because it was built in part based on real-world measurements, which can't help but reflect the effects of clutter. In any event, since the Longley-Rice model *without* a special clutter factor is already highly accurate -- and well-balanced between overpredictions and underpredictions -- putting a thumb on one side of the scale with a new clutter factor would make the model *less* accurate.

The National Association of Broadcasters ("NAB") hereby files its comments in response to the Notice of Inquiry ("Notice") released by the Commission on May 3, 2005, in the above-referenced proceeding.[1/]

I. THE SATELLITE HOME VIEWER ACT, THE SHVIA, AND THE SHVERA

The Commission's Notice of Inquiry asks for comment on several specific issues relating to the measurement and prediction of over-the-air digital television signals. Because it is important to appreciate both the broader policy issues behind these issues and the specific statutory context, we begin with a brief history of the key features of the Satellite Home Viewer Extension and Reauthorization Act of 2004 ("SHVERA") and its predecessors.

A. SHVA (1988, 1994): Distant Signal Delivery to "Unserved" Households -- Those Unable To Receive a Grade B Signal From An Over-the-Air Network Station with a Rooftop Antenna

Section 119 of the Copyright Act, first enacted as part of the Satellite Home Viewer Act in 1988 and renewed in 1994, allows satellite companies to provide a lifeline service to the small number of households that cannot receive ABC, CBS, Fox, and NBC stations over the air -- *i.e.*, "unserved households." 17 U.S.C. § 119. The key test for whether a household is "unserved" is whether it can receive an analog signal of "Grade B intensity." *Id.*, § 119(d)(10). Despite claims by DBS companies that "Grade B intensity" could be determined by asking viewers if they are satisfied with their TV reception, the courts -- and the Commission -- have uniformly and correctly concluded that Grade B intensity is an *objective* measure of analog signal strength.

[1/] NAB is a nonprofit, incorporated association of radio and television broadcast stations that serves and represents the American broadcast industry.

Congress has revised the original SHVA in 1994, 1999, and 2004. In each instance, Congress has confirmed that, to evaluate whether a household can receive a Grade B intensity analog signal, the Act assumes use of a *rooftop* -- not an indoor -- antenna. In addition, as the Commission found in 2000, the rooftop antenna must be properly oriented to obtain the strongest signal from the station in question. *In Re Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Under the Satellite Home Viewer Improvement Act*, ET Dkt. No. 00-90, ¶¶ 33-36 (released Nov. 29, 2000).

B. SHVIA (1999) Permits DBS Firms to Deliver Distant Signals Based on Either a *Measurement* or a *Prediction* that the <u>Household Cannot Receive a Grade B Intensity Analog Signal</u>

In 1999, in revising the distant signal license as part of the Satellite Home Viewer Improvement Act ("SHVIA"), Congress decided that a satellite carrier could show that a household was "unserved" over-the-air by an analog station *either* through a field test *or* through a prediction made by the Individual Location Longley-Rice ("ILLR") model. 17 U.S.C. § 119(a)(2)(B)(ii). Last year, in the Satellite Home Viewer Extension and Renewal Act ("SHVERA"), Congress extended the basic "Grade B intensity" standard for reception of distant analog network affiliate signals, including eligibility based either on a field measurement or on an ILLR prediction.

C. SHVERA Confirms that DBS Firms Can Deliver Distant *Digital* Signals Based on an ILLR Prediction that <u>the Household Cannot Receive a Grade B Intensity *Analog* Signal</u>

In the 2004 SHVERA, Congress endorsed (for the next five years) the principle that a household unable to receive a Grade B analog signal from any station affiliated with the relevant network may receive *either* a distant **analog** *or* a distant **digital** signal of an affiliate of that network. 47 U.S.C. § 339(a)(2)(D)(i)(I), (II). Thus, under current law, a household that is unable to receive a Grade B signal from (say) an NBC station is eligible to receive a distant *digital* NBC station signal. In other words, satellite companies can *already* rely on the ILLR model -- the *analog* ILLR model -- to determine whether it is lawful to deliver a distant digital signal to a household.

D. SHVERA Authorizes DBS Firms to Deliver Distant Digital Signals Based on *Site Tests* of Certain Over-the-Air Digital Signals, But Does Not Authorize DBS Firms to Do So Based on *Predictions* About Over-the-Air Digital Signals

In the SHVERA, Congress for the first time modified the distant signal statutory scheme to permit transmission of distant signals based on the unavailability of an over-the-air *digital* signal. 47 U.S.C. § 339(a)(2)(D)(i)(III). This new method of qualifying subscribers to receive distant signals will not go into effect until April 30, 2006, and even then it will apply only to a limited number of stations in the top 100 markets. (Other stations will be subject to this new rule in 2007 or later.) If a satellite company wishes to deliver distant digital signals to a subscriber based on this new criterion, it must conduct a site measurement to establish that fact. 47 U.S.C. § 339(a)(2)(D)(vi) ("Signal Testing for Digital Signals").[2/]

Whether a satellite household should be considered eligible to receive a distant digital ABC, CBS, Fox, or NBC signal based on a *prediction* that it cannot receive an over-the-air digital signal is a separate issue. While the Senate Commerce Committee approved a bill in 2004 authorizing creation of digital predictive model,[3/] Congress as a whole ultimately rejected

---

2/ As discussed below, distant digital signals cannot be offered to new subscribers once the DBS company offers digital local-to-local service to the those subscribers. 47 U.S.C. § 339(a)(2)(D)(iv). In addition, if *analog* local-to-local is available to the household, the subscriber must purchase that service in order to receive a distant digital signal, even if the household has been tested and found not to receive a digital signal over the air. 47 U.S.C. § 339(a)(2)(D)(iii)(III) (analog buy-through provision).

3/ Senate Committee on Commerce, Science, and Transportation, *Satellite Home Viewer Extension And Rural Consumer Access To Digital Television Act Of 2004*, S. Rep. No. 108-427, that approach. As enacted, the SHVERA allows a satellite carrier to sign up a subscriber claiming unavailability of an over-the-air digital signal *only* based on the results of an actual field measurement. 47 U.S.C. §§ 339(a)(2)(D)(i)(III), 339(a)(2)(D)(vi). It would take an act of Congress for a DBS firm to be able to rely on a digital predictive model to sign up a subscriber for a distant digital signal.

II. THE IMPORTANCE OF LOCALISM AND THE NEED TO PROMOTE LOCAL-TO-LOCAL SERVICE, RATHER THAN DISTANT SIGNALS

As just discussed, in the SHVERA Congress elected to take a cautious approach in authorizing DBS companies to carry digital signals of distant ABC, CBS, Fox, and NBC stations based on claims that subscribers cannot receive digital signals from nearby over-the-air stations. That decision fits squarely into the philosophy that both Congress and the Commission have followed for many decades: that the public interest is served when multichannel video programming distributors carry *local* television stations, but can easily be harmed when they import *distant* TV stations.

---

at 8-9 (2004) ("Thus, the Commission would (1) determine the appropriate signal standard for determining eligibility for distant digital signals; (2) develop a predictive model for presumptively determining the ability of individual locations to receive digital signals in accordance with the signal standard . . . .").

A. The Commission's Recommendations Should Reflect the Importance of Preserving Localism and Free, Over-the-Air Broadcasting

1. Congress and the Commission Have Consistently Recognized the Importance of Protecting Free, Over-the-Air, Local Television Broadcasting

Unlike many other countries that offer only national television channels, the United States has succeeded in creating a rich mix of *local* television outlets through which more than 200 communities can have their own local voices. But as the House Judiciary Committee observed last year, "[t]he availability of local programming is largely dependent on the continued health of network affiliates, who use revenue from the sale of advertising, the rates for which depend on audience size, to produce local content." Committee on the Judiciary, *Satellite Home Viewer Extension and Reauthorization Act of 2004*, H.R. Rep. No. 108-660, at 7-8 n.4 (2004).

Although cable, satellite, and other technologies offer alternative ways to obtain television programming, at least 20 million American TV households still rely on broadcast stations -- principally ABC, CBS, Fox, and NBC stations -- as their exclusive source of television programming.[4/] In addition, tens of millions of other households rely on over-the-air reception for some of the televisions in their homes.[5/]

The 1988 SHVA and its successors (including the 2004 SHVERA) implement a longstanding communications policy of ensuring that these free, local, over-the-air outlets will

---

4/ *See* Reply Comments of National Association of Broadcasters, *In Re Over-the-Air Broadcast Television Viewers*, MB Docket No. 04-210, at 3 (Sept. 7, 2004) ("NAB OTA Reply Comments"); *see Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming*, MB Docket No. 04-227, at 52 (2005) (citing conservative estimate of 16 million households).

5/ NAB OTA Reply Comments, MB Docket No. 04-210, at 9.

continue to provide high-quality programming in more than 200 local markets, large and small, around the United States. In particular, the "unserved household" limitation of SHVA and its successors is designed to protect local network affiliates from importation of duplicative network programming, such as delivery of the New York City ABC station to viewers in Omaha. In considering possible recommendations about how to implement the latest revision of the SHVA, the Commission should keep these overarching policy considerations in mind.

2. Unlike Delivery of Distant Signals, Local-to-Local is a Winning Formula for Satellite Carriers, Broadcasters, and Consumers Alike

Unlike importation of distant network affiliates, delivery of local stations is good for consumers, for broadcasters, and for DBS firms alike. For that reason, Congress and the Commission have consistently sought to foster local-to-local service and to minimize delivery of distant signals.

From a policy perspective, there is no benefit -- and there are many drawbacks -- to satellite delivery of distant, as opposed to local, network stations. Unlike local stations, distant stations do not provide viewers with their *own* local news, weather, emergency, and public service programming. Nor does viewership of distant stations provide any financial benefit to *local* stations to help fund their free, over-the-air service. To the contrary, distant signals, when delivered to any household that can receive local over-the-air stations, simply siphon off audiences and diminish the revenues that would otherwise go to support free, over-the-air programming.

Until 1999, satellite carriers, unlike cable systems, lacked a copyright compulsory license authorizing them to carry local TV stations. The 1999 SHVIA created, for the first time, such a compulsory license. And thanks to the ability to offer local stations, DirecTV and EchoStar have enjoyed growth rates since SHVIA's enactment that any industry would envy.

In June 1999, just before the enactment of the new local-to-local compulsory license in the SHVIA, the DBS industry had 10.1 million subscribers. 2000 Annual Assessment, ¶ 8. As of March 2005, the DBS firms have *25.7 million* subscribers.[6] That this supercharged growth has been spurred by the availability of local-to-local is beyond doubt: the DBS industry's trade association has explained that over the past few years, "the availability of local services has been *a key factor driving the continued growth of DBS*." Comments of the Satellite Broadcasting & Communications Ass'n at 4, Dkt. No. 04-227 (filed July 23, 2004) (emphasis added).

3. **SHVERA Explicitly Reaffirms And Strengthens Congress' Longstanding Preference For Local Over Distant Station Delivery**

The philosophy behind the latest revision of the original SHVA – the Satellite Home Viewer Extension and Reauthorization Act of 2004 ("SHVERA") -- is captured in Section 204, which is entitled "Replacement of Distant Signals with Local Signals." This provision reiterates Congress' preference for local over distant signals in a variety of ways, including through implementation of the "if local, no distant" principle. For example:

- **Analog "if local, no distant" rule**: the Act prohibits signups of subscribers for distant *analog* signals if the satellite carrier offers *analog* local-to-local service to the subscriber, 47 U.S.C. § 339(a)(2)(C).

[6] Press Release, *The DIRECTV Group Announces First Quarter 2005 Results* (May 2, 2005), available at www.forbes.com/businesswire/feeds/businesswire/2005/05/02/ businesswire20050502005455r1.html (DIRECTV had 14.45 million subscribers as of March 2005); Press Release, *EchoStar Reports First Quarter 2005 Financial Results* (May 5, 2005), available at www.forbes.com/businesswire/feeds/businesswire/2005/05/05/businesswire 20050505005159r1.html (EchoStar had 11.23 million subscribers as of March 2005).

- **Digital "if local, no distant" rule**: the Act precludes new signups of subscribers for distant *digital* signals if the satellite carrier offers *digital* local-to-local service to that household, *id.*, § 339(a)(2)(D)(iv).

- **Analog local-to-local buythrough as prerequisite for receipt of distant digital signals**: the Act requires subscribers to purchase analog local-to-local service (if available) if they wish to receive a distant digital signal, even if they are tested and found to be unable to receive an over-the-air digital signal, *id.*, § 339(a)(2)(D)(iii)(III).

- **No testing of digital signals in markets with no analog local-to-local**: to encourage the further spread of local-to-local service, the Act provides for digital testing waivers in any DMA in which satellite carriers do not offer analog local-to-local service, *id.*, § 339(a)(2)(D)(viii)(VI).

- **No use of distant signals from another time zone to watch programming earlier than when it is broadcast locally**: the Act bars importation of distant digital signals from a time zone in which programming is broadcast earlier, such as delivery of the digital signal of the New York City ABC station to a viewer in San Diego or Missoula, *id.*, § 339(a)(2)(D)(iii)(I), 339(a)(2)(D)(v). It thus prevents use of the compulsory license to "scoop" local stations in the Mountain, Pacific, Alaskan, or Hawaii-Aleutian time zones with their own programming from distant signals.

- **No distant signals for "grandfathered" subscribers who receive local-to-local**: the Act bars delivery of distant signals to subscribers who were "grandfathered" by the 1999 SHVIA but who now receive local stations by satellite, 47 U.S.C. § 339(a)(2)(A)(i).

- **Grandfathering terminated for those not receiving distant signals as of October 2004**: the Act *ends* "grandfathering" for those subscribers who did not receive a distant signal as of October 2004, *id.*, § 339(a)(2)(A)(ii).

B. Local-Into-Local Service Is Almost Universally Available Today, And Local Digital Signals Will Soon Be Available On DBS

EchoStar and DirecTV already offer transmissions the analog signals of local ABC, CBS, Fox, and NBC stations to nearly all U.S. television households -- and soon *all* local markets will have the option of receiving local programming from DBS. In this sense, no household in an analog local-to-local market is truly "unserved," regardless of the ambient field strength of the station's over-the-air digital signal near his or her home.

Ever since SHVIA was passed, DBS has rapidly rolled out local-into-local service across the country. Today, EchoStar *alone* reaches 155 markets, covering more than 95% of TV households, while DirecTV reaches 130 markets.[7/] Soon, DBS local-into-local service will be available everywhere: DirecTV has committed to offering local channels in all 210 markets as early as 2006 and no later than 2008.[8/]

In their local-to-local service, both DBS firms typically work with stations to obtain a direct feed from the stations' studios. The DBS firms then "digitize" the signals for retransmission to their customers.

7/ DIRECTV web site, www.directv.com; EchoStar Press Release *DISH Network Satellite Television Brings Local Channels to Billings, Mont.* (March 5, 2005).

8/ *See Memorandum Opinion and Order, In re General Motors Corporation and Hughes Electronics Corporation, Transferors, And The News Corporation Limited, Transferee, For Authority to Transfer Control*, ¶ 332, FCC 03-330, MB Docket No. 03-124 (released Jan. 14, 2004).

DirecTV and EchoStar often boast about the reception quality their subscribers can enjoy through their "digitized" analog local-to-local service. For example, DIRECTV tells customers that it "offers local channels in most major U.S. cities and their surrounding areas, *always in digital quality*," and EchoStar declares that its local-into-local programming is in "100% digital clarity."[9/] The result, according to the DBS industry's trade association, is that DBS "always delivers a *100 percent, crystal-clear digital audio and video signal*." SBCA Web site, www.sbca.com/mediaguide/faq.htm <visited June 14, 2005> (emphasis added). The SBCA tells consumers that, unlike a signal delivered by cable, "[t]he quality of a digital signal beamed from a satellite to a dish is not subject to degradation and therefore, is a *superior quality signal*." *Id.* (emphasis added).

Even as the DBS firms continue to expand their analog local-to-local offerings, they are simultaneously planning to roll out *digital* local-to-local. In September 2004, DirecTV announced plans to launch four new satellites through 2007 that would give it the capacity to carry up to ***1,500* HD local channels.**[10/] Since then, DirecTV has announced plans to offer local HD channels *this year* in at least 24 large markets that collectively cover *45%* of U.S. television households.[11/] The first 12 markets in which DirecTV will launch HD local-to-local are New

---

9/ *See* DIRECTV Local Programming FAQ (available at www.directv.com/DTVAPP/learn/FAQ_DTVProgramming_Local.dsp#1); www.dishnetwork.com/content/getdish/what_is/index.shtml.

10/ Press Release, *DIRECTV Announces Plan to Launch Next Generation Satellites to Provide Dramatic Expansion of High-Definition and Advanced Programming Services* (Sept. 8, 2004), available at http://phx.corporate-ir.net/phoenix.zhtml?c=127160&p=irol-newsArticle&ID=617918&highlight=. These plans by the DBS firms are logical, given the advantage their cable competitors currently enjoy from their local HD offerings.

11/ Press Release, *DIRECTV Spaceway F2 Satellite will Expand Local Digital/HD Services for DIRECTV Customers* (May 25, 2005), available at www.directv.com/DTVAPP/aboutus/headline.dsp?id=05_25_2005A.

York, Los Angeles, Chicago, Philadelphia, Boston, San Francisco, Dallas, Washington D.C., Atlanta, Detroit, Houston, and Tampa.[12/] *Id.* Once DIRECTV or EchoStar offers digital local-into-local in a particular market, of course, that firm will be barred from signing up new subscribers for *distant* digital signals, under the "if local, no distant" rules discussed above.

Although EchoStar has not announced detailed plans for offering digital local-to-local, the competitive pressure on EchoStar to do so will be intense, since its two principal competitors (cable and DIRECTV) are now offering, or will soon offer, HD local-to-local to the vast majority of U.S. television households. As discussed below, the Commission should take care not to endorse a system that would encourage EchoStar to use distant digital signals as a large-scale *alternative* to local-into-local service.

C. The Commission Should Encourage the Growth of Digital Local-to-Local and Discourage Use of Distant Digital Signals As a Substitute for Local Signals

In the 1990s the DBS companies illegally delivered distant *analog* signals to millions of their customers.[13/] The Commission should keep that experience in mind as it considers the practical consequences of satellite delivery of distant *digital* signals. While DIRECTV is commendably making a major investment to offer local HD programming in markets across the country, EchoStar has signaled that it may make a much more limited investment in delivering

---

12/ Press Release, *New HD Local Markets Mark First Stage in Dramatic Expansion of HD Programming Over the Next Two Years* (Jan. 6, 2005) (available at http://phx.corporate-ir.net/phoenix.zhtml?c=127160&p=irol-newsArticle&ID=660037 &highlight=.

13/ *CBS Broadcasting Inc. v. PrimeTime 24*, 9 F. Supp. 2d 1333 (S.D. Fla. 1998) (entering preliminary injunction against DirecTV's and EchoStar's distributor, PrimeTime 24); *CBS Broadcasting Inc. v. PrimeTime 24 Joint Venture,* 48 F. Supp. 2d 1342 (S.D. Fla. 1998) (permanent injunction); *CBS Broadcasting Inc. v. DIRECTV, Inc.*, No. 99-0565-CIV-NESBITT (S.D. Fla. Sept. 17, 1999) (permanent injunction after entry of contested preliminary injunction); *ABC, Inc. v. PrimeTime 24,* 184 F.3d 348 (4th Cir. 1999) (affirming issuance of permanent injunction).

local digital and HD signals, at least in the near term. *See EchoStar Wants to 'See the Playing Field' Before Making HDTV and Broadband Bets*, Satellite Week (May 9, 2005) ("while HD 'on a national level is relatively economical, [the economics of] HD on a local level is still unknown'"); ("We're pretty sure that the top 20 markets make sense, but we're not sure about the 21st market, and we're definitely not sure if the 51st market makes sense.") (quoting EchoStar CEO Charlie Ergen).[14/]

There is a serious danger of history repeating itself: that is, that EchoStar will again try to use *national* feeds -- this time of the HD broadcasts of the network stations in New York and Los Angeles -- as an inexpensive way to deliver ABC, CBS, Fox, and NBC programming to large numbers of customers, rather than promptly investing in local-to-local HD service as its competitors have done.

As the record shows, EchoStar has no compunction about bending -- or breaking -- signal carriage rules. *CBS Broad., Inc. v. EchoStar Communications Corp.*, 276 F. Supp. 2d 1237, at ¶ 46 (S.D. Fla. 2003) ("EchoStar executives, including Ergen and [General Counsel] David Moskowitz, when confronted with the prospect of cutting off network programming to hundreds of thousands of subscribers, *elected instead to break Mr. Ergen's promise to the Court.*") (emphasis added); *see also EchoStar Satellite Corp. v. Brockbank Ins. Servs., Inc.*, No. 00-N-1513, at 23 (D. Colo. Feb. 5, 2004) (EchoStar's actions "rose to the level of conscious

---

[14/] As to the Mr. Ergen's stated doubts about EchoStar's ability to offer digital local-to-local: in 2002 the two DBS firms claimed that unless they were permitted to merge, neither firm could offer local-to-local in more than about 50 to 70 markets. *EchoStar, DirecTV CEOs Testify On Benefits of Pending Merger Before U.S. Senate Antitrust Subcommittee*, www.spacedaily.com/news/satellite-biz-02p.html ("Without the merger, the most markets that each company would serve with local channels as a standalone provider, both for technical and economic reasons, would be about 50 to 70."). Since EchoStar alone now offers local-to-local service in *155* markets, the Commission should be skeptical of its current claims that it would be difficult (or uneconomical) to offer digital local-to-local in a large number of markets.

wrongdoing"); *National Association of Broadcasters and Association of Local Broadcasters Request for Modification or Clarification of Broadcast Carriage Rules for Satellite Carriers*, Declaratory Ruling and Order, DA 02-765, ¶ 37 n.116 (released April 4, 2002) (collecting examples of EchoStar misconduct in Commission proceedings).

As the Commission considers possible recommendations about carriage of distant *digital* signals, therefore, it should keep in mind the need to prevent the recurrence of past DBS industry abuses of distant signals.

III. THE COMMISSION'S PLANNING FACTORS FOR DIGITAL SERVICE

As we show here, the present proceeding is intimately related to, and for powerful policy reasons must be consistent with, the Commission's decisions over the past decade concerning the transition from analog to digital television broadcasting, including most notably the planning factors that the Commission relied on in making digital channel assignments.

A. The Commission's Use of Planning Factors to Determine the Minimum Signal Strength Needed to Receive Over-the-Air Analog and Digital Signals

In planning the analog television system decades ago, and in devising the digital television system much more recently, the Commission needed to determine how strong a signal is required to receive a television picture. In each case, the Commission has used a formula based on a set of "planning factors," that is, assumptions about a variety of technical issues, including about the types of equipment that would be used in the "receive" setup, *i.e.*, by consumers at their homes.

In previous proceedings under SHVA and its successor laws, the Commission has carefully reviewed the *analog* planning factors and endorsed the long-standing definition of "Grade B intensity" for analog signals (*e.g.*, 47 dBu for low-VHF channels). *E.g.*, *Satellite Delivery of Network Signals to Unserved Households for Purposes of Satellite Home Viewer Act*, Report and Order, FCC 99-14 (released Feb. 2, 1999). The Commission has also evaluated the antennas and other equipment available to consumers and concluded that the analog planning factors make realistic assumptions about what steps consumers can be expected to take to receive over-the-air signals. *See id.*; *In Re Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Under the Satellite Home Viewer Improvement Act*, ET Dkt. No. 00-90, ¶¶ 33-56 (released Nov. 29, 2000).

To implement digital television and to make digital channel assignments, the Commission developed a similar set of planning factors to determine the minimum signal strengths -- in dBu's -- that are the digital equivalent of "Grade B intensity" for analog. As it did with the analog planning factors, the Commission again had to make assumptions about the types of equipment that consumers can reasonably be expected to acquire to obtain over-the-air TV signals. For example, as with the analog planning factors, the Commission's DTV planning factors assumed an outdoor antenna with substantial gain.

In predicting the expected service areas of digital TV signals -- using the Longley-Rice propagation model -- the Commission likewise had to make assumptions about consumer reception equipment. As the Commission explains in its Notice of Inquiry in this proceeding, the procedures the Commission has used in predicting expected digital service areas "presume that households will exert similar efforts to receive DTV broadcast stations as they have always been expected to exert to receive NTSC analog TV signals." NOI, ¶ 6.

Based on the analog and digital planning factors, the Commission's rules (Sections 73.622(e)(1) & 73.683(a)) specify the following minimum signal strengths for analog and digital service:[15]

Channel Numbers	Channel Label	Minimum Analog Field Strength (dBμV/m)	Minimum Digital Field Strength (dBμV/m)
2-6	Low VHF	47	28
7-13	High VHF	56	36
14-69	UHF	64	41

As explained in the Engineering Statement of Meintel, Sgrignoli & Wallace (Attachment 1 hereto), the minimum field strengths for DTV are derived from the planning factors shown in the following table:

[15] While OET Bulletin 69 provides for slight variations in the UHF minimum field strength, based on the dipole factor, the Commission's regulations specify the *specific* dBu levels indicated in the text, including for UHF. In the SHVERA, Congress specifies that the specific dBu levels mentioned in the regulations shall be used in determining whether households are considered "unserved." *See* 17 U.S.C. § 119(d)(10)(A) (incorporating analog signal strength figures from Section 73.683(a)) and 47 U.S.C. § 339(a)(2)(D)(vi)(I) (incorporating digital signal strength figures from Section 73.622(e)(1)).

Planning Factor	Symbol	Low VHF	High VHF	UHF
Geometric Mean Frequency	F	69	194	615
Dipole Factor nominal (dBm-dBμ)	K_d	-111.8	-120.8	-130.8
Dipole Factor adjustment	Ka	None	None	See text
Thermal Noise (dBm/6 MHz)	N_t	-106.2	-106.2	-106.2
Antenna Gain (dBd)	G	4	6	10
Antenna Front/Back Ratio (dB)	FB	10	12	14
Downlead Line Loss, 50' cable (dB)	L	1	2	4
System Noise Figure (dB)	N_s	10	10	7
Required Carrier Noise (dB)	C/N	15	15	15
Calculated Minimum Rx Power (dBm/6 MHz)	P_{min}	-81	-81	-84

B. The Assumptions Made in the Commission's DTV Planning Factors and in the Longley-Rice Model About Household Reception Equipment Are Reasonable and Realistic

Because the topic is germane to many of the specific questions raised by the Commission in its Notice of Inquiry in this proceeding, we show here that the Commission's assumptions about consumer equipment for DTV reception are entirely reasonable.

1. Rooftop vs. indoor antennas. The Commission asks whether it should assume, for purposes of implementing SHVERA, that consumers use a *rooftop* antenna or instead an *indoor* antenna. NOI, ¶ 7. The answer is plain: the Commission should assume use of a rooftop antenna.

a. Indoor antennas perform much less well at receiving over-the-air TV signals. As the Notice of Inquiry observes, the reception characteristics of indoor antennas are much worse than those of outdoor rooftop antennas. *E.g.*, NOI, ¶ 20 ("indoor-mounted antennas will generally receive weaker signals than outdoor-mounted antennas"). In particular:

- **Indoor antennas have lower gain**: As recent tests confirm, indoor antennas have much less gain than good outdoor antennas, and in some cases actually deliver a *weaker* signal than a reference dipole (*i.e.*, the indoor antenna has a "loss," not a gain). *See* Kerry W. Cozad, *Measured Parameters for Receive Antennas Used in DTV Reception* (Attachment 2 hereto).

- **The location of indoor antennas is much worse for reception of over-the-air signals**: An indoor antenna is placed at a location inside a building and below -- sometimes much below -- the location of an outdoor rooftop antenna. This location hurts the antenna's performance in two ways: the lower height usually means reduced signal strength, and placement behind walls (sometimes multiple walls) translates into still lower ambient field strength. MSW Engineering Statement, ¶ 38.

- **Indoor antennas are typically nondirectional**: Indoor antennas are usually nondirectional, and therefore more prone to problems from both multipath and interference. *Id.*

- **Indoor antennas are affected by the motions of people in the room:** Because indoor antennas are so close to the viewers, they can easily be affected by the changing positions of people in the room, which can radically alter the antenna's reception pattern. *Id.*

Because rooftop antennas are so much better than indoor antennas, households have long used rooftop antennas to achieve over-the-air reception, particularly if the household is at some distance from the transmitting tower. In fact, rural households often rely on small towers -- with over-the-air antennas considerably *higher* than rooftop level -- to receive a strong signal from stations several dozen miles away. MSW Engineering Statement, ¶ 39.

b. ***Satellite* antennas work only outdoors, and are usually placed on the rooftop**. This proceeding is about how *satellite subscribers* can receive over-the-air digital signals. But when those same subscribers wish to receive signals from DIRECTV or EchoStar, they use a satellite reception antenna (popularly known as a satellite dish) that *can only be used outdoors*, and usually on a rooftop. An "indoor" satellite antenna would be useless. It would be egregiously discriminatory to conclude that while satellite subscribers are expected to rely on a rooftop antenna for their satellite reception, they cannot be expected to do the same to pick up over-the-air signals.

c. **The Commission's digital transition proceeding has always assumed use of a rooftop antenna.** The Commission's entire digital transition effort -- assigning digital channels to TV stations, determining their coverage area, replicating analog coverage areas, and assessing the power levels at which the stations should operate -- has been based on the assumption that consumers are using rooftop receiving antennas to receive DTV signals. *See* NOI, ¶ 6. It would be totally unfair -- and without any rational basis -- for the Commission to now treat households as "unserved" by digital signals, and allow importation of duplicative signals from other cities, based on the new premise that households even 50 miles from TV towers use only *indoor* antennas. Such an eleventh-hour change would be like telling hurdlers, as they line up for the final race of the Olympics, that the officials have decided to raise the height of the hurdles by two feet.

Had the Commission assumed use of indoor antennas in planning the digital transition, that process would have been radically different. For example, to replicate analog coverage areas (which have always been premised on outdoor antennas), the Commission would need to have authorized stations to transmit their digital signals at enormously higher power levels to reach *indoor* antennas 50 or 60 miles away. Those vastly higher power levels, in turn, would have required completely different interference calculations. MSW Engineering Statement, ¶ 9. Having correctly rejected -- throughout the digital transition -- the assumption that consumers use only indoor antennas, and having encouraged broadcasters to build out their digital facilities based on outdoor antennas, it would be an abuse of discretion for the Commission suddenly to reverse course now.

d. **Proper vs. improper antenna orientation**. The Commission asks whether it should assume that the over-the-air antenna is properly oriented to achieve the best reception from the station in question. NOI, ¶ 7. Again, it is essential to assume proper orientation. In particular:

- **Assuming improper orientation would be discriminatory and unfair.** As with the issue of rooftop vs. indoor antennas, it would be exceedingly discriminatory to assume that a DBS household's over-the-air antenna is *improperly* oriented when the same household's satellite antenna must be *precisely oriented* towards the satellite to get any signal at all. In addition, as discussed above, the entire digital transition has been premised on the assumption that consumers will use properly-oriented rooftop antennas to receive digital TV signals. *E.g.*, Notice of Inquiry, ¶ 10 (process used by the Commission in assigning digital channels assumes that receive antenna "is oriented in the direction which maximizes the values for field strength for the signal being measured."). Similarly, SHVA and its successors have always assumed that a household's ability to receive an analog signal assumes use of a properly-oriented directional antenna. *See, e.g., In Re Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Under the Satellite Home Viewer Improvement Act*, ET Dkt. No. 00-90, ¶¶ 33-36 (released Nov. 29, 2000). For the same reasons it would be unfair to suddenly assume an *indoor* antenna for purposes of evaluating the availability of a digital signal in this context, it would be unfair to assume that the household's *outdoor* antenna is improperly oriented.

- **TV towers are co-located in many markets**. Although consumers can reasonably be expected to orient their over-the-air antennas correctly in any market, it will often be possible for consumers to do so with a single, fixed antenna, because the TV transmitters in many markets are co-located. In these cases, there will be no need for a rotor. MSW Engineering Statement, ¶ 44.

- **Special antennas for non-co-located towers**. In markets in which TV towers are located at different sites, local electronics installers sometimes offer a special antenna designed to receive signals from two different directions, again without the need for a rotor. *Id.*

- **Rotors are readily available at modest cost**. For those instances in which the options just discussed are not available, consumers can acquire, at modest cost, a rotor that enables a rooftop antenna to be moved to achieve the best signal from a particular station. Manufacturers today sell not only basic rotors but new, sophisticated models that offer features such as remote control operation. For example, the CM 9521A manufactured by Channel Master (sold by Solid Signal for only $68.99) includes a remote control that allows television viewers to select the proper orientation to receive a particular station simply by keying in that station's channel. *See* www.solidsignal.com/prod_display.asp?main_cat=03&CAT=&PROD=MTRTR200#MORE.

e. **Antenna gains**. In its digital planning factors, the Commission assumes use of a receiving antenna with gains of 4 dB for low-VHF, 6 dB for high-VHF, and 10 dB for

UHF. As discussed in greater detail by the Network Affiliates in their Comments, a wide variety of rooftop antennas are available at reasonable prices with these or greater gains.

The Commission has "long recommended that consumers in outlying or difficult reception areas use *separate* UHF and VHF outdoor antennas, which provide better performance on UHF than a combination UHF/VHF antenna, at little or no additional cost." *In Re Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Under the Satellite Home Viewer Improvement Act*, ET Dkt. No. 00-90, ¶ 32 (released Nov. 29, 2000) (emphasis added). As the Network Affiliates discuss in their Comments, separate UHF and VHF outdoor antennas can easily be purchased at moderate expense to achieve gains better than those assumed in the DTV planning factors. That fact alone means that the DTV planning factors already contain a substantial "safety margin."

For the Commission's convenience, in these Comments we show that even if a consumer prefers not to use separate antennas, he or she can easily obtain (1) a *single* antenna (the Channel Master 4228, costing $39) that exceeds (or is very close to) the DTV planning factors across all channel bands, or (2) a single, attractive, relatively small antenna / preamplifier combination (the Winegard SquareShooter SS-2000, costing about $100) that will substantially exceed the performance assumptions in the DTV planning factors.

As recent empirical tests show, the Channel Master 4228 achieves gains that are at least as good as, and in some cases better than, those assumed in the DTV planning factors. Kerry W. Cozad, *Measured Parameters for Receive Antennas Used in DTV Reception* (Attachment 2 hereto). Specifically, the Channel Master antenna achieves gains of about 14 or 15 dB for most UHF channels, while the planning factors call for a gain of only 10 dB for UHF. Similarly, for high-VHF, the Cozad paper shows that the Channel Master antenna achieves gains of about 8 or 9 dB, compared to the assumption in the planning factors of only 6 dB of gain.

Even for low-VHF -- a channel range in which very few network affiliate stations will broadcast in digital -- the Channel Master 4228 antenna offers gains nearly as high as those specified in the DTV planning factors. (In the relatively unusual case of a household located at the fringe of the coverage area of one of the few low-VHF DTV stations, one can either use a preamplifier with this antenna, or use a separate VHF antenna, to deliver results far above the planning factors for VHF.) The Channel Master antenna is available for as little as $39. *See* Solid Signal web site, www.solidsignal.com/prod_display.asp?
main_cat=03&CAT=&PROD=ANC4228.

Another option is the Winegard SquareShooter 2000, a small, attractive directional antenna with a preamplifier. Although the manufacturer states that the antenna alone has a gain of 4.5 dB for UHF (below the planning factor assumption), the combined setup *with* the preamplifier far exceeds the planning factors. MSW Engineering Statement, ¶ 46. The SquareShooter 2000 is available for $98.99. *See* www.solidsignal.com/prod_display.asp?
main_cat=3&CAT=&PROD=SS-2000.

f. **System noise figure**. The Commission's planning factors assume a system noise figure of 10 dB for VHF channels and of 7 dB for UHF channels. While there is little published data about receiver noise figures, consumers can in any event make the noise figure of the receiver irrelevant -- and achieve many other benefits -- with an inexpensive preamplifier.

g. **Use of low-noise amplifier (or "preamplifer")**. Although not included in the DTV planning factors, consumers can easily do much *better* than the DTV planning factors by using a low noise amplifier (LNA), or "preamplifier," mounted on the mast that holds the rooftop antenna. As explained by Meintel Sgrignoli & Wallace, a preamplifier offers several different advantages, that cumulatively can add at least 12-15 dB of effective gain -- and sometimes much more -- to the consumer's system.

Low-noise amplifiers are readily available at a modest price: Meintel Sgrignoli & Wallace identify four highly effective low-noise amplifiers that range in price from $56.99 to $164.00. MSW Engineering Statement, ¶ 50 and Table 5. Because of their benefits and low cost, consumers in locations where signal strength may be marginal often use preamplifiers to boost reception. As Meintel Sgrignoli & Wallace explain, "[t]he availability of . . . preamplifiers . . . provides a substantial 'cushion' against the possibility of losses not specifically accounted for in the planning factors, including impedance mismatches and additional attenation from signal splitters." MSW Engineering Statement, ¶ 51.

h. **Downlead line loss**. As the planning factors recognize, a certain degree of signal loss occurs as the signal is transmitted from the rooftop antenna through a cable to the household's television equipment. The extent of the loss depends, of course, on the type of cable used. EchoStar recommends use of RG-6 coaxial cable as the downlead for satellite signals,[16] and it is reasonable to assume use of that same type of cable for the off-air signal downlead. *See In Re Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Under the Satellite Home Viewer Improvement Act*, ET Dkt. No. 00-90, ¶ 28 (released Nov. 29, 2000) ("there is no serious question that RG-6 is clearly the preferred and recommended choice that consumers residing near the Grade B contours of TV stations would typically employ").

16/ EchoStar web site, www.dishnetwork.com/content/products/installation/index.shtml.

The DTV planning factors assume downlead line losses of 1 dB for low-VHF, 2 dB for high-VHF, and 4 dB for UHF. According to the specifications published by two major manufacturers of RG-6 cable, the actual line losses are lower than those assumed in the planning factors. MSW Engineering Statement, ¶ 53. It is therefore reasonable to assume that consumer downlead losses will be no greater than -- and often less than -- those specified in the DTV planning factors.

i. **Front-to-back ratio**. For DTV, the Commission's planning factors assume that the consumer's receiver antenna has a front-to-back ratio of 10, 12, and 14 dB for low-VHF, high-VHF, and UHF, respectively. These ratios are readily available in consumer equipment; for example, the Channel Master 4228 rooftop antenna (which costs $39) does considerably better than the planning factors assume, with a front-to-back ratio of roughly 25 dB for VHF and 18 db for UHF. *See* MSW Engineering Statement, ¶ 47.

j. **Conclusion with respect to DTV planning factors**. Even if they choose not to take advantage of the benefits of a preamplifer, consumers can easily acquire, at relatively modest expense, reception equipment that is in line with -- or somewhat better than -- what the DTV planning factors assume. If the consumer chooses to use a preamplifer, he or she can easily have a reception setup that is *much superior* to what the DTV planning factors assume. Particularly since satellite subscribers must pay roughly $6 per month ($72 a year, or hundreds of dollars in just a few years) to a satellite company to receive retransmitted TV station signals, the modest expenditures required for an over-the-air antenna and associated equipment are plainly reasonable.

Put another way, the Commission has it exactly right in its Notice of Inquiry (at ¶ 6) in stating that households should be expected to "exert similar efforts to receive DTV broadcast stations as they have always been expected to exert to receive NTSC analog TV signals," including the use of directional rooftop antennas with significant gain.

IV. RESPONSES TO THE OTHER QUESTIONS ASKED BY THE COMMISSION

The preceding section answers the Commission's first inquiry, namely whether, for purposes of SHVA/SHVERA, the Commission should assume use of a properly oriented rooftop antenna as opposed to an improperly oriented outdoor antenna or an indoor antenna. In this section, we respond to the other specific questions in the Notice of Inquiry.

A. The Commission's Existing Site Testing Procedures In Section 73.686(d), With Minor Adjustments, Will Work Well For Digital

The Commission has previously developed standardized procedures for measuring analog signal intensity at individual households for purposes of the Satellite Home Viewer Act and successor legislation. *See* 47 C.F.R. § 73.686(d). Those procedures call for signal strength measurements at five locations near the household, with a properly-oriented antenna raised to 30 feet above ground level (for two-story homes) or 20 feet above ground level (for one-story homes).

As discussed below, and as explained in more detail in the Engineering Statement of Meintel, Sgrignoli & Wallace, the Commission's existing methods for measuring field intensity at individual households will -- with a few minor modifications -- work well for digital. (Messrs. Meintel, Sgrignoli & Wallace have collectively performed thousands of digital signal strength measurements, and are therefore in an excellent position to provide guidance to the Commission on this topic.)

The procedures adopted by the Commission for signal intensity testing at individual sites are very similar to those used by engineers around the world for that purpose. MSW Engineering Statement, ¶ 56. With minor adjustments, these procedures will work well for digital testing as well. Before discussing those adjustments, however, we discuss a special challenge that will have to be confronted in implementing the "digital testing" process. The challenge arises because Congress has postponed -- in some cases by years -- the dates by which certain stations (including virtually all translators) may have their digital signals tested for SHVERA purposes. *See* below. But simply *ignoring* those stations in the testing process would be wrong: it would amount to *performing* the prohibited test (of a nonexistent signal) and finding that the station had failed the test. As more fully explained below, the Commission's rules for digital testing should, until the end of the transition, call for testing of the *analog* signals of any stations that are exempt from digital testing under the Act.

With regard to those stations that *are* subject to digital signal tests under SHVERA, the adjustments required to adapt the existing measurement procedures in Section 73.686(d) to digital testing are as follows:

- **<u>Different minimum signal values</u>**: the signal intensity thresholds (in dBu's) that must be met for a location to be considered "served" are, obviously, different for analog and for digital. Engineers performing signal strength tests must be careful to ensure that they are looking for the correct minimum dBu figure for each station (and in some cases for *analog* minimum dBu levels).

- **<u>No "visual carrier."</u>** The Commission's Notice of Inquiry (¶ 13) correctly points out that there is no visual carrier to be measured in a digital television signal. In response to the Commission's specific question (NOI, ¶ 13), the digital "pilot signal" is *not* a good substitute for the visual carrier in analog testing: the engineer doing the test should not simply measure the pilot power in a narrow band, and then attempt to determine the total power from this value. As Meintel Sgringnoli & Wallace explain, in doing field measurements, multipath can create sharp peaks and valleys in the pilot signal that could easily cause large measurement errors. (What *should* be measured is discussed below.)

- **Need for different measuring equipment**. As explained in the MSW Engineering report, it will be necessary to use different equipment to measure digital signal strength than the field strength meters used to measure NTSC signal intensity. The Commission defines DTV signals by their *integrated average power* in a 6 MHz bandwidth. *Id.* The instrument used to measure digital field strength must therefore be able to tune to the center of the DTV RF channel and measure this integrated power over 6 MHz. Analog field strength meters cannot do this. MSW Engineering Statement, ¶ 58. As explained by Meintel Sgrignoli & Wallace, however, there are several types of equipment that *can* perform this function. *Id.*, ¶ 59.

- **Need for antenna with substantial gain**. Digital signal testing should be done not with a simple dipole but with a directional antenna with substantial gain, such as the Channel Master 4228. As Meintel Sgrignoli & Wallace explain, use of an antenna with gain helps to ensure that the measured power levels (after line loss) are high enough to permit accurate measurements at all channel ranges. MSW Engineering Statement, ¶ 60.

Since the Commission has assumed that consumers will "exert similar efforts" to receive digital signals as they have always done for analog signals, tests should continue to be conducted at 30 feet (for two-story homes) and 20 feet (for one-story homes). For similar reasons, and as discussed in detail above, the Commission should not permit testing to be done of *indoor* antennas. *See* MSW Engineering Statement, ¶ 61.

B. As with Analog Testing, Signal Strength Tests are the Best Way to Determine Whether Households Can Receive Digital Signals Over the Air

Next, the Commission asks (NOI, ¶ 14) whether it should recommend use of objective signal strength -- or some other metric -- to determine whether a household can receive an over-the-air digital signal. As it turns out, empirical data from thousands of site tests show that signal strength is a very good proxy for availability of digital service. (With new improvements in receivers, signal strength will be an even better proxy for digital service in the near future.) Notwithstanding the digital "cliff effect," a digital picture quality test would pose problems similar to those that led both Congress and the FCC consistently (since 1988) to reject a picture quality test for determining whether a household is "served" by an over-the-air analog TV station. As Congress and the Commission have recognized, it is preferable to have a highly reliable -- although necessarily imperfect -- objective standard than a highly "political" and easy-to-abuse subjective standard.

For *analog* television, it is well-established that Grade B intensity is an excellent proxy for the ability to achieve successful reception. More recently, the results of site tests in cities across the United States show that the FCC's minimum digital strength values (such as 41 dBu for Channel 38) are an excellent proxy for successful *digital* reception.

As explained in the Engineering Statement of Meintel, Sgrignoli & Wallace, engineers have conducted thousands of field tests -- in 15 separate measurement programs across 12 different cities – to evaluate both (i) whether the ambient *field strength* was above the FCC-specified minimums and (ii) if so, whether it was possible to achieve successful *reception* at that location. MSW Engineering Statement, ¶ 64. Engineers developed a statistic called the "System Performance Index": the percentage of sites with signal levels above the FCC-defined minimums that also successfully achieved DTV reception. In essence, this statistic measures how well digital signal strength functions as a proxy for the ability to receive a high-quality picture.

Importantly, the "System Performance Index" percentages achieved in the tests done from 1994 through 2001 are undoubtedly much *lower* than would be achieved if the same tests were done today. The reason is that the receivers used for the tests done from 1994-2001 were much less sophisticated than later generations of receivers, and in particular than the much-improved fifth generation receivers, which do far better at resolving difficult multipath problems. *See* MSW Engineering Statement, ¶¶ 65-66. Since DIRECTV and EchoStar can easily incorporate higher-quality receiver chips into their set-top boxes going forward, the real-world System Performance Index figures will be even higher in the future.

In any event, *even with relatively low-quality, now-obsolete receivers*, the average System Performance Index across the 15 digital testing programs was 90%. MSW Engineering Statement, ¶ 68. In the small minority of instances in which ambient digital field strength was above threshold but successful reception was not achieved, the causes are usually multipath or interference problems. *Id.* But since the latest generation of receivers do so much better at handling difficult reception environments, even this low rate of reception problems will decline substantially during the period (starting in May 2006) when digital testing is authorized for purposes of SHVA/SHVERA.

NAB anticipates that some commenters may urge use of a "picture quality" test instead of a signal strength test. While it is true that a small group of highly-trained and experienced engineers have both measured field strength *and* evaluated digital picture quality for purposes of evaluating competing digital television systems (such as 8-VSB vs. COFDM),[17/] **evaluating**

[17/] In the testing done in Charlotte for the Grand Alliance, engineers evaluated the picture quality achieved with *analog* signals. Nevertheless, the SHVA provides for a strictly objective signal strength test for over-the-air analog reception. The fact that picture quality tests are done

whether digital reception has been achieved by watching the picture on a screen nevertheless requires subjective judgments. As Meintel, Sgrignoli & Wallace explain, while a DTV set often displays a blank (or blue) screen when there is a reception problem, at times a DTV picture may suffer from "blockiness" or sometimes a freeze frame. MSW Engineering Statement, ¶ 70. While a small group of highly-trained engineers have counted such "impairments" in tests conducted during the digital planning process, determining whether a momentary event counts as an "impairment" is necessarily a subjective assessment, just as with analog television. *Id.*

To complicate matters further, DTV receivers often use "error concealment" (such as repeating information from the previous frame) that can hide the errors on static portions of the picture -- so that the "lost packets" may or may not be visible on the screen. *Id.* For all of these reasons, assessing whether the picture is "flawed" at a given moment, and counting the total flaws, calls for subtle and complicated judgment calls. *Id.*

Because the results of field testing by experienced engineers show that objective signal strength is an excellent proxy for the availability of a high-quality digital picture, there is no *need* for such subtle judgments to be made in field testing at individual households for purposes of SHVA/SHVERA. And there is no way that such difficult subjective judgments could be made neutrally and accurately -- much less consistently -- by a wide variety of testing personnel around the country, with far less experience in making such judgments, and often with the homeowner standing nearby urging the tester to give the picture a "bad grade" so that the household will be deemed unserved. Since objective signal strength is such a good proxy for

---

by engineers in evaluating a television delivery method therefore does not mean that a picture quality test should be done in the field for testing individual households.

successful reception -- even with early-generation receivers -- the Commission should continue to rely on objective signal strength as the legal standard. It should reject a *subjective* standard, which the DBS industry used in the 1990s to sign up millions of illegal subscribers for distant signals.

While there exists an additional *objective* method (beyond signal strength) that could be used to evaluate picture quality, the Commission should not endorse it: as Meintel Sgrignoli & Wallace explain, this method is highly complex and requires specialized equipment. MSW Engineering Statement, ¶¶ 72-73.

C. The Longley-Rice Model Is Very Accurate At Predicting Whether Signal Strength At Particular Locations Is Above Or Below DTV Minimums, But There Are Practical Issues About Use Of A "Digital ILLR" Model For SHVERA Purposes

In principle, the Longley-Rice model does an excellent job of predicting whether particular locations can receive a signal above the DTV minimums. And should it be necessary -- after the digital transition is complete -- to predict whether particular households can receive DTV signals, the Longley-Rice model is the best candidate for that task. (Of course, there may be no need to do that, because digital local-to-local may be universal at that point.)

Despite Longley-Rice's demonstrated excellence as a predictive model, in the *short run*, there are serious concerns about allowing DBS companies to use Longley-Rice as a basis for delivering distant digital signals based on the claimed absence of a digital signal over the air. These concerns arise, for example, from the fact that very few translator stations have channel assignments, much less fully functioning facilities, and that many full-power stations will not be subject to digital testing until July 2007 or later. These concerns no doubt lie behind Congress' decision not to permit DBS companies to serve subscribers based on a prediction about the lack of an over-the-air digital signal. In the interim, however, satellite companies can rely on the *analog* ILLR model to deliver distant digital signals to subscribers who are predicted to be unable to receive an analog station affiliated with the relevant network.

1. The Results of Thousands of Digital Signal Tests Show that Longley-Rice is a Highly Accurate Model

In its Notice of Inquiry, the Commission states that the Longley-Rice model is "an accurate, practical, and readily available model for determining signal intensity at individual locations when used with analog signals." (NOI, ¶ 15). That conclusion is amply justified: as the data developed in the Commission's prior SHVA proceedings attests, Longley-Rice has an excellent track record of predicting whether particular locations receive a signal above Grade B intensity.

As detailed in the Engineering Statement of Meintel, Sgrignoli & Wallace, a similar conclusion applies to use of Longley-Rice to predict digital signal strength. In recent years, engineers have performed thousands of digital signal intensity tests in 12 different U.S. cities. Meintel, Sgrignoli & Wallace have analyzed these digital data using the same principle the Commission applied in analyzing analog data in its 2000 ILLR Order: that is, they compared the Longley-Rice *predictions* for these locations with the actual *measured signal strength* for the same locations. In each case, the question was whether the prediction -- or the measurement -- was above or below the noise-limited contour values specified in the Commission's rules for DTV signals.

These real-world empirical data show that the Longley-Rice model does very well when judged against actual measurements of digital signal strength. Across all channel bands, Longley-Rice correctly predicted 94.4% of the time that the signal would be above (or below) the DTV minimum. MSW Engineering Statement, ¶ 76. Indeed, the relevant percentage is even higher -- 96.9% -- if one includes instances of *underprediction*, where the Longley-Rice model predicts that the location is below the minimum signal strength but it is measured to be above that level. (DBS companies and their customers, of course, *benefit* from this type of "error," while local TV stations are hurt by it.)

2. Although Longley-Rice Will Work Well Once the Digital Television System is Fully Operational, There Are Major Practical Concerns About Giving Legal Effect Now to Predictions of Digital Field Strength

As discussed above, the Longley-Rice model does an excellent job of predicting whether a particular location can, or cannot, receive an over-the-air signal above the DTV minimums over the air. Because of the continuing rapid evolution of digital broadcasting, however, and in light of Congress' decision to exempt many transmitters from having their digital signal strength evaluated when they cannot be expected to broadcast in digital, there are serious concerns about whether a "digital ILLR" model makes sense in the near term.

As Meintel Sgrignoli & Wallace explain, the next several years can be divided into two distinct periods: the *long term*, after the transition from analog to digital TV broadcasting is complete, and the *short term*, before that date. MSW Engineering Statement, ¶¶81-85. In the long term, when the transition to digital is complete, there *may* be a need for a digital Longley-Rice model to predict which households are "unserved" over the air. (There may *not* be any such need, because the DBS firms may have rolled out digital local-to-local service in all markets by then.)

As discussed above, DIRECTV has already announced aggressive plans to deliver more than 1,500 local stations in high-definition by 2007, beginning with stations in 24 markets (covering 45% of U.S. television households) this year. As DIRECTV's digital local-to-local coverage increases, distant digital signals -- and the need to predict local digital signals -- will become irrelevant, given the "if local, no distant" rule adopted by SHVERA.

EchoStar has not yet announced its detailed plans for digital local-to-local service. But so long as the Commission does not create incentives for EchoStar to declare large numbers of urban and suburban subscribers to be "unserved" over the air -- as it unlawfully did with analog -- EchoStar is likely to be forced to match its cable and DBS competitors in ramping up digital local-to-local service.

In short, this pro-consumer competition to offer local digital and HD signals will make both measurement and prediction of over-the-air signal strength irrelevant in a growing number of markets – and perhaps in all 210 markets by the time the transition is complete. And given EchoStar's past abuse of analog predictive models -- including its manipulation of the analog ILLR model with three improper factors designed to treat additional customers as "unserved" -- there is special reason for caution in creating a predictive model that would, as a practical matter, be used only by the company with the worst compliance record in the television industry. *See CBS Broadcasting Inc.*, 265 F. Supp. 2d at 1248-50 (describing unlawful manipulations of analog ILLR model by EchoStar).

In any event, here are some of the practical problems with applying the Longley-Rice model in the near future:

a. <u>Congress has postponed the date on which many broadcast stations can have their digital signals evaluated</u>. In the SHVERA, Congress recognized that it would be unfair to punish a station for failing to deliver a digital signal when it cannot reasonably be expected to do so. The SHVERA therefore includes an unavoidably complex system for deciding which stations are eligible to have their digital signals tested. 39 U.S.C. § 339(a)(2)(d)(vii) ("Trigger Dates for Testing"). The schedule includes the following timetable:

April 30, 2006 trigger date for testing:

- stations in the top 100 markets that (i) have chosen a tentative digital television service channel designation that is the same as the station's current digital television service channel, and (ii) that have not been granted a testing waiver pursuant to 39 U.S.C. § 339(a)(2)(d)(vii); and
- stations in the top 100 markets that have been found by the Commission to have lost interference protection.

July 15, 2007 trigger date for testing:

- stations in the top 100 markets that (i) have chosen a tentative digital television service channel designation that is different from the station's current digital television service channel, and (ii) that have not been granted a testing waiver pursuant to 39 U.S.C. § 339(a)(2)(d)(vii); and
- stations below the top 100 markets that have not been granted a testing waiver pursuant to 39 U.S.C. § 339(a)(2)(d)(vii).

Unknown future trigger dates for testing:

- ***translator stations*** will be subject to testing "one year after the date on which the Commission completes all actions necessary for the allocation and assignment of digital television licenses to television translator stations," except to the extent that the translator station has been granted a testing waiver pursuant to 39 U.S.C. § 339(a)(2)(d)(ix);
- ***full-power stations that have obtained testing waivers*** will continue to be exempt from testing for as long as the Commission continues to approve six-month extensions of an existing waiver.

MSW Engineering Statement, ¶ 85.

* * * * * * * * * * * * * * * * * *

To protect stations from a draconian loss of local viewers due to circumstances beyond their control, Congress has thus created a complex and -- necessarily -- somewhat unpredictable schedule for when particular stations can have their digital signal evaluated. (Since Congress barred *site testing* of certain station's digital signals, it would be equally improper to subject them to Longley-Rice predictions about those same signals.) There is serious reason to doubt whether a system so complex and rapidly-changing will lead to accurate results.

b. Those stations *exempt* from having their digital signals evaluated would need analog predictions in the interim. Under the Satellite Home Viewer Act and its successors, a household is unserved if it cannot receive a signal from *any* tower transmitting a station affiliated with the relevant network (say, ABC). Thus, if a household can receive a signal from a *translator* that retransmits the signal of an ABC station, the household is not eligible to receive a distant ABC station. *See* 17 U.S.C. § 119(d)(2)(A) (definition of "network station" includes "any translator station or terrestrial satellite station that rebroadcasts all or substantially all of the programming broadcast by a network station"). Similarly, if the household can receive a signal from a nearby ABC station in a different market, it is ineligible to receive a distant ABC station, whether or not the household can receive the station in its own DMA over the air. *See CBS Broadcasting Inc.*, 265 F. Supp. 2d at 1249 (describing improper exclusion by EchoStar of signals from stations in other DMAs).

As described above, Congress has decreed that certain towers may not have their digital signal evaluated until some time in the future: stations in markets 101-210 may not be evaluated before July 2007 at the earliest; translator stations may not be evaluated until a much later date;

and individual stations that receive temporary testing waivers from the Commission will have varying dates on which their digital signals are subject to evaluation.

This schedule creates a practical conundrum: if a station cannot be tested -- and therefore could not have its digital signal evaluated in the Longley-Rice model -- how is the station to be treated in the testing or prediction process? Meintel Sgringnoli & Wallace give the example of household near the Shenandoah Mountains in Virginia that is predicted to (and does) receive an analog signal of a Washington, D.C. network affiliate from a translator station. Congress has directed that the digital signal of this translator station cannot be evaluated until some future date – which is only fair, since the translator does not even have a digital channel assignment as of now. How should this translator tower be treated for purposes of tests or predictions?

What Congress must have had in mind is that, if a station is not yet eligible to have its digital coverage evaluated, one must look to the station's *analog* service. Thus, when a *test* is performed, the engineer must look both for the digital signal of any affiliate of the relevant network (say, ABC) and *also* for the analog signal of any tower in the area that is not yet subject to digital testing. This is the logical way to give stations "credit" for their coverage when they have been excused -- for the time being -- from digital testing. MSW Engineering Statement, ¶ 89.

The need to conduct both digital and analog tests, and to determine which stations are and are not subject to digital testing, will add further complexity to the task of conducting tests starting in April 2006 pursuant to SHVERA. Adding these additional twists to a *nationwide predictive model*, however, may take matters over the edge.

c. **<u>Station channel assignments are still in flux</u>**. The "repacking" process, designed to place all digital TV stations in Channels 2-51, is ongoing. And under the timetable announced last week in MM Docket No. 03-15, not until August 2006 will the Commission issue a Notice of Proposed Rulemaking proposing a new DTV Table of Allotments, which will then be subject to comment by the public and potentially to significant revision by the Commission thereafter. The continuing movement by stations to different channels will add a further challenge to both the testing process and to application of the Longley-Rice model.

D. Even If Congress Does Not Alter the Act to Make Subscribers Eligible Based on Predictions about Digital Service, the Law Already Authorizes Signups for Distant Digital Signals Based on the *Analog* ILLR Model

The "three-dimensional chess" quality of a digital Longley-Rice model applied in the current transitional environment no doubt explains why Congress elected to rely on field measurements, rather than a predictive model, to decide whether individual subscribers can receive distant digital signals based on the claimed absence of an over-the-air digital signal. That is, when a *test* is conducted, knowledgeable people on the ground (such as station personnel) can at least try to ensure that the tester knows the relevant facts. But when a satellite carrier runs a computerized predictive model at its headquarters, there is little a station can do to protect itself.

At the same time, in an ideal world, it is desirable to be able to rely on a predictive model as well as measurements. Fortunately, the Act allows DBS companies to sign up subscribers for distant digital signals -- based on the well-defined *analog* ILLR model, with which both broadcasters and DBS companies have years of experience. That is, under pre-existing law, as extended by SHVERA, the DBS firms can retransmit a *digital* signal of (for example) an ABC station to a household that is predicted to be unable to receive an analog signal of an ABC station over the air. While imperfect, there is an undeniable logic to this interim rule, since the goal of the digital transition is, after all, to replicate TV stations' analog coverage areas. In any event, both DBS companies and their subscribers will continue to enjoy the convenience of relying on a predictive computer model to determine eligibility to receive distant digital signals.

E. "Fifth Generation" Receivers, Which The DBS Firms Can Build Into Their Set-Top Boxes, Do Much Better In Handling Difficult Reception Environments

Finally, the Commission asks (¶ 7) about the differences in reception ability between different types of digital TV sets and digital receivers. We provide the Commission in this section, and in the accompanying engineering report, with extensive data responsive to that question.

Even though the tests were done with early-generation receivers, real-world field tests show that the availability of a signal above the DTV minimum signal strength is a very good proxy for ability to receive a high-quality DTV picture. *See* above. Conveniently, that already high success rate will shoot up still further in the near future: *fifth generation* DTV receivers achieve much better performance in the difficult reception environments (such as multipath) that contributed to the small number of reception failures in past tests. Since satellite subscribers regularly replace their set-top boxes for a wide variety of reasons, and since DirecTV and EchoStar firms are currently in the process of switching their customers to new set-top boxes to use MPEG-4 compression, it will be a simple matter for most DBS customers to be able to take advantage of this advanced technology.

We anticipate that some commenters may urge that the Commission must assume use of outdated receivers because some subscribers have such receivers. But as previously discussed, *even with early-generation receivers*, DTV signal intensity is a very good proxy for actual DTV reception -- making the "which generation of receivers" issue of little relevance. Moreover, while the DBS companies have tens of millions of subscribers, the number of DBS subscribers who have *high-definition* receivers is only a tiny fraction of the DBS companies' total subscriber base. And even among those households, only a few will be unable (even with an older receiver) to translate an above-minimum field strength into a digital picture.

* * * * * * *

In response to the Commission's questions, NAB's outside engineers have provided a detailed description of advances in digital receiver technology. *See* MSW Engineering Statement, ¶¶ 93-103. In brief, there have been several generations of 8-VSB receivers during the digital era, with the most important advances being realized in the fifth generation boxes. As a recent paper published in an IEEE journal discusses, the new generation of receivers conquers difficult reception problems -- such as multipath -- that confounded earlier generations of receivers. *See* T. Laud, M. Aitken, W, Bretl, & K. Kwak, *Performance of 5th Generation 8-VSB Receivers*, 50 IEEE Transactions on Consumer Electronics, No. 4 (Nov. 2004) (Attachment 3 hereto). This remarkable improvement has been seen both in lab tests (against so-called "ensembles" of heavily-multipathed signals) and in field tests, in which engineers have returned to extremely difficult environments (such as Rosslyn, Virginia) that were part of the small minority of locations that, using previous generations of receivers, had adequate signal strength but nevertheless had reception problems. The improvements have been so dramatic that previous critics of the 8-VSB system, such as Sinclair Broadcasting, now strongly endorse that system based on the results of testing of fifth-generation receivers. MSW Engineering Statement, ¶ 114 (quoting Sinclair representatives).

F. The Addition of an Extra Clutter Factor for DTV Would Make the Longley-Rice Model Less Accurate in Predicting Whether Households Can Receive the Minimum DTV Field Strength

The Commission also asks (NOI, ¶ 7) whether it should add an extra "clutter" factor to the standard digital Longley-Rice model. As Meintel Sgrignoli & Wallace explain, the Longley-Rice model is partially based on actual field measurements, and thus *already* takes clutter into account to a significant degree, because clutter affects real-world field measurements. MSW Engineering Statement, ¶ 77. In any event, as the Commission found in 2000, whether a special "clutter factor" will improve the accuracy of the Longley-Rice model is a question that can and should be addressed by *empirical* data. *In Re Establishment of an Improved Model for Predicting the Broadcast Television Field Strength Received at Individual Locations*, First Report and Order, FCC 00-185 (May 26, 2000).

Since no predictive model can achieve 100% accuracy, *see* NOI ¶ 15 n.14, the criteria for evaluating whether a predictive model is functioning well are (1) whether it achieves a high level of accurate predictions and (2) whether its errors are roughly balanced between overpredictions and underpredictions. In evaluating the *analog* ILLR model in 2000, the Commission found that adding a clutter factor for analog UHF channels was desirable, because the model was otherwise somewhat tilted towards overpredictions. On the other hand, the Commission found that adding a clutter favor for analog VHF channels would make it *less* accurate by tilting it towards underpredictions. *In Re Establishment of an Improved Model for Predicting the Broadcast Television Field Strength Received at Individual Locations*, First Report and Order, FCC 00-185 (May 26, 2000).

Meintel Sgrignoli & Wallace have performed a similar analysis of the Longley-Rice model for *digital* signals, looking at the small percentage of predictive errors to determine how they split between over- and underpredictions. MSW Engineering Report, ¶¶ 78-79. The analysis shows that the model is already in balance *without* the addition of any additional clutter factor. A special clutter factor would put a thumb on one side of the scale and therefore reduce, not enhance, the accuracy of the Longley-Rice model for digital signals.

Conclusion

For these reasons, the Commission should make recommendations concerning testing and prediction of over-the-air digital signals in accordance with the suggestions discussed above.

Respectfully submitted,

/s/

Marsha J. MacBride
Benjamin F.P. Ivins
Kelly Williams
NATIONAL ASSOCIATION OF BROADCASTERS
1771 N Street, N.W.
Washington, D.C. 20036

June 17, 2005

ATTACHMENT 1

Before the
Federal Communications Commission
Washington, D.C. 20554

In Re Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act	))))	**ET Docket No. 05-182**

Engineering Statement of Meintel, Sgrignoli, & Wallace Concerning Measurement and Prediction of Digital Television Reception

1. At the request of the National Association of Broadcasters, the undersigned have prepared this engineering statement for consideration by the Commission in connection with its inquiry into available methods for measuring and predicting the ability of households to receive over-the-air digital television signals. The credentials and experience of the undersigned are set forth in the attached as **Exhibit A**. As detailed there, we have, among other things, conducted thousands of digital signal intensity tests in a variety of locations around the United States; helped to design and test state-of-the-art digital receivers; and developed industry-standard computer-based analysis applications and specialized software concerning RF propagation. We attempt in this Engineering Statement to provide the Commission with the benefit of this experience. We begin with a short discussion of pertinent background facts, before addressing the specific issues raised by the Commission.

INTRODUCTION AND BACKGROUND

Analog Television and the Beginnings of the Digital Era

2. Black and white analog television, commonly referred to by reference to its origins with the National Television Systems Committee (NTSC), was adopted as the standard in the United States in 1941. The analog color TV system was adopted in December 1953.

3. In 1987, 58 broadcast organizations petitioned the Commission to develop high definition television (HDTV) standards in the United States to remain competitive with new, emerging technologies. The FCC immediately created a multi-industry advisory committee to study this topic, calling the group the Advisory Committee on Advanced Television Services (ACATS).

4. After six years of competition and at the suggestion of the ACATS group, a consortium of companies banded together in May 1993, calling itself the Grand Alliance (GA). Over the subsequent two and one-half years, a digital television system was developed and thoroughly examined, with prototype hardware evaluated in both the laboratory and the field. In November 1995, the ACATS group recommended this system to the FCC as the next television system for the United States. From this work, the Advanced Television Systems Committee (ATSC) developed and documented a standard **(Ref 1)**.

Commission Implementation of the Transition to Digital Television, Based on the Assumption of Properly-Oriented Rooftop Receive Antennas

5. In December 1996, the FCC adopted the ATSC system as the new digital television standard for the United States **(Ref 2)**, thus officially beginning the transition from the old analog NTSC system to the new digital ATSC television system. In April 1997, the FCC issued its rules for digital operation **(Ref 3)**. The Commission also made public its first set of channel allocations, lending each U.S. broadcaster a second 6 MHz channel for digital television transmission **(Ref 4)** for the purpose of replicating the station's analog NTSC service area. The next year, in February 1998, the Commission issued a revised set of allocations with additional and revised rules **(Ref 5)**.

6. The Commission's procedures for allocating digital TV channels were based on a set of "planning factors" concerning DTV transmission and reception. (We discuss these

planning factors in greater detail below.) Of particular importance to the current inquiry, the FCC's planning factors assume a *typical* receive site with predetermined antenna gain and directivity, antenna height nine meters above ground level (AGL), antenna dipole factor, downlead loss, receiver noise figure, DTV signal-to-white noise (SNR) threshold of errors (≈ 15 dB), and desired-to-undesired (D/U) interference ratios (between DTV and NTSC signals as well as between DTV and other DTV signals).

7. As discussed in greater detail below, these planning factors for the DTV receive antenna setup are reasonable based on readily available, and moderately priced, equipment available to consumers in the marketplace. For around $40, for example, a household can purchase an excellent rooftop antenna (the Channel Master 4228) with gain figures for UHF and high-VHF channels (on which almost all network affiliates will operate) above those specified by the Commission in its DTV planning factors. And for a similarly modest expenditure, consumers can acquire a low-noise amplifier (LNA) or "preamplifier," which will enable consumers to *exceed* the DTV reception performance assumed in the digital planning factors.

8. The FCC's planning factors, first described in the April 1997 Sixth Report and Order (**Ref 4**), were further clarified in Bulletin 69 (**Ref 6**) from the Commission's Office of Engineering and Technology (OET). OET Bulletin 69 is a set of guidelines on "Longley-Rice Methodology for Evaluating TV Coverage and Interference" to aid broadcasters.

9. In determining the service area of *analog* TV channels, the Commission has always assumed use at the receive site of a properly-oriented *rooftop* antenna with significant gain. (We understand that the Satellite Home Viewer Act of 1988 and its successors have done so as well.) When the Commission sought to replicate stations' current analog service areas in its assignments of *digital* channels, it likewise assumed use of such a rooftop antenna. Had the

Commission instead assumed use of an indoor antenna (or of a low-quality or improperly-oriented rooftop antenna), the digital channel allocation process, and the Commission's determination of the amounts of power authorized to be used by stations, would have been entirely different. For a station to be expected to deliver a digital signal viewable via an *indoor* antenna at a distance of 50 miles from the tower, for example, it would need to transmit at an enormously higher power level than the Commission has authorized. In turn, the Commission's calculations concerning avoidance of interference would have been radically different if it had assumed that DTV stations would transmit at the extraordinary power levels needed to replicate analog coverage areas via use of an indoor (or poor-quality outdoor) antenna for digital reception.

10. The digital terrestrial standard is described in the FCC rules and regulations **(Ref 7)**. Full service U.S. broadcasters, as part of the DTV build-out schedule, are now implementing terrestrial DTV, which consists of standard definition and high definition video signals, 5.1 channel (5 full bandwidth, 1 low bandwidth subwoofer) compact-disc quality audio, and the capability of a plethora of ancillary data services. Digital low-power TV (LPTV) and translators were first addressed in the Commission's rules as of September 2004. However, television translators and LPTV broadcasters have not yet received licenses for additional DTV channels. (Even after receiving channel assignments, translators and LPTV stations will need time to build out their digital facilities.) As discussed below, these and other timing issues create a serious challenge in implementing a digital predictive model for individual households in the near future.

The Repacking Process

11. During the transition from analog to digital television, broadcasters were given an extra 6 MHz channel for transmitting their digital ATSC DTV signal. However, it was always known that stations would be required to return one of their two channels in the future. As the transition enters its final phase, the broadcasters must not only give up the extra channel, but must also squeeze their digital channels into the range that the Commission has designated as the "core" spectrum, namely Channels 2-51.

12. Spectrum repacking is the process through which TV stations determine whether to keep their current DTV channel (if it resides in the core), move back to their original analog channel (if it resides in the core), or find a new channel in the core. Spectrum re-packing began in earnest in January 2005, and is currently moving forward as broadcasters are selecting their final DTV post-transition channels.

Very Few Network Affiliates Will Broadcast Digital Signals on Low-VHF Channels

13. As of today, there are roughly 43 broadcast stations with a low-VHF digital channel. It appears that very few broadcasters want to keep these low-VHF channels, and it is expected that fewer than 30 of the approximately 1,700 TV stations will broadcast in digital on low-VHF channels. For purposes of the present inquiry, of course, the stations of interest are Big-4 (ABC, CBS, Fox, NBC) network affiliates. Currently, only about 27 network affiliates have digital channels in the low-VHF range, and that figure may decrease, or at most increase slightly, as the repacking process proceeds.

The ATSC Transmission System

14. The ATSC data transmission system is digital Vestigial Side Band (VSB), and includes two modes: a trellis-coded 8-VSB mode for terrestrial use and a high data-rate 16-VSB mode for cable use. The ATSC system is described in **References 8, 9, and 10**.

15. The ATSC's 8-VSB system transmits 19.4 Mbps over a 6 MHz RF channel utilizing vestigial modulation (lower RF sideband is missing). All FCC-licensed power measurements use the *average* power of the VSB signal, and are made across the *entire* 6 MHz channel bandwidth. A small CW pilot is added to the randomized, noise-like signal that has very similar characteristics to white Gaussian noise.

16. An MPEG-transport stream of 188-byte data packets is inserted into the VSB exciter, with one MPEG packet placed within one VSB transmission data segment. Forward error correction is employed in the form of a cascaded trellis-coded modulation scheme (2/3-rate, 4-state, Ungerboeck code) with a Reed-Solomon coding scheme (187, 207, t=10) that can correct up to 10 byte errors per data segment (packet).

17-22. [Intentionally omitted.]

The FCC Planning Factors For Digital Service

23. The planning factors recommended by ACATS were first described in the FCC's Sixth Report and Order (**Ref 4 Appendix A**). These factors are for use with the Longley-Rice predictive software for determining NTSC and DTV *outdoor* field strengths regarding service coverage and interference evaluation. The Sixth Report and Order describes the methodology for predicting field strengths using terrain models. OET Bulletin No. 69 (**Ref 6**) further clarified the implementation and use of the Longley-Rice software methodology for evaluation of *outdoor* TV coverage and service.

24. As indicated above, the FCC's goals are to *replicate* the analog NTSC Grade B coverage area with the new digital ATSC system. The Grade B coverage area (Section 73.688 of the FCC rules) of a TV station is determined using the FCC(50, 50) statistical field strength curves (Section 73.699 of the FCC rules). The distance to the NTSC Grade B contour in a given direction from the transmitter is determined by the field strength value shown in **Table 1** for the geometric mean frequency within each of the three television bands. The DTV field strength values in **Table 1** are then used with the FCC(50, 90) curves to determine the maximum effective radiated power (ERP) in a given direction that matches the NTSC Grade B distance (but keeping the DTV ERP values between 50 kW and 1 MWatt for UHF, between 3.2 kW and 316 kW for high-VHF, and between 1.0 kW and 100 kW for low-VHF). This then defines the DTV area subject to calculation. The Longley-Rice radio propagation model is then used to make NTSC and DTV predictions of the RF field strength at specific geographic points based on the elevation profile of terrain between the transmitter and any reception point. The predicted field strength values for both NTSC and DTV within their respective contours determine whether each system is expected to deliver service at a particular receive site.

25. The Longley-Rice computer software that supplies these predictions is published in an appendix of an NTIA Report **(Ref 11)**. Subsequently, G.A. Hufford described modifications to the software code in a memo dated January 30, 1985. This modified code is referred to as Version 1.2.2 of the Longley-Rice model, and it is the version used by the FCC for spectrum allocation evaluation.

26. OET Bulletin No. 69 was eventually updated with certain new parameters, and published in a revised version in February 2004 **(Ref 6)**. Certain adjacent channel desired-to-

undesired (D/U) interference ratios were corrected. These new values were also reflected in the FCC rules, and are the ones that will be described in this report.

Receive Site Planning Factor Values

27. To evaluate TV service coverage, the Longley-Rice predictive software determines whether a particular location is expected to receive a signal of a certain specified minimum (or "threshold") field strength. The field strength minimums are, of course, different for analog and digital, and also depend on which channel band is being considered. As the Commission observes in the NOI, "[f]or DTV stations, the counterparts to the Grade B signal intensity standards for analog television stations are the values set forth in Section 73.622(e) of the Commission's rules describing the DTV noise-limited service contour." NOI, ¶ 2. (We understand that the Act incorporates by reference the specific dBu levels, by channel band, that are set forth in the Commission's rules.) The minimum values, as set forth in the rules, are as follows:

Channel Numbers	Channel Label	Defining NTSC Field Strength Using F(50, 50) Curves (dBμV/m)	Defining ATSC Field Strength Using F(50, 90) Curves (dBμV/m)
2-6	Low VHF	47	28
7-13	High VHF	56	36
14-69	UHF	64	41

Table 1 NTSC and DTV defining field strengths for use in FCC spectrum allocation planning

28. Note that the NTSC defining field strengths are determined using the traditional F(50, 50) statistical field strength prediction curves, while DTV defining field strengths are determined using F(50, 90) curves: that is, the curves predict a given field strength (or higher) for a given transmitter effective radiated power (ERP), and a given transmitter antenna height

above average terrain (HAAT) that occurs at a given distance from the transmitter at 50% of locations and 90% of the time. (The analog field strength figures, however, include an extra 6, 5, and 4 dB for the three channel groups which raise the time fading factor from median (50%) to 90 percent; in effect, then, the analog system is intended to deliver an acceptable picture 90% of the time at 50% of locations.)

29. In addition, while the two VHF bands have fixed minimum required field strength values for their entire respective frequency bands based on their geometric mean frequency, the FCC chose to modify UHF band values with a correction factor. This correction represents the dipole factor, which takes into account the fact that for a given RF field strength, the voltage output from a ½-wave dipole antenna (terminated in a matched impedance) decreases with increasing frequency.

30. The NTSC field strengths in **Table 1** are the same as those used over the years. However, the DTV field strength values in **Table 1** are determined from the DTV planning factors identified in **Table 2**, and statistically characterize the equipment -- including outdoor antenna systems -- used for home reception. That is, they represent a "typical" DTV receive site system in the modern era.

Planning Factor	Symbol	Low VHF	High VHF	UHF
Geometric Mean Frequency (MHz)	F	69	194	615
Geometric Mean Wavelength (m)	λ_m	4.3	1.5	0.5
Geometric Means Wavelength (feet)	λ_{ft}	14.3	5.1	1.6
Dipole Factor nominal (dBm-dBμ)	K_d	-111.8	-120.8	-130.8
Dipole Factor adjustment	Ka	None	None	See text
Thermal Noise (dBm/6 MHz)	N_t	-106.2	-106.2	-106.2
Antenna Gain (dBd)	G	4	6	10
Antenna Front/Back Ratio (dB)	FB	10	12	14
Downlead Line Loss, 50' cable (dB)	L	1	2	4
System Noise Figure (dB)	N_s	10	10	7
Required Carrier Noise (dB)	C/N	15	15	15
Calculated Minimum Rx Power (dBm/6 MHz)	P_{min}	-81	-81	-84

Table 2 FCC's planning factors for a typical DTV receive site.

31. The minimum required DTV field strengths can be obtained from the planning factors in **Table 2** by viewing the block diagram in **Figure 1**. The equation for the minimum required field strength E at the input to the antenna can be created by starting at the DTV receiver input and working back to the antenna. The equivalent noise floor at this point is the kTB noise (i.e., the theoretical amount of noise in a matched resistor) plus the noise figure (NF1) of the receiver (*i.e.,* the excess noise that the imperfect receiver adds to the theoretical kTB noise). The minimum required S/N ratio for the 8-VSB system is added to the noise floor, providing the minimum required signal level at the input of a DTV receiver for error-free operation. The coaxial cable downlead loss (L) is then added, providing the minimum required signal power at the output of the antenna. The dipole factor (Kd) is then taken into account, which consists of two components: the conversion between voltage to power as well as the dipole antenna conversion between field strength and voltage. The resulting field strength is the minimum required level at the input of a ½-wavelength dipole antenna for error-free DTV operation. However, the FCC's planning factors account for a typical receive site that uses a directional outdoor antenna with directivity and gain (Ga) that is then subtracted, indicating that

less field strength is needed when an antenna with gain is employed. The following equation represents the DTV field strength calculation, along with the UHF receive site parameter values:

$$E\ (dB\mu V/m) = (Nt + NF1) + SNR + L + Kd - Ga$$

$$E\ (dB\mu V/m) = (-106.2\ dBm/6\ MHz + 7\ dB) + 15.2 + 4 + 130.8 - 10 = 40.8\ dB\mu V/m$$

32. The above value of 40.8 dBμV/m, which the FCC rounds to 41 dBμV/m, is for Channel 38 (*i.e.*, 615 MHz) only. In OET Bulletin 69, the minimum field strength at other UHF channels is determined by applying the dipole factor. (As mentioned, for purposes of SHVERA, Congress has "locked in" 28, 36, and 41 dBu as the relevant field strengths for the three channel bands.)

33-35. [Intentionally omitted.]

The Commission's Planning Factors
For Digital Reception Equipment

36. In its Notice of Inquiry, the Commission asks for comments on a number of issues relating to consumer equipment setups. We address those issues here.

37. **Rooftop versus indoor antennas**. The Commission asks whether the digital reception standard should be premised on a *rooftop* antenna or instead on an *indoor* antenna. NOI, ¶ 7. For several reasons, the logical choice is to assume a rooftop antenna.

38. First, the reception characteristics of indoor antennas are much worse than those of outdoor, rooftop antennas. As a recent research paper confirms (**Ref 12**), indoor antennas have much less gain -- and in some cases actual losses as compared to a dipole -- while good outdoor antennas offer substantial gain, in line with the Commission's planning factors. Also, because indoor antennas are placed at a lower height (sometimes below ground) and behind walls, their lower inherent gain (or loss) characteristics are exacerbated. *See* NOI, ¶ 20 ("indoor-mounted antennas will generally receive weaker signals than outdoor-mounted antennas"). In

addition, indoor antennas generally have little or no directivity and therefore they are more susceptible to reception problems from both multipath and interference. They are also affected by the movements of people near the antennas, which can abruptly change the antenna's reception pattern.

39. Because of these many ways in which rooftop antennas are superior to indoor antennas, households have long used rooftop antennas to achieve over-the-air reception. In fact, many rural viewers have placed large (high gain) over-the-air antennas *higher* than rooftop level, on small towers near the household. These tower setups not only provide more signal level (because of higher gain and higher elevation) but also reduce multipath effects with greater antenna directionality.

40. A second reason rooftop antennas are the logical choice is this: the households at issue are those of satellite subscribers -- and satellite reception antennas (usually called "satellite dishes") can only be used outdoors, typically on a rooftop. An "indoor" satellite antenna would simply not function. Since satellite antennas must be located outdoors, and usually on the roof, there is no reason over-the-air antennas cannot be similarly located.

41. Third, the entire process of allocating digital channels to TV stations, of determining their coverage area, of replicating analog coverage areas, and of assessing the power levels at which the stations should operate, are all critically based on the assumption of a rooftop over-the-air reception antenna. As the Commission correctly observes in its NOI, the minimum DTV field strengths for the noise-limited contour "presume that households will exert similar efforts to receive DTV broadcast stations as they have always been expected to exert to receive analog NTSC TV signals." NOI, ¶ 6. Broadcasters are building an multibillion-dollar digital

broadcast system premised on rooftop antennas, and it would be a fundamental change in engineering principles -- with very large economic consequences -- to reverse course now.

42. **Proper vs. improper antenna orientation**. The Commission also asks whether it would be appropriate to assume that the over-the-air antenna is properly oriented to achieve the best reception from the station in question. NOI, ¶ 7. For reasons similar to those just discussed, the Commission should assume proper orientation.

43. First, as with the rooftop-vs.-indoor issue, a DBS household gets no satellite reception unless its dish is *precisely oriented* towards the carrier's geosynchronous satellite. Holding the household's over-the-air antenna to the same expectation appears reasonable. Second, as discussed above, the Commission's entire effort in developing its digital television assignments has been grounded in the assumption of properly-oriented rooftop antennas for reception of digital television signals.

44. Of course, in many markets TV towers are (nearly) co-located, making it possible to orient a *fixed* rooftop antenna accurately towards all of the network affiliate towers in a particular market. This is particularly true for viewers that are some distance from the transmitter locations because the farther the viewer is from the transmitter, the *difference* in bearing angles for the various stations become smaller. In general, many markets have essentially co-located facilities which makes the orientation of the receive antenna a simple matter. Currently, about 83% of the television markets with four network affiliates (112 of 135 markets) have essentially co-located transmitter sites. In these markets, a single antenna oriented in the general direction of the transmitter sites should be sufficient for good digital television reception. To the extent that towers are located in different directions in other markets, local electronics installers may offer a special, fixed antenna that is designed to receive signals from

two different directions. These antenna systems were developed over the years to allow customers to receive signals from adjacent markets or stations within the same market with disparate tower locations. Typically, these antenna systems consist of two receive antennas that are combined with a simple 3-dB hybrid combiner. This allows a receive antenna system that is directional in the bearings of the desired signals without the need for re-orienting the antenna when changing channels.

And when those solutions are unavailable to a viewer, manufacturers have long offered reasonably priced rotors that enable a rooftop antenna to be moved to achieve the best orientation for a particular station. In fact, today rotors are available with advanced features, including presets for particular stations as well as remote control operation. For example, the Channel Master Model 9521A allows the consumer to program the rotor controller to respond to the infrared (IR) commands from their TV set's remote control. The rotor controller receives these channel commands and then actuates the rotor to the appropriate bearing for the channel requested by the TV set remote control. Thus, the rotor automatically orients for the consumer without the need to operate the rotor manually. This makes the antenna orientation experience appear seamless to the viewer.

Table 3 illustrates some of the available rotor units.

Manufacturer	Model	Special Features	Cost
Pacific Custom Cable	200-600		$95.00
Pacific Custom Cable	200-603	Remote Control	$105.00
Channel Master	9521	Remote Control with 69-channel memory	$69.95
Centron	AR-500XL	Remote Control with 12-channel programmable memory	$69.95
GEMINI	OR360	Heavy Duty Automatic Antenna Rotator	$49.95
Hy-gain	AR-35		$69.95
JVI	MAR160		$54.95
Magnavox	M61415		$49.95
Radio Shack	15-1245	Separate remote controller ($54.99 extra)	$74.99
Warren Electronics	32-9015		$59.95
Antennacraft	TDP2		$94.88
Yaesu	G-450A	Handles larger weight loads then the others above	$249.00

Table 3 Antenna rotors.

45. **Antenna gains**. The Commission's DTV planning factors assume antenna gains of 4 dB for low-VHF, 6 dB for high-VHF, and 10 dB for UHF. These assumptions are realistic. As recently tested by engineer Kerry Cozad of Dielectric, for example, the measured Channel Master 4228 antenna offers gain figures for high-VHF digital signals and for UHF digital signals that exceed those specified in the planning factors (**Ref 12**). As Mr. Cozad's paper shows, the Channel Master antenna achieves gains of about 14 or 15 dB for most UHF channels, while the planning factors call for a gain of only 10 dB for UHF. For high-VHF, the paper shows that the Channel Master antenna achieves gains of about 8 or 9 dB, compared to the assumption in the planning factors of only 6 dB of gain. Even for low-VHF -- a channel range in which very few network affiliate stations will broadcast in digital -- the Channel Master antenna offers gains nearly as high as those specified in the DTV planning factors (the slight deficiency in the gain values at low-VHF can easily be overcome with an LNA). The Channel Master antenna is available from a variety of vendors for between $38 and $50. Further information can be found at www.winegard.com/products.htm.

46. Another antenna to consider is the Winegard Square Shooter SS-1000 consumer antenna. This new high-VHF and UHF antenna exhibits good gain and front-to-back characteristics despite its aesthetically-pleasing design and compact size of 16" W x 16"H x 4" D. The antenna can easily attach inconspicuously to the side of a wall, or even act as an extension to a satellite dish (*e.g.*, it meets DirecTV and Dish Network's wind load requirements). The 4.5 dB reported gain across the UHF band is below the FCC planning factor, but can be easily be increased using an external LNA. Or, the related Winegard Square Shooter 2000 can be used; it is the same antenna design, but has an *internal* broadband 12-dB amplifier that boosts the signal (equivalent net antenna system gain averaging about 15 dB across the UHF band), lowers the effective system noise figure, and minimizes any mismatch losses. The Winegard SS-1000 antenna is available from Solid Signal for $87.99 and the SS-2000 is available for $98.99. *See* www.solidsignal.com/search_results.asp?main_cat=0&search_crit=square+shooter&SiteREF=SSCOM. Further information can be found at www.channelmaster.com/home.htm.

47. **Front-to-back ratio**. The DTV planning factors assume an antenna front-to-back ratio of 10, 12, and 14 dB for low-VHF, high-VHF, and UHF, respectively. The Channel Master 4228 rooftop antenna does considerably better than the planning factors assume, with a front-to-back ratio of roughly 25 dB for VHF and 18 dB for UHF. Based on manufacturer's published specifications, the Winegard Square Shooter SS-1000 and SS-2000 antennas have 16 dB of front-to-back ratio at Channel 32 (with an average of 15 dB across UHF band).

48. **System noise figure**. The Commission's planning factors assume a receive system noise figure of 10 for VHF channels and of 7 for UHF channels. These VHF and UHF noise figure values plus the accepted 8-VSB system's 15 dB white noise threshold for errors predict minimum receiver input levels (also called sensitivity values) of –81 dBm and –84 dBm,

respectively. Although there is little published data about receiver noise figures for DTV receivers, use of a low-noise amplifier (discussed in the next section) effectively reduces the overall noise level of the system.

49. **Use of low-noise amplifier**. Consumers can readily, and at modest cost, do much *better* than the DTV planning factors for receive sites by using a mast-mounted low noise amplifier (LNA), or "preamplifier," which boosts the signal before it is sent through the downlead cable into the consumer's home. **Figure 3** contains the block diagram of receive site system that uses an LNA to provide more margin for DTV reception. The equations, similar to the ones in **Figure 1**, illustrate how the minimum antenna input field strength can be calculated. The use of a preamplifier has three advantages. First, the preamplifier increases the received signal level before being attenuated in the downlead coaxial cable. Second, the preamplifier's low noise level effectively lowers the equivalent noise figure of the receive system since the LNA is an external device that can easily have a noise figure that is 4-7 dB *lower* than the DTV tuner. Finally, the preamplifier mitigates any impedance mismatch loss between the antenna and the DTV receiver (tuner). These benefits allow an LNA to easily add at least 12-15 dB (and often significantly more) of *effective* gain to a receive system, even with a "below-par" receive system that would not otherwise meet the FCC planning factors.

50. Low-noise amplifiers are readily available at moderate expense for mounting on the rooftop antenna mast. Many work with both the VHF and UHF bands, while others are optimized for just the UHF band. Because of their benefits and low cost, preamplifiers are commonly used to boost reception at locations when signal strength may be close to the margin. Four common LNAs that are currently on the market were tested in the laboratory, and the performance test results are summarized below in **Table 5**.

Parameter	Channel Master Titan 2	Winegard AP-8700	Blonder-Tongue CMA-Uc	Radio Shack 15-2507
Average UHF Gain	23 dB	19 dB	18 dB	30.1 dB
Average UHF Noise Figure	3 dB	3.5 dB	4 dB	4.8 dB
Cost	$56.99	$78.58	$164.00	$59.99

Table 5 LNA “preamps”.

51. Signal amplification is available in values between 18–30 dB and the noise figure value between 3–5 dB. The availability of these preamplifiers (and similar ones from other manufacturers) provides a substantial "cushion" against the possibility of any losses not specifically accounted for in the planning factors.

52. [Intentionally omitted.]

53. **Downlead line loss**. As the planning factors recognize, a certain degree of signal loss occurs as the signal moves from the rooftop antenna through a cable to the household's television equipment. The planning factors assume losses of 1 dB for low-VHF, 2 dB for high-VHF, and 4 dB for UHF. Based on published data for standard RG-59 and RG-6 coaxial cable, these figures are conservative. RG-6 coaxial cable, which is commonly used in satellite installations, offers other benefits as well: improved shielding to help prevent extraneous signals (such as signals generated within the home) from leaking into the system. A brief summary of different coaxial cable types is in **Table 6**. Note that the loss numbers stated below are for the worst case -- Channel 51 -- within the digital core (Channels 2-51).

Manufacturer Model #	Belden 1186A	Belden 1152A	Belden 1189A	West Penn 819	West Penn 6350	Units
Type	RG-59	RG-6	RG-6	RG-59	RG-6	-------
Impedance	75	75	75	75	75	Ohms
Attenuation (UHF CH 69)	2.9	3.3	2.7	3.1	2.3	dB/50'

Table 6 Coaxial cable types

The most expensive cable shown above costs about $25 for the typical 50' cable lengths assumed in the FCC planning factors. Thus, it is reasonable to assume that consumer setups will be at least consistent with the DTV planning factors for downlead line loss.

54. **Conclusion**. In short, consumers can acquire, at relatively modest expense, reception equipment that is substantially better than what is assumed by the DTV planning factors. In determining how to measure the availability of an over-the-air digital signal at a satellite subscriber's household, the Commission should therefore assume that, in the words of the Notice (at ¶ 6), that "households will exert similar efforts to receive DTV broadcast stations as they have always been expected to exert to receive NTSC analog TV signals," including the use of directional rooftop antennas with significant gain. For households where signal strength is close to the margin, the optional availability of a modestly-priced preamplifiers provides a significant buffer against any signal losses not accounted for in the planning factors.

Procedures For Measuring
Signal Intensity At Individual Households

55. In its Notice of Inquiry, the Commission asks whether its existing procedures for measuring signal intensity at individual households for purposes of the Satellite Home Viewer Act (and successor legislation), which are set forth in Section 73.686(d), are appropriate for measuring digital signal strength. NOI, ¶ 12-13. As the Notice explains, the existing procedure

calls for measurements to be taken at five locations near the household, with an antenna raised to nine meters above ground level.

56. The Commission's existing procedures for measuring analog field intensity at particular locations in Section 73.686(d) are a modest variant of the standard engineering protocol used worldwide for verifying coverage, verifying transmit antenna radiation patterns, and developing propagation algorithms used in planning for allocation of broadcast station spectrum. With certain minor adjustments, the procedures set forth in Section 73.686(d) will work well for measuring *digital* signal strength.

57. The first necessary adjustment is obvious: when testing for the availability of a digital signal, the minimum field strength values will be different (*e.g.* 41 dBu for UHF) than for analog signals. In addition, as the Commission observes, unlike with analog, there is no visual carrier for digital signals, so measuring the visual carrier is not an option. NOI, ¶ 13.

58. A second necessary adjustment is this: the instrument used to measure DTV signal strength in the field must be different from the ones currently used to measure the narrow-band NTSC video signal. Use of existing analog NTSC field strength meters will *not* be sufficient, since they do not measure the entire DTV signal power, which utilizes almost the entire 6 MHz channel (DTV has an equivalent noise bandwidth of 5.381 MHz). The Commission defines DTV signals by their *integrated average power* in a 6 MHz bandwidth, whether describing transmitter power output (TPO), its effective radiated power (ERP), or its field strength at the input to a receive antenna or the input power to a DTV receiver.

59. A power measurement instrument must therefore be used that can tune to the center of the DTV RF channel and measure this integrated power over 6 MHz. This instrument may take the form of a common swept-tuned spectrum analyzer that has a variety of small IF

bandwidths from which to select (small compared to the 6 MHz DTV signal bandwidth), and can easily integrate (sum up) the total DTV power across 6 MHz (*e.g.*, by use of band power markers). Examples of such instruments are the Agilent E4402B or Rhode & Schwarz FSH-3 spectrum analyzers. However, a low-noise amplifier should be included prior to the power measurement instrument to ensure that the receive system measurement sensitivity (antenna, coaxial cable, and power measurement device) is sufficient to accurately measure the weakest of signals (i.e., 41 dBuV/m). Alternatively, the power measurement device can take the form of a calibrated field strength meter that has one fixed narrow bandwidth, but can be *swept* across the entire 6 MHz band -- integrating the power in each IF sub-band as it sweeps to produce the correct total power. An example of such an instrument is the Z-Technology R507 that is routinely used for measuring DTV field strength in coverage testing. Finally, such a power measurement device could take the form in the future of a calibrated fixed tuned receiver that has an IF bandwidth equal to the 6 MHz DTV channel. But under no circumstances should a power measurement device simply measure the pilot power in a narrow band, and then calculate the total power from this value. This is due to the fact that in the field, multipath can create sharp peaks and valleys in the DTV spectrum that, if one is measuring only a narrow band, could easily cause measurement errors in the ± 10-dB range.

60. In addition, the testing should ***not*** be done with a simple half-wave dipole but with a calibrated directional antenna with characteristics consistent with the planning factors, such as the Channel Master 4228 or the Winegard Square Shooter SS-2000. Based on our practical experience from thousands of field tests, use of an antenna with gain helps greatly in ensuring that the power levels (after line loss) are sufficiently high to permit accurate measurements at all channel ranges. Also, a calibrated directional antenna should be utilized

rather than a simple ½-wave dipole antenna since a ½-wave dipole antenna has very little directivity and no front-to-back ratio protection as would be needed per the FCC allocation planning assumptions. Significant measurement errors could easily occur from multipath signals from the rear as well as from nearby interfering analog and digital stations if a simple ½-wave dipole antenna were used.

61. The height of the receiving antenna above ground level should be as set forth in the existing regulation: 20 feet for one-story residences, and 30 feet for two-story residences. The Commission should not permit testing to be done of *indoor* antennas, a step that would be inconsistent with the premise of the DTV transition that households will make the same efforts to receive digital signals that they have historically made to receive analog signals. In addition, indoor testing would be impossible to standardize.

Use of Signal Strength as a Proxy for Picture Reception

62. In ¶ 14 of the Notice of Inquiry, the Commission inquires about whether *objective* signal strength, or instead some other metric, should be used to determine whether a household can receive an over-the-air digital signal. As we discuss here, an *objective* signal strength test is an excellent proxy for availability of digital service and will avoid the serious technical and practical problems with implementing a *subjective* test – whether for analog or digital service.

63. With both analog and digital television, the availability of a signal level above the minimums set forth in the rules is a very good proxy for ability to receive a picture. (With digital, subject to certain exceptions, if one gets a picture at all, it is a high-quality picture.)

64. There exist abundant empirical data showing that the ability to receive a digital signal above the thresholds specified in the Commission's rules (*e.g.*, 41 dBu for UHF) is in fact

a strong indicator of ability to receive a high-quality digital picture. Between 1994 and 2001, engineers conducted thousands of field measurements – in 15 separate measurement programs for different digital transmitters, across 12 different cities – to evaluate both (i) whether a signal above the minimum field intensity was present at a particular location and (ii) if so, whether the system achieved successful *reception* at that location. For present purposes, the key statistic from these tests is the "System Performance Index": the percentage of sites with signal levels above the FCC-defined minimum field strength value that had successful DTV reception. This statistic is relevant for the Commission's current purposes, namely determining whether signal strength is a good proxy for the ability to receive a picture. (Again, with digital, it will generally be true that if one can receive a picture at all, it will be a high-quality picture.)

65. Before discussing the results of these studies, an important qualification is in order: the receivers used for *all* of these tests were, by present standards, relatively primitive. As discussed in more detail below, this fact is significant, because newer-generation receivers are far better than the receivers used in these historic tests at handling difficult reception environments, and in particular at resolving multipath problems. Thus, if the same tests were done today, one can be confident that the System Performance Indices for these locations would be higher still.

66. The DTV receiver used in 11 of the 15 field testing programs was the original Grand Alliance prototype ("blue rack") receiver. This hardware is now known to have significantly worse equalizer performance than either fourth generation receivers (widely available today) or the fifth generation receivers discussed in detail below. As documented in recent years **(Ref 13, 14)**, the Grand Alliance receiver had an equalizer range of only –3 to +22 usecs compared to the ±50 usec of the fifth generation receiver. It also did not apply data-

directed equalization to the decision-feedback section that handled multipath delays from +3 to +22 usec, and thereby had very poor dynamic performance in this echo delay range. Also, the Grand Alliance receiver did not handle multipath with amplitudes greater than 3 dB (70%), whereas recent 5th generation chip sets easily handle 90 – 95% and even handle 0 dB (100 %) echoes within a certain delay range. Finally, the AGC speed of the Grand Alliance receiver was less than 10 Hz while most modern day DTV receivers utilize speeds greater than 100 or 200 Hz. The four testing programs that did *not* use the original Grand Alliance receiver utilized either a second generation VSB chip (two tests) or a third generation VSB chip (two tests). Not one of these 15 field tests employed a fourth generation (or later) VSB chip in the reference DTV receiver.

67. **Table 7** summarizes the System Performance Index results from the 15 digital field test programs conducted between 1994 and 2001 with these relatively low-quality receivers:

Station Call Letters	City of Testing	CH #	System Performance Index (%)
ACATS	Charlotte 1994	53	95.8
ACATS	Charlotte 1994	6	82.2
WRAL	Raleigh 1997	32	95.4
WGN	Chicago 1998	20	93.7
KICU	San Jose 1998	52	98.7
WCBS	N.Y. City 1998 & 1999	56	88.2
WFAA	Dallas 1999	9	96.1
WMVS	Milwaukee 2001	8	98.2
WHD	Washington DC 1997 & 1998	30	81.9
WETA	Washington DC 1997 & 1998	34	83.4
KOMO	Seattle 1998	38	78.1
KING	Seattle 1998	48	76.8
WKRC	Cincinnati 1999	31	91.9
KYW	Philadelphia 1999 & 2000	26	94.0
KMOV	St. Louis 2001	56	93.4
Average	-------	-------	**90.0**

Table 7 Field Test results from 1994 through 2001

68. As these results show, with low-quality, early-generation receivers, the average System Performance Index across these 15 testing programs was 90%. To the extent that the tests showed that a signal above the minimum was present but that reception was not

successfully achieved, the culprits are in most cases multipath or interference problems. But as discussed below, newer generation receivers do far better at handling difficult reception environments, including "concrete canyon" multipath problems (such as in Rosslyn, Virginia). With these higher-quality receivers – which the DBS companies can readily incorporate into their own set-top boxes – the System Performance Index will likely be even higher than the 90% figure from the tests several years ago.

69. The alternative to an objective signal strength test would presumably be some form of picture quality test. During the testing phase of the digital rollout, engineers have typically checked both signal strength and picture quality. But despite the well-known "cliff effect" for digital pictures, evaluating whether digital reception has been achieved by watching the picture on a screen nevertheless requires subjective judgments.

70. Ordinarily, the digital cliff effect causes a DTV set to either display a moving picture or a blank screen (or blue screen, in some cases). But there are times when the DTV signal is near threshold and occasional excursions below threshold occur, causing occasional (MPEG) "blockiness" or an occasional brief freeze frame. Determining whether this picture is acceptable or not is a subjective assessment, just as with analog television. What makes things even more difficult is the fact that DTV receivers often employ some form of error concealment in their decoder circuitry (such as repeating the macro block information from the last frame) that tends to hide the errors on static portions of the picture. Therefore, the exact MPEG packets lost may or may not show up on the screen for the test viewer, depending on the video content. Evaluating whether there is an unacceptable level of flaws in the picture therefore requires complex and subtle judgments.

71. Expecting difficult subjective judgments to be made fairly and accurately in the hotbed environment of a test at a subscriber's home is not realistic. Because the availability of a signal above the Commission minimums is such a good proxy for successful reception, the Commission should ensure a manageable testing process by continuing to rely on objective signal strength as the key test.

72. Another alternative – which we mention for the sake of completeness but do not recommend -- would be to rely on an additional objective test for assessing whether successful reception can be achieved. This method was developed during the ACATS lab testing at Advanced Television Test Center in Alexandria VA in 1995 (Ref 13). To determine if Bit Error Rate (BER) measurements could be used at ATTC to accurately determine threshold of visibility (i.e., visible errors, or TOV) rather than using expert observers (of the video), a subset of 11 different tests were performed using both methods of TOV determination. The results of comparing the subjective video and the objective BER indicated that TOV could be determined within ± 0.5 dB. Bit Error Rate (BER) was selected at ATTC rather than the preferred MPEG Packet Error Rate (PER) measurement because no third-party test equipment was available at the time of the ACATS testing.

73. Therefore, a professional VSB demodulator, with fifth generation decoder performance and packet error rate (PER) readout capability can accurately, quickly, and objectively determine TOV for a digital signal without having the DTV station go off the air, provided that an appropriate antenna and other test equipment are used. However, because of the added complexity of ensuring that such a test is done correctly, we do not recommend it.

Evaluating the Accuracy of the Longley-Rice Model in Predicting Whether Signal Strength at Particular Locations is Above or Below the DTV Minimums

74. The Commission states in its Notice of Inquiry: "We believe that the modified Longley-Rice is an accurate, practical, and readily available model for determining signal intensity at individual locations when used with analog signals." Based on our experience, we endorse that conclusion; Longley-Rice has an excellent track record of predicting whether particular locations will, or will not, receive a signal above the analog threshold (e.g., 47 dBu for low-VHF).

75. We present here extensive data showing that the same conclusion applies to Longley-Rice's performance in predicting digital signal strength. As discussed above, engineers performed thousands of digital signal intensity tests between 1994 and 2001 in 15 different testing programs in 12 different cities. We have analyzed 2,169 of these locations (those for which data could be analyzed in this time frame) using the same method described by the Commission in its 2000 ILLR Order, namely comparing the Longley-Rice predictions for these locations (*i.e.*, whether the household is predicted to be above or below the signal strength minimum) with the actual measured signal strength for the same locations (*i.e.*, whether the household was measured to be above or below the signal strength minimum).

76. The results show – with a large sample size – that the Longley-Rice model does well when judged against actual measurements. All told, the model correctly predicted that the signal would be above (or below) the noise-limited threshold at 2,047 locations out of a total of 2,169 (94.4%).

Evaluating Whether Addition of a Clutter Factor to the Digital
<u>Longley-Rice Model Would Make the Model More Accurate</u>

77. The Commission asks (NOI, ¶ 7) whether it needs to add an extra "clutter" factor to the standard digital Longley-Rice model. (The Longley-Rice model is in part based on actual field measurements (from land mobile measurements in Ohio and Colorado plus the original TASO data from the 1950s), and, to that extent, already takes clutter into account, without the need for a special clutter factor.) As the Commission recognized in 2000, whether a clutter factor will make the standard Longley-Rice model more accurate is an empirical issue. For example, in 2000 the Commission found that adding a clutter factor for analog UHF channels would make the model more accurate, but that adding a clutter factor for analog VHF channels would make it less accurate. *In Re Establishment of an Improved Model for Predicting the Broadcast Television Field Strength Received at Individual Locations*, ET Docket No. 00-11 (May 26, 2000). The Commission's finding was based on a review of the accuracy of the model – and the extent to which it "underpredicts" or "overpredicts" actual test results. No model of RF signal propagation will predict correctly 100% of the time, *see* NOI ¶ 15 n.14 ("the absolute intensity of broadcast signals at particular locations and at particular times cannot be precisely determined through predictive means, regardless of the predictive method used."). The goal is therefore to have a model that achieves high accuracy and whose errors are roughly balanced between underpredictions and overpredictions.

78. For the small percentage of cases (5.6%) in which the Longley-Rice model did not accurately predict whether the location would be above or below the noise-limited threshold dBu level, we have performed a similar "overprediction / underprediction" analysis of the Longley-Rice model. The results show that the model is already in balance without the addition of an extra clutter factor. The incorrect predictions (122 locations out of 2,169) were split

between 49 locations where the measured value was greater than the predicted and 73 locations where the measured value was less than the predicted value. Breaking the analysis down by TV-bands (low-VHF, high-VHF, and UHF) yields the following **Table 8.**

Band	Total Number of Sites Measured	Correct Predictions	Over Predictions	Underpredictions
Low VHF	93	96.8 %	0.0 %	1.1 %
High VHF	464	92.0 %	4.1 %	5.8 %
UHF	1,612	94.9 %	3.4 %	1.4 %
All Bands	2,169	94.6 %	3.4 %	2.3 %

Table 8 Comparison of Measured vs. Predicted Field Strength

(Note: Based upon 41dBu Threshold for UHF)

79. [Intentionally omitted.]

Challenges In Implementing a Digital Longley-Rice Model in <u>the Near Term for Purposes of the Satellite Home Viewer Act</u>

80. In a world in which matters have "settled down," Longley-Rice is an excellent predictive model, as discussed above. In the near term, however, the world of digital broadcasting has not settled down, but is in a state of rapid flux.

81. The Commission may wish to consider two eras in which the Longley-Rice model might be used for purposes of determining whether households can receive digital signals over the air: the *long term*, after the transition from analog to digital is complete, and the *short term*, before that date.

82. In the long term, when the transition from analog to digital television broadcasting is complete, there *may* be an unavoidable need for a digital Longley-Rice model to predict which households are "unserved" over the air by a station affiliated with the relevant

network. Whether there will be such a need depends, of course, on whether the DBS companies have then completed their rollout of digital local-into-local service in all 210 DMA. (Under SHVERA, we understand that once digital local-to-local is available in a particular market, the issue of over-the-air availability of digital signals becomes irrelevant. 47 U.S.C. 339(a)(2) ("Replacement of Distant Signals with Local Signals").

83. We understand that DIRECTV has already announced plans to deliver more than 1,500 local stations in high-definition by 2007, beginning with stations in 24 large markets (covering some 45% of U.S. television households) during 2005. Given competition in the industry, EchoStar may well follow suit.

84. Hence, there is an open question whether, at the end of the transition, there will be a need for a "digital ILLR" model to predict signal strength in any local markets. In the meantime, the FCC must report to Congress its views about whether to give legal effect *in the near term* to Longley-Rice predictions about whether particular households are, or are not, able to receive digital signals of network affiliates over the air.

85. In the *short term*, there are serious practical problems with applying the Longley-Rice model, including the following:

a. Congress has postponed the date on which many broadcast stations can be "tested" – or, presumably, have their digital service predicted by Longley-Rice. To avoid punishing a station for failing to deliver a digital signal when it cannot reasonably be expected to do so, Congress created a multistage timetable about when particular stations are eligible to be tested. 39 U.S.C. § 339(a)(2)(d)(vii) ("Trigger Dates for Testing"). The schedule includes the following:

April 30, 2006 trigger date for testing:

- stations in the top 100 markets that (i) have chosen a tentative digital television service channel designation that is the same as the station's current digital television service channel, and (ii) that have not been granted a testing waiver pursuant to 39 U.S.C. § 339(a)(2)(d)(vii); and
- stations in the top 100 markets that have been found by the Commission to have lost interference protection.

July 15, 2007 trigger date for testing:

- stations in the top 100 markets that (i) have chosen a tentative digital television service channel designation that is different from the station's current digital television service channel, and (ii) that have not been granted a testing waiver pursuant to 39 U.S.C. § 339(a)(2)(d)(vii); and
- stations below the top 100 markets that have not been granted a testing waiver pursuant to 39 U.S.C. § 339(a)(2)(d)(vii).

Unknown future trigger dates for testing:

- ***translator stations*** will be subject to testing "one year after the date on which the Commission completes all actions necessary for the allocation and assignment of digital television licenses to television translator stations," except to the extent that the translator station has been granted a testing waiver pursuant to 39 U.S.C. § 339(a)(2)(d)(ix);
- ***full-power stations that have obtained testing waivers*** will continue to be exempt from testing for as long as the Commission continues to approve six-month extensions of an existing waiver.

* * * * * * * * * * * * * * * * * *

In the context of a *predictive model*, this is a high level of complexity to manage.

b. Many stations that are *exempt* from having their digital signals evaluated would require analog predictions as an alternative. We understand that under the Satellite Home Viewer Act and its successors, a household is unserved if it cannot receive a signal from *any* facility transmitting a station affiliated with the relevant network (say, ABC). Thus, if a household can receive a signal from a *translator* that retransmits the signal of an ABC station, the household is not eligible to receive a distant ABC station. Similarly, if the household can receive a signal from a nearby ABC station, it is not eligible to receive a distant ABC station, whether or not the station happens to be in the same local market as the subscriber. Thus, if a household in a top-100 market can receive a digital signal from a CBS station over the air from a neighboring below-top-100 market, we understand that it is not eligible to receive a distant signal, whether or not it can receive the signal of the CBS station in the larger market.

As indicated, Congress has ruled that certain stations may not have their digital signal "tested" until some time in the future. This principle would presumably apply to any predictive model as well.

What does this "no testing / no prediction" rule mean as a practical matter? Consider the following example: suppose a household near the Shenandoah Mountains in Virginia is now predicted to (and can) receive an analog signal of a Washington, D.C. network affiliate from a translator station. Congress has decreed that the digital signal of this translator station cannot be "tested" until some future date – which is no surprise, since the station does not even have a digital channel assignment yet. How, then, should this translator station – which is currently transmitting only in analog – be treated for purposes of tests, and for purposes of predictions?

If a station is not yet eligible to have its digital coverage evaluated, one must give the station "credit" for its *analog* service area. Thus, when a *test* is performed at such a household, the tester must look for the digital signal of any (for example) ABC affiliate that might be available over the air, and *also* for the analog signal of any ABC affiliate that is not yet subject to digital testing. Since there is no digital signal to test, this appears to be the only logical method of giving stations "credit" for their coverage when they have been excused (for now) from digital testing. This result is also reasonable in that the eventual goal of the digital rollout will be to replicate the stations' current analog coverage areas.

The need for a constantly evolving "analog / digital hybrid" would therefore add still greater complexity to a nationwide predictive model about digital signals.

c. **<u>Station channel assignments are still in flux</u>**. The Commission and the broadcast industry are still in the midst of the "repacking" process and of other regulatory decisions that must be made before all stations settle on their final digital channel. Under the timetable announced last week in MM Docket No. 03-15, not until August 2006 will the Commission issue a Notice of Proposed Rulemaking proposing a new DTV Table of Allotments, which will then be subject to comment by the public and potentially to significant revision by the Commission thereafter. The continuing movement by stations to different channels will add a further challenge to both the testing process and to application of the Longley-Rice model.

86-91. [Intentionally omitted.]

92. This does not mean that the Longley-Rice model would have no role in determining subscriber eligibility for distant signals in the short run: we understand that the Act already provides that households predicted by the ILLR model to be unserved by over-the-air *analog* stations are eligible to receive distant digital stations. Thus, the convenience to both

consumers and satellite companies of the ability to rely on a predictive computer model will continue to be available.

Major Improvements in Fifth-Generation DTV Receiver Boxes

93. As discussed above, even with early and unrefined digital receivers, the results of thousands of real-world tests show that if a digital signal above the noise-limited threshold is available, it is possible to achieve successful (and high-quality) DTV reception 90% of the time. That figure will increase substantially in the near future: the results of extensive lab and field tests show that fifth-generation DTV receivers achieve far better performance in difficult reception environments (such as multipath) that contributed to the small number of reception failures in past tests. Since DBS customers regularly replace their set-top boxes for a variety of reasons anyway, and since the DBS firms are currently in the process of switching their customers to new set-top boxes for another reason (to use MPEG-4 compression),[1/] it will be a simple matter for most DBS customers to be able to take advantage of this advanced technology. Indeed, while the DBS companies collectively have tens of millions of subscribers, the number of DBS subscribers who have *high-definition-compatible* receivers is vastly smaller. Only DirecTV and EchoStar know these numbers for certain, but our understanding based on industry information is that they are very low.

94. Since the adoption of the DTV standard and the first DTV receivers appeared on the market in late 1998 and early 1999, there has been a new "generation" of VSB receiver approximately every two years. Using the information learned from DTV field tests and RF field

---

[1/] *See Sharper Vision For Local Ambitions: DirecTV Places a Big Bet on High-Definition Local Channels*, Multichannel News (May 23, 2005) ("Even DirecTV subscribers who already watch national HD programming will need new dishes and receivers using MPEG-4 (Moving Picture Expert Group) compression technology to receive local HD signals."); *EchoStar Wants to 'See the Playing Field' Before Making HDTV and Broadband Bets*, Satellite Week (May 9, 2005) (discussing expanded rollout of MPEG-4 in 2006 including production of new set-top boxes) data captures, novel equalization algorithms and advanced hardware architectures have been developed to handle severe multipath conditions. Using a variety of new simulation tools, much was learned about real-world propagation environments, which led to the departure from traditional implementation hardware. Along with improved equalization capability, synchronization (carrier, clock, & data packet) and tuner overload performance have been improved as well.

95. To appreciate where the DTV receiver has come from, a bit of history is helpful. The performance improvement of the various generations of DTV receivers has been significant **(Ref 15)**, as can be seen from **Figure 2**. The first- and second-generation receivers had very short pre-echo and post-echo equalizer ranges, limiting their performance to short ghosts. Note that any multipath that is *longer* than the equalizer hardware (equivalent to a tapped delay line) can only withstand an 18% ghost (i.e., D/U = 15 dB) under *strong* signal conditions before the data eyes are closed and the forward error correction (FEC) overrun. In weak signal conditions (i.e., low SNR), the situation is even worse in that a ghost *smaller* than 18% along in concert with the receiver's white noise can close the data eyes and cause errors. In addition to this liability, the early receivers did not use the predictive slice methodology for creating the sliced data-directed reference signal for the equalizer's ghost-canceling algorithm, thus weakening its performance.

96. The third generation recognized the need to handle longer ghosts, and therefore increased the equalizer *range* of post-echoes significantly ($\approx$ 45 μsec) and increased the Doppler tracking speed as well as the robustness. However, the pre-echo cancellation range was not increased.

97. Each generation of 8-VSB receiver has had major improvements, but the fourth generation offered the most significant improvement up to that time. In that generation, designers recognized that pre-echoes were just as important as post-echoes, and addressed the issue in part. (Pre-echoes occur when the main signal (direct path) is attenuated by terrain or some object, and a delayed version of the signal is stronger than the main signal.)

98. The most remarkable improvement, however, has come with the fifth generation receivers. The primary goal of the fifth generation receiver was improved indoor DTV reception with simpler antennas, minimal antenna positioning, and stable reception in the presence of moving people within the room. But as discussed below, the success of the fifth generation receivers in combating multipath also makes for superior results with outdoor antennas in areas with such reception challenges.

99. With fifth-generation receivers, the new equalizer architecture and algorithm enhance convergence under combinations of complex multipath and noise. Equalizer convergence to the correct final solution in a speedy manner has been improved by *starting* the process with an accurate estimate of the severely distorted channel response rather than starting from a fixed condition. Equalizer range has been significantly increased (*e.g.*, 50 μsecs) in *both* pre-echo and post-echo directions. LMS algorithms track moving (Doppler) multipath, aided by new zero-delay trellis decoders that provide fast, accurate error estimates for the equalizer algorithm from the 8-level data.

100. In both *lab* testing and *field* testing, the new fifth-generation VSB receiver has outperformed previous generations of DTV receivers.

101. In lab tests, the receiver has been confronted with severe multipath "ensembles" – recordings of RF transmissions in severe multipath environments. **Table 9** (from **Ref 15**) describes the various test ensembles, and the receiver performance of each generation.

Multipath Description	**2G**	**3G**	**4G**	**5G**
ATTC D	**Pass**	**Pass**	**Pass**	**Pass**
Brazil A	**Pass**	**Pass**	**Pass**	**Pass**
Brazil B	*Fail*	*Fail*	*Fail*	**Pass**
Brazil C	*Fail*	*Fail*	*Fail*	**Pass**
Brazil D	*Fail*	*Fail*	*Fail*	**Pass**
Brazil E	*Fail*	*Fail*	*Fail*	**Pass**
CRC-3	*Fail*	*Fail*	*Fail*	**Pass**
CRC-4	*Fail*	*Fail*	*Fail*	**Pass**

Table 9 VSB Generation comparison of multipath performance (multipath complexity increased from top to bottom)

102. When a fourth generation and fifth generation receiver were compared to each other in the lab using the 50 RF field data captures (from Washington, D.C. and New York City) recommended in the A/74 ATSC Receiver Performance Guidelines (**Ref 16**), the number of "reception failures" was cut by a factor of five.

103. The results of *field* tests are similarly encouraging. As reported in a paper published by the IEEE, when tested in the field in Washington, D.C. (MSTV), Ottawa Canada (Canadian Research Center), and Baltimore, MD (Sinclair Broadcast Group), similar dramatic improvements were documented between older generations and the new fifth generation VSB receiver. In Washington and Baltimore, engineers visited not *typical* receive sites but *known, difficult* receive sites – and nevertheless found that the fifth generation receiver was able to achieve reception where prior generations had failed.

Additional Information About Lab Testing Of Fifth Generation Receivers

104. Two early versions of fifth generation VSB decoder prototype chips were *independently* tested at Communication Research Centre (CRC) in Canada. These test results indicated a significant improvement in multipath performance.

105. In the Linx test (**Ref 17**), Linx Electronics Inc. (now owned by Micronas) sent an early prototype rack (FPGA circuit board encased in a 19" rack) to CRC to be tested in March 2002. The new prototype was a state-of-the-art receiver "designed to operate under severe channel degradation, including the possible nulling of the VSB pilot." The hardware contained a single-conversion consumer-grade tuner and a 10-bit A/D converter, along with an equalizer with "a unique configuration that enables proper equalization of strong ghosts while minimizing equalizer noise enhancement."

106. In the Zenith/LGE test (**Ref 18**), an early prototype rack was tested in September 2003. Likewise, it had significantly new architecture design that provided significant improvement in multipath cancellation. Similar tests were performed on the LGE unit as was done on the Linx unit. (The data is summarized below.)

107. While many tests were performed at the CRC labs, the following is a brief discussion of some of the pertinent tests that illustrate the primary improvements to the DTV equalizer and tuner performance.

108. The first comparison test is the white noise threshold test, which is performed with no impairments or signal distortion to the DTV signal other than added noise. Both prototype 5G units have the characteristically low white noise threshold of just over 15 dB, C/N that contributes to the needed sensitivity of DTV receivers The results are shown in **Table 10.**

Laboratory Test	Linx	LGE	Units
White Noise Threshold (TOV @ -53 dBm moderate level)	15.1	15.5	dB

Table 10 White noise performance

109. **Table 11** contains the multipath delay range test results for both prototype units. A significant increase in pre-echo range can be observed and compared to that offered in past VSB decoder generations, which is advantageous in hilly outdoor reception situations near the fringe of the coverage area as well as in near urban areas with no direct line-of-sight to the transmitter (e.g., "concrete canyons" of major downtown areas).

Laboratory Test	Linx		LGE		Units
-10 dB echo	-30	+39	-49	+49	usec

Table 11 Multipath delay range.

110. From **Table 12**, it can be observed that severe static multipath was handled by both prototypes, with minimal noise enhancement. Brazil E is a pathological case with three 100% ghosts, each 1 usec longer than the next, and exactly phased the same. It is supposed to represent the worst-case condition for a single-frequency network (SFN) at one particular location where three signals are exactly equal in strength. Excluding this special, unique case, only 3 or 4 dB extra signal strength is needed in the main DTV signal to overcome the noise enhancement in the equalizer due to these severe multipath conditions. Note that some of the C/N values are less than the white Gaussian noise threshold value. This is due to the definition used at CRC for describing the multipath. All carrier signal levels (signal plus pilot) are referenced to the *non*-ghosted signal, so when some of the multipath ensembles are created with very short ghosts, these short ghosts added in phase with the original signal to provide a greater signal level than without the ghost.

Laboratory Test	Linx	LGE	Units
Brazil A *Static* Ensemble plus white noise	15.3	15.6	C/N (dB)
Brazil B *Static* Ensemble plus white noise	19.4	18.6	C/N (dB)
Brazil C *Static* Ensemble plus white noise	12.5	14.4	C/N (dB)
Brazil D *Static* Ensemble plus white noise	13.0	14.5	C/N (dB)
Brazil E *Static* Ensemble plus white noise	22.8	23.8	C/N (dB)
Special Brazil C *Static* Ensemble plus white noise	12.6	16.5	C/N (dB)

Table 12 *Static* ensemble multipath plus noise performance.

111. Even when looking at *static* ensembles in **Table 13** where one of the paths is increased until TOV is reached, 0 dB (100%) ghosts are canceled in addition to the other "lower-level" ghosts. While the 4th generation VSB decoder chips performed significantly better than earlier receivers and work well in both outdoor and indoor reception venues with directional antennas, this level of 5th generation multipath performance has not been achieved in any of the previous generations of VSB chips.

Laboratory Test	Linx	LGE	Units
ACATS #286 Static Ensemble, strongest ghost level	0	0	dB
Modified Brazil C Static Ensemble, strongest ghost level	0	1.3	dB
Modified Brazil D Static Ensemble, strongest ghost level	0	0	dB

Table 13 Static ensemble multipath with one strong component performance.

112. Finally, NTSC-into-DTV interference testing was performed, as shown in **Table 14.** The co-channel interference results indicate an ability to reject the strong NTSC co-channel to about 3-4 dB, D/U (i.e., average DTV signal power to peak envelope sync NTSC power). The adjacent channel NTSC interference is rejected to values beyond the –40 dB, D/U value.

Laboratory Test	Linx	LGE	Units
Co-channel	3.9	3.1	dB, D/U
Lower Adjacent Channel	-43.7	-42.0	dB, D/U
Upper Adjacent Channel	-39.9	-41.8	dB, D/U

Table 14 NTSC interference rejection.

113. Note that the above tests at the CRC labs are 2-3 years old and made on *early* prototype receivers (designed with FPGA chips). Both chip manufacturers have since received their initial integrated chips and have stated that improvements over the prototype hardware have been achieved. Both companies also state that fifth generation VSB consumer products will be available on the market this year (2005), well before the April 2006 date on which the first testing of digital signals of a limited number of stations can begin under SHVERA.

114. Even critics of the 8-VSB system have been impressed with the 5G-receiver performance in severe multipath sites. After testing the 5G prototype in Baltimore at the same sites at which previous VSB decoders failed, Sinclair Broadcasting put out a press release on June 8, 2004 (**Ref 19**). "We are pleased to see the progress made by Zenith that will allow consumers to easily receive free digital television broadcasts in their homes. Broadcasters and consumers can now look forward to robust DTV service delivered over-the-air without having to subscribe to cable or satellite," said Nat Ostroff, Vice President, New Technology, Sinclair Broadcast Group. He went on to say: "[T]he innovations in the fifth-generation integrated circuit allow it to lock onto signals in severe multipath environments even when the ghosts have long delays or are larger than the main signal."

115. In a similar report, engineer, consultant, and author Mark Schubin in his "Monday Memo" on Thursday July 22, 2004 (**Ref 20**), was apparently not able to wait until the following Monday to publish what he had learned. He stated: "Count me among the believers in the fifth-generation LG/Zenith ATSC receiver! We just did a test this morning in my apartment, and I thought the news was too important not to release immediately. With a simple loop antenna, with no care in the positioning, we were able to pull in seven DTT stations reliably. When I say 'reliably', I mean not only that the pictures and sound were okay but that people could move

around the room and I could move the antenna around without causing any breakup. For the first time, I could receive signals (six channels) from an antenna atop my TV, where I normally get analog channels. I now believe that any "shmo" with reception conditions similar to mine can simply take the receiver out of the box, connect a cheap loop antenna, stick it wherever it looks good, and start to receive ATSC signals from all full-power, full-pattern stations."

Conclusion

116. As consumers transition from analog television to digital television, they will need to acquire a digital television receiver. For consumers who wish to receive local TV stations over the air, a modest investment in a good quality rooftop receiving antenna (and preamplifier, in appropriate cases), just as in the analog case, is a reasonable expectation.

117. The performance of digital television receivers continues to improve with each new generation of products that are introduced into the market. The reception capabilities of DTV receivers are continually improving and the performance of early-generation receivers, as evidenced by the field test results, was sufficient to achieve a 90% System Performance Index. It is reasonable to base the service eligibility criteria on the field strength of the received DTV signal, rather than attempting to conduct subjective quality judgments at thousands of homes. We can expect that this Service Performance Index will continue to increase as new products are introduced.

118. The measurement procedures contained in Section 73.686(d) can be modified easily to reflect proper measurement methodology for DTV signals. The change in measurement instrumentation is the most significant, and there is readily available equipment in the market that is capable of measuring the DTV signal power within the integrated 6MHz channel. Also, these measurements should be performed using an antenna with some gain and directionality in

order to minimize the effects of multipath and other impairments that may lead to inaccurate power measurements.

Respectfully Submitted:

_______/s/_______________
William Meintel

_______/s/_______________
Gary Sgrignoli

_______/s/_______________
Dennis Wallace

REFERENCES

1 ATSC Digital Television Standard, Document A/53B (with amendments 1 and 2), www.atsc.org.

2 Fourth Report and Order, MM Docket 87-268, FCC 96-493, Federal Communications Commission, December 24, 1996.

3 Fifth Report and Order, MM Docket 87-268, FCC 97-116, Federal Communications Commission, April 3, 1997.

4 Sixth Report and Order, MM Docket 87-268, FCC 97-115, Federal Communications Commission, April 3, 1997.

5 Memorandum Opinion and Order on Reconsideration of the Sixth Report and Order, MM Docket No. 87-268, FCC 98-24, Federal Communications Commission, February 17, 1998.

6 "OET Bulletin No. 69: Longley-Rice Methodology for Evaluating TV Coverage and Interference", FCC Office of Engineering & Technology, original version July 2, 1997, revised version February 6, 2004.

7 Code of Federal Regulations, Title 47, Telecommunications, Parts 70-79, Revised as of October 1, 2003.

8 "Digital Television Standard for HDTV Transmission: ATSC Standard", Doc. A53, Advanced Television Systems Committee, September 16, 1995.

9 "Guide to the Use of the Digital Television Standard for HDTV Transmission", Doc. A54, Advanced Television Systems Committee, October 4, 1995.

10 "VSB Tutorial", Richard Citta and Gary Sgrignoli, Montreux Symposium, June 12, 1997.

11 Report 82-100, "A Guide to the Use of the ITS Irregular Terrain Model in the Area Prediction Mode", by G. A. Hufford, A/G. Longley, and W.A. Kissick, US Department of Commerce, April 1982.

12 "Measured Performance Parameters for Receive Antennas used in DTV Reception", Kerry W. Cozad, Dielectric Communications, NAB Engineering Conference, April 2005.

13 "Digital Grand Alliance: Record of Test Results", submitted to Advisory Committee on Advanced Television Services by ATTC, CableLabs, ATEL, Task Forces on Digital Specific Tests (Audio & Field Tests Systems Subcommittee/Working Party 2, ACATS), MSTV, PBS, Hitachi, and IBM, October 1995.

14 "ATSC VSB Transmission System Notes", by Gary Sgrignoli, handout notebook used in VSB Seminars, 6/2/05 (see www.MSWdtv.com).

15 "Performance of 5th Generation 8-VSB Receivers", T. Laud, M. Aitken, W, Bretl, K. Kwak, IEEE Transactions on Consumer Electronics, Vol 50, No. 4, November 2004.

16 "A/74 ATSC Recommended Practice: Receiver Performance Guidelines", Advanced Television Systems Committee, June 18, 2004.

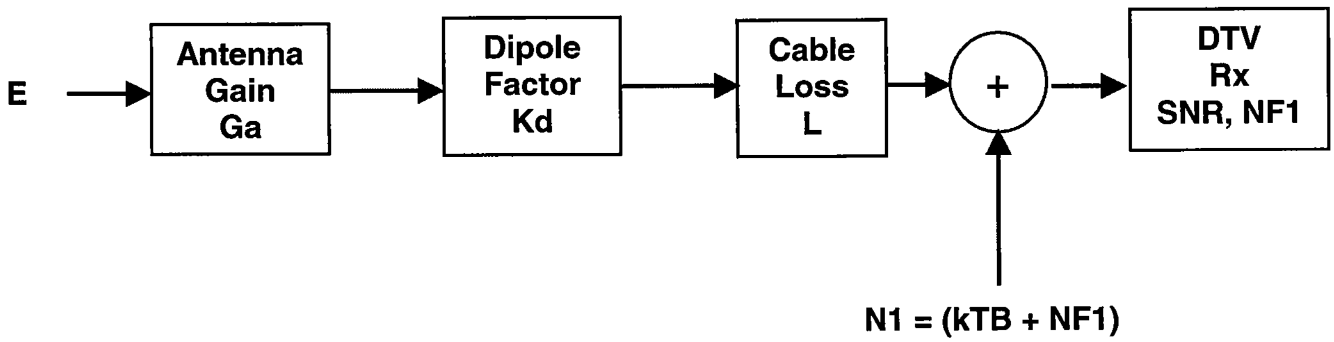
17 "Results of the Laboratory Evaluation of Linx ATSC Prototype Receiver with 8-VSB Modulation for Terrestrial Broadcasting", Final Report, Version 1.4, Communication Research Centre Canada, April 4, 2002 (see CRC website: www.crc.ca)

18 "Results of the Laboratory Evaluation of Zenith5th Generation VSB Television Receiver for Terrestrial Broadcasting", Report, Version 1.1, Communication Research Centre Canada, September 2003 (see CRC website: www.crc.ca)

19 Sinclair Broadcast Group press release, June 8, 2004 (see Sinclair website: http://www.sbgi.net/press/release_200468_72.shtml).

20 "Monday Memo", Mark Schubin, July 22, 2004 (Schubin website: http://www.digitaltelevision.com/mondaymemo/mlist/).

FIGURES



E (dBuV/m) = (kTB + NF1) + SNR + L + Kd - Ga

40.8 (dBuV/m) = -106 + 7 + 15 + 4 + 130.8 - 10

Figure 1 Block diagram of typical FCC receive site

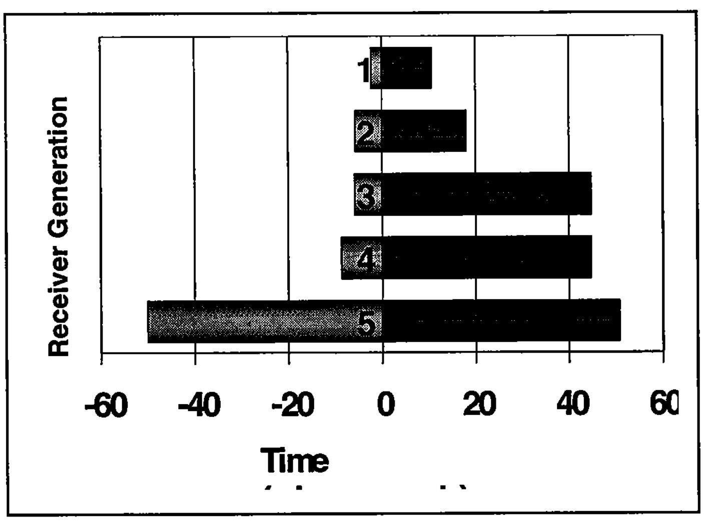


Figure 2a Equalizer delay improvement with generations

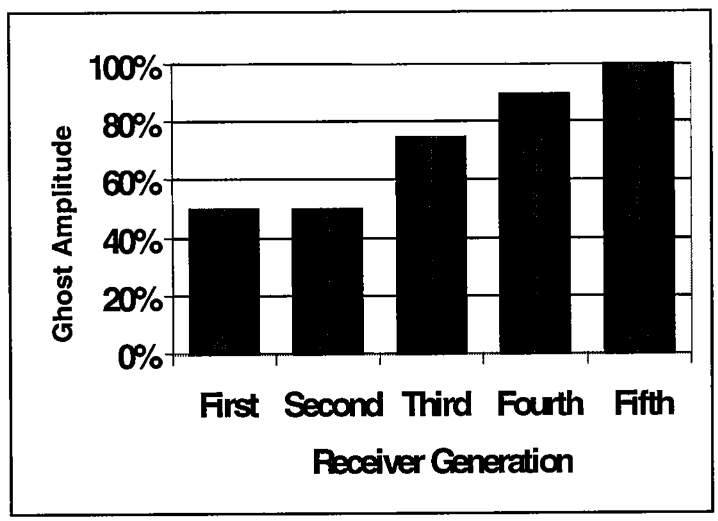
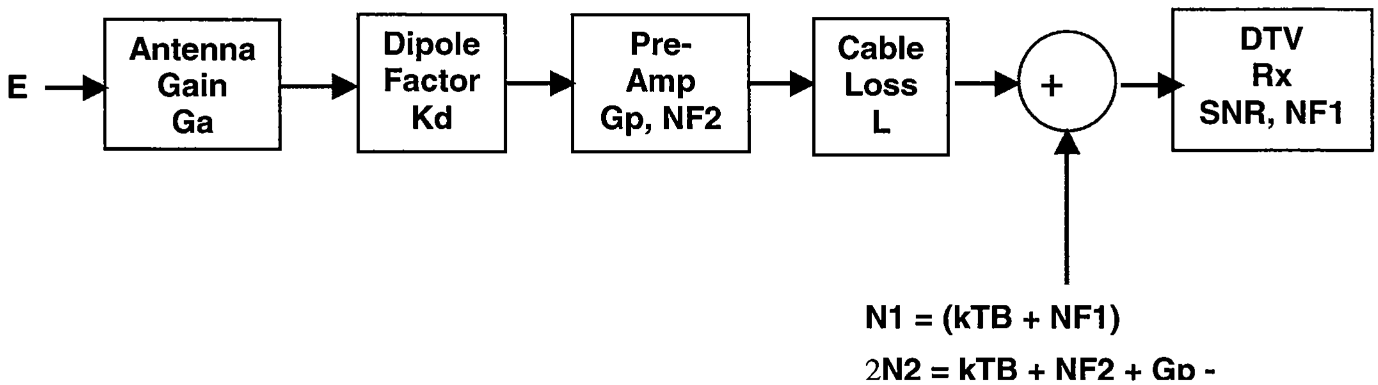


Figure 2b Equalizer amplitude improvement with generations



$$E(dBuV/m) = 10*Log[10^{0.1*(kTB+NF1)} + 10^{0.1*(kTB + NF2+Gp-L)}] + SNR + L - Gp + Kd - Ga$$

Figure 3 Block diagram of typical FCC receive site with added preamplifier

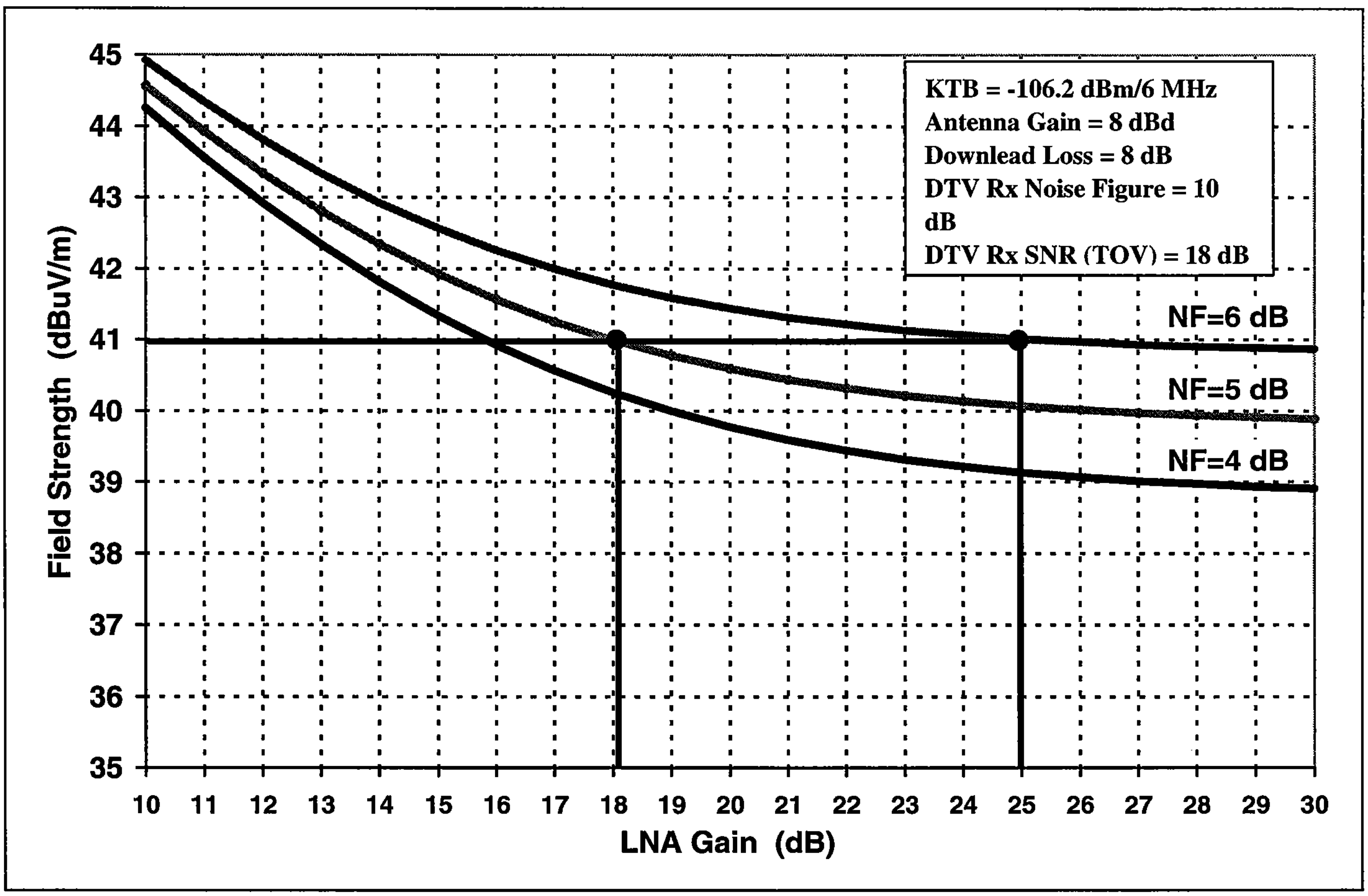


Figure 4 Field strength curves versus LNA gain for various noise figures

Exhibit A

Qualifications of the Firm
Meintel, Sgrignoli, & Wallace

William Meintel

Mr. Meintel holds a degree in Electrical Engineering and has 36 years experience in the communications field. After graduation, he was employed by the Federal Communications Commission, first as a field engineer and then in the Mass Media Bureau's Policy and Rules Division. While in Policy and Rules, he served as the division's computer expert and directed the development of several major computer modeling projects related to spectrum utilization and planning.

He entered private practice in 1989, and has been heavily involved in technical consulting, computer modeling and spectrum planning for the broadcast industry. In April 2005, Mr. Meintel merged his consulting practice into the firm Meintel, Sgrignoli, & Wallace.

Mr. Meintel co-authored a report for the NAB on spectrum requirements for Digital Audio Broadcasting (DAB), created a plan for independent television broadcasting for Romania and has been extensively involved in spectrum planning for digital television (DTV) in both the US and internationally.

Mr. Meintel wrote the coverage and interference analysis software utilized to develop the DTV Table Of Allotments and is well versed in the application of Longley-Rice and other propagation models. Mr. Meintel also wrote the software for the FCC's processing of DTV applications utilizing OET-69. He is a member of IEEE and Tau Beta Pi.

Gary Sgrignoli:

Gary Sgrignoli is a principal engineer and founder of Meintel, Sgrignoli, & Wallace. Mr. Sgrignoli received his MSEE from the University of Illinois in 1977. He was a Principal Engineer and Consulting Engineer at Zenith Electronics Corporation from 1977 till February 2004, when he left for private practice.

Mr. Sgrignoli has worked in the research, development, and design area on television "ghost" canceling, cable TV scrambling, and cable TV two-way data systems before turning to digital television transmission systems. Since 1991, he has been extensively involved in the 8-VSB transmission system design, its prototype implementation, and lab and field tests with Zenith and the Grand Alliance.

He holds 35 U.S. patents, including some that are related to digital television transmission and the 8-VSB transmission system. Mr. Sgrignoli is a recipient of the IEEE Matti S. Suikloa award presented by the IEEE Broadcast Technology Society.

He was involved with the DTV Station Project in Washington DC, helping to develop DTV RF test plans. He has also been involved with numerous television broadcast stations around the country, training them for DTV field testing and data analysis, and participated in numerous DTV over-the-air demonstrations with the Grand Alliance and the ATSC, both in the U.S. and abroad. In addition to publishing technical papers and giving presentations at various conferences, he has given many of his VSB transmission system tutorials around the country. He is a member of IEEE.

Dennis Wallace:

Dennis Wallace has an extensive background in Digital Television Systems. Mr. Wallace managed all the Laboratory RF Testing of the Grand Alliance ATSC HDTV System, having served as the RF Systems Engineer at the Advanced Television Test Center (ATTC). He managed test plans, configurations, and operations for Grand Alliance Testing and several Datacasting Systems. Prior to joining ATTC, he held positions in Field Operations Engineering, Applications Engineering, and was Product Manager for two Television transmitter manufacturers.

In July 1997, Dennis founded Wallace & Associates a broadcast engineering and consulting firm specializing in Digital Television, RF Propagation Measurements, Spectrum Policy issues, and Technical Consulting. His clients include major broadcast groups, The DTV Station Project, ATTC, Trade Associations, and both Professional and Consumer Electronics Manufacturers. In April of 2005 Wallace & Associates was merged into the firm of Meintel, Sgrignoli, & Wallace.

He has worked on the Broadcast side of the fence, as well, holding Chief Engineer and Operations Manager, positions with both Radio and Television Stations.

In 1999, Mr. Wallace was awarded the prestigious Matti S. Suikola award by the IEEE Broadcast Technology Society.

Mr. Wallace is a Certified Broadcast Television Engineer by the Society of Broadcast Engineers. He is also a member of the IEEE Broadcast Technology Society, SMPTE, an Associate member of the Federal Communications Bar Association, and is active on several industry standards committees and the ATSC.

ATTACHMENT 2

Measured Performance Parameters for Receive Antennas used in DTV Reception

Kerry W. Cozad
Dielectric Communications
Raymond, Maine

ABSTRACT

As more terrestrial-based off-air DTV programming becomes available, broadcast engineers are being asked to assist viewers in optimizing their receiving system. A typical receiving system would include a DTV receiver and display, downlead transmission line and a receiving antenna. The component with the most variability will be the receive antenna (type, orientation, mounting configuration, etc.). Utilizing input from broadcast engineers, this paper presents results from a study of typical receive antennas available to consumers. Performance parameters such as radiation patterns, polarization response and VSWR will be investigated. The objective of the investigation is to provide engineers with more detailed information regarding the in-home conditions viewers may be facing when trying to optimize off-air DTV reception.

BACKGROUND

Over-the-air TV reception concerns are as old as TV transmissions. Rabbit ears, bow-ties, loops, log periodics, etc. are familiar phrases for antenna types used for receiving TV signals at the homes of viewers. Because of the "graceful" degradation in the quality of received NTSC signals, coat hangers, aluminum foil and standing on one foot in a corner of the room have also been techniques for improving the quality of signal reception. With the introduction of cable TV and remote controls for the primary TV sets in a household, the latter techniques are typically unacceptable to the viewer as they require multiple attempts at adjustments for best picture and then when you change the channel, the process must be repeated. "Couchpotato-itis" has had a significant impact on the viewing habits of American consumers.

Since the first DTV receiving sets purchased for home use will most likely be replacements for the primary TV set now hooked up to cable through which there is presently limited access to retransmission of over-the-air digital programming, receive antenna usage is expected to increase.

Combining the consumer desire for simplicity in viewing (couchpotato-itis) and the rapid deterioration of DTV signal quality when signal margins are low, the reliability of reception when using an antenna system must be as high as possible.

PLANNING FACTORS

One method of attempting to assist in the design of reliable receiving systems is to provide accurate information that can be used by engineers to design these systems.

Receiver Planning Factors Used by PS/WP3

Planning Factors	Low VHF	High VHF	UHF
Antenna Impedance (ohms)	75	75	75
Bandwidth (MHz)	6	6	6
Thermal noise (dBm)	-106.2	-106.2	-106.2
Noise Figure (dB)	10	10	10
Frequency (MHz)	69	194	615
Antenna Factor (dBm/dBμ)	-111.7	-120.7	-130.7
Line loss (dB)	1	2	4
Antenna Gain (dB)	4	6	10
Antenna F/B ratio (dB)	10	12	14

Table 1

Table 1 is from the ACATS PS/WP3 Document 296 and is an example of the types of information needed to evaluate and design transmission/reception systems. Since the initial publishing of this table, several concerns have arisen regarding how "typical" some of these values are in commercially available products. Specifically, the receiver noise figure and antenna gain under real life conditions. We also know that multipath will impact the signal-to-noise (SNR) level at the receiver and the antenna F/B ratio may improve the rejection of multipath signals that arrive at the antenna from directions other than the primary transmitter site. One purpose for this investigation is to identify these key planning factors dependent on the receiving antenna and document measured performance of several "typical" antenna types for comparison to the performance "standards" presently being used. For real life situations, the ideal or best case conditions are not typical. The same can be said for worst case conditions. Therefore, to be able to respond to viewer concerns regarding reception issues, it is necessary for the broadcast engineer to be aware of the range of performance possible for various conditions.

GOALS

A primary goal for this investigation was to document the actual performance of typical consumer available receive antenna products for comparison to the planning factors now being used. Also, based on that comparison and any additional information that may be acquired during the testing, identify possible areas of improvement in the design or in home set up of these antennas.

DESCRIPTION OF TESTING PROTOCOL

Two methods of testing and evaluation were determined to be useful in the documentation phase: full scale range measurements and computer modeling.

For the range tests, it was desirable to use standard procedures that would maintain consistency between the measurements and data/specification sheets supplied with the sample antennas by the manufacturer. The Consumer Electronics Association Standard CEA-774-A was used for identifying the performance parameters and the IEEE Standard Test Procedures for Antennas 149-1979 was used for setting up the measurement range facility. A photo of the range layout is shown in Figure 1.

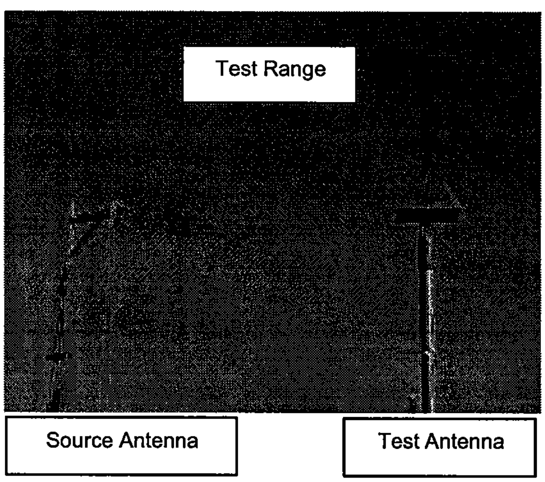


Figure 1

The outdoor far field range consisted of elevated platforms to support the source antenna and the antenna under test. The platforms were approximately 20 feet above ground level and located to minimize the effects of other objects near the range. The source antenna was a corner reflector with a dipole feed. A network analyzer was used as a signal source and receiver. A standard dipole was used to calibrate the range and then a calibrated half-wave dipole for each channel was used to measure the antenna gains by comparison. The network analyzer was also used to measure the input impedance of the antenna including any jumper cable that came with the antenna as a standard component.

Additionally, computer modeling was performed to compare results and determine the feasibility of using software analysis to simulate changes and determine improvements in the antenna designs. SuperNEC 2.7 was used for the computer modeling. SuperNEC 2.7 is a hybrid Method of Moment /Unified Theory of Diffraction antenna analysis program provided by Poynting Software (Pty) Ltd It is based on the Numerical Electromagnetics Code programs (NEC2) developed by Lawrence Livermore Labs in 1982. The program allows for inputting 2-D and 3-D models for simulation of electromagnetic characteristics such as radiation patterns, current flow, voltage levels and gain calculations.

The primary performance parameters to be tested were:

Antenna Principal Plane Patterns
- Azimuth Pattern
- Elevation Pattern

Polarization Response
- Horizontal
- Vertical

Frequency Response
- Variations within design band
- Response out of design band

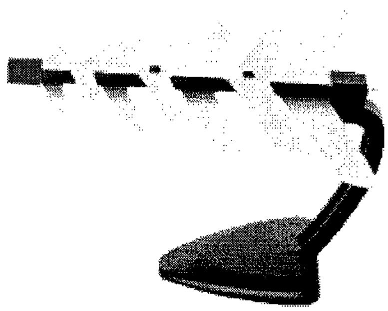
Directivity

Gain

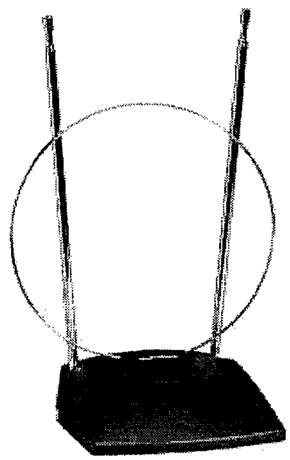
PRODUCTS TESTED

The receive antenna types to be tested were chosen based on availability to the consumer, specific design for the band of interest and to provide comparisons between typical types from different manufacturers. They were divided into two types based on whether they would be mounted inside or outside the home.

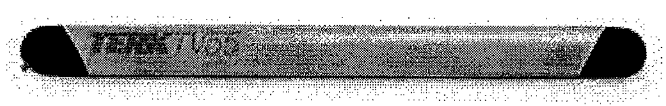
"Set Top" (indoor)



Zenith Silver Sensor

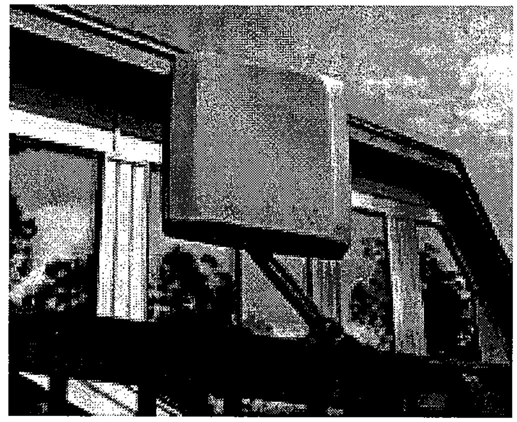


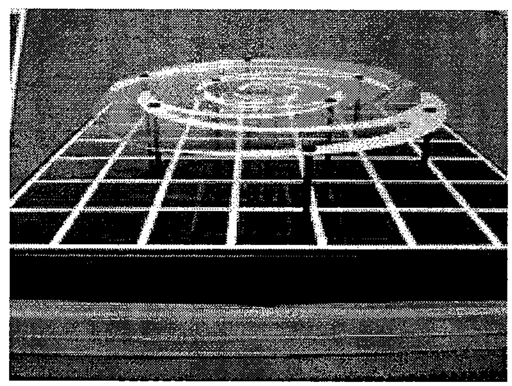
Radio Shack 15-1864 Loop



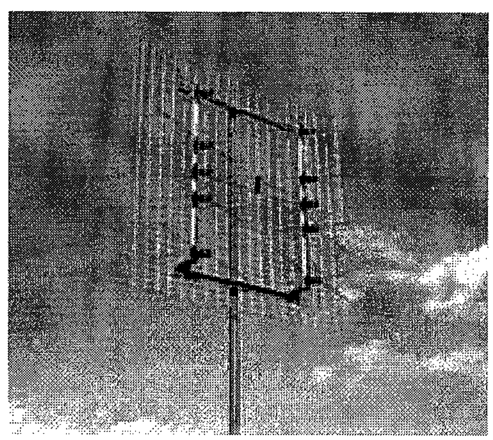
Terk Antenna Pro

Attic or Outdoor

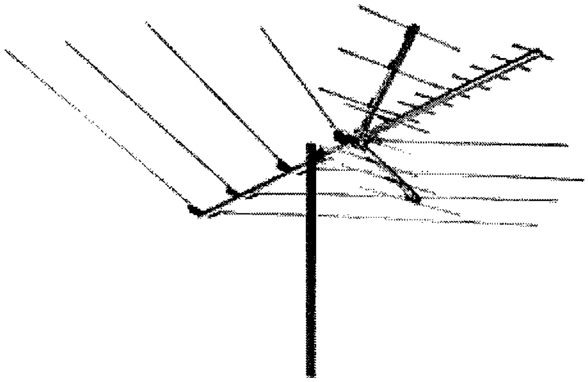




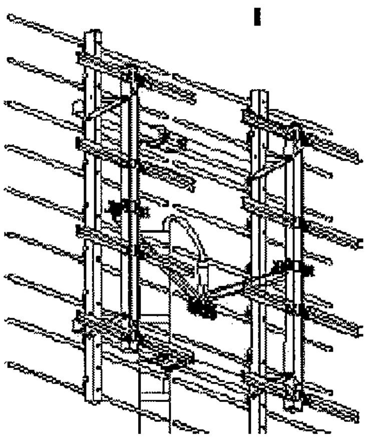
Winegard SS-1000



Channel Master 4228



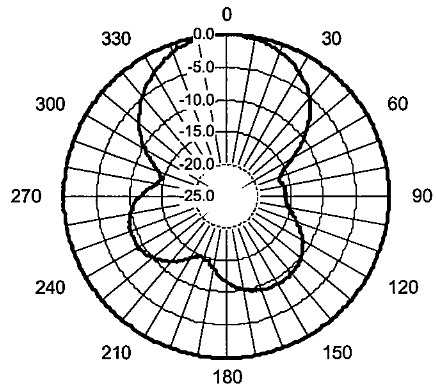
RCA ANT3020



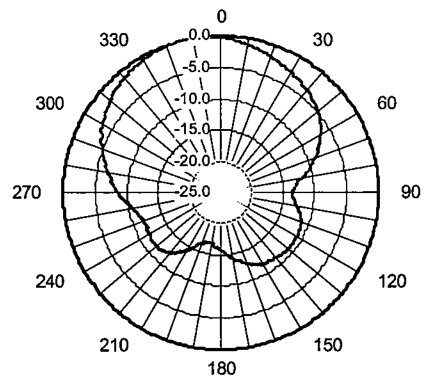
Winegard PR-8800

MEASURED RESULTS

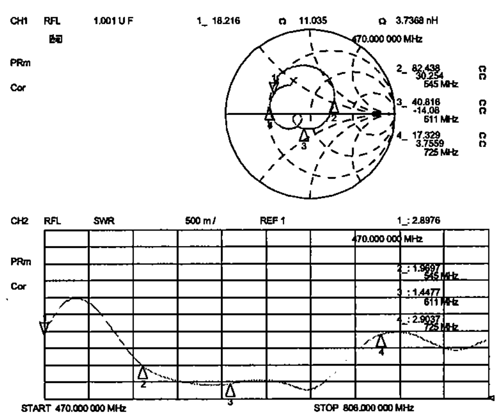
The amount of measurement data acquired during the testing of these antennas prohibits presentation of all the data in this paper. If the reader is interested in the specific data, please contact the author at the address included at the end of the paper. Below are samples of the data measured on two of the typical indoor antenna types. A summary of parameters for more samples of the antennas is included in a later section of this paper.



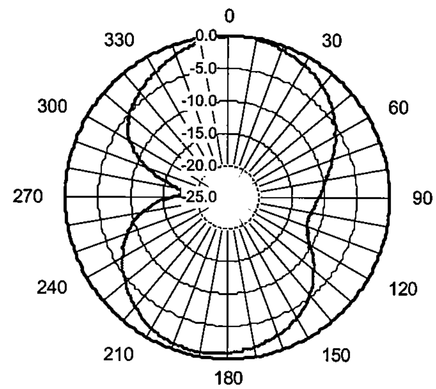
Silver Sensor: Azimuth



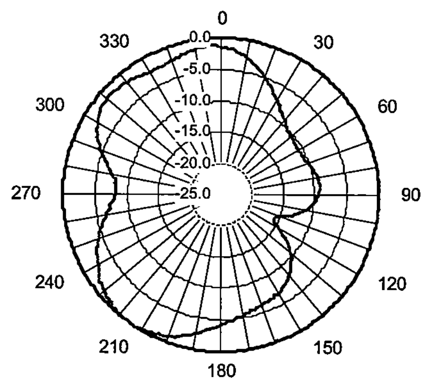
Silver Sensor: Elevation



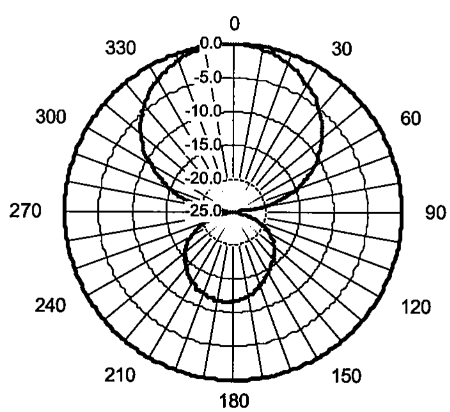
Silver Sensor VSWR



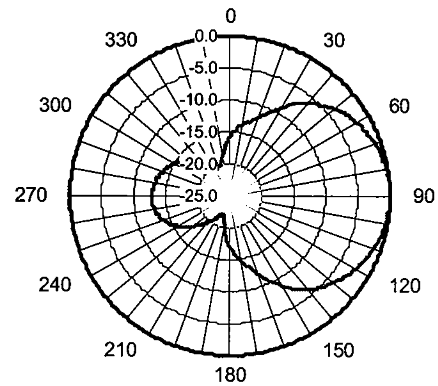
Radio Shack 1864: Azimuth



Radio Shack 1864: Elevation



Winegard SquareShooter: Azimuth



Winegard SquareShooter: Elevation

The previous measurements were all taken in the horizontal polarization mode. Data was also taken in the vertical polarization and the gains were compared to determine the effectiveness of the standard antenna to receive cross-polarized signals. This information can be used to study the use of transmitting cross-polarized signals to minimize interference or the reception of multipath echoes. A sample comparison is shown in Table 2.

Average V-Pol/H-Pol Ratios

Zenith	-20 dB
Channel Master	-19 dB
Radio Shack 1864	-5 dB

Table 2

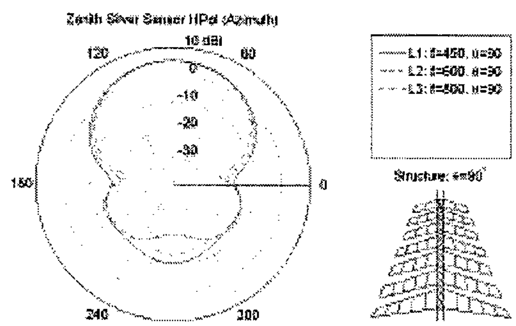
OBSERVATIONS FROM MEASURED DATA

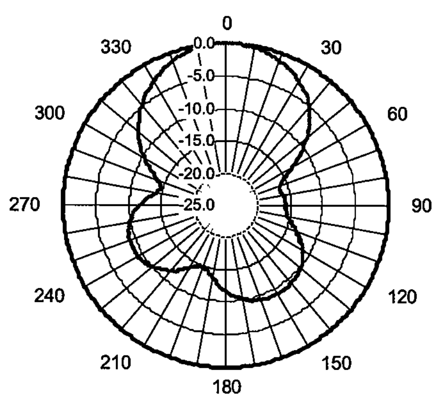
There were two basic antenna designs tested: the loop indoor antenna and a linear array of elements. The loop antenna was the less directional design and therefore exhibited lower gains. It also showed the greater sensitivity to receiving polarizations other than horizontal which could be a benefit for broadcasters that choose to transmit a vertically polarized signal along with the horizontally polarized signal to improve close in coverage and penetration through buildings but would not be a benefit in minimizing the reception of multipath. The higher gain receive antennas that would typically be used for locations at some distance from the transmitter have more defined pattern shapes with a specific directionality in the direction of the array. This provides for the ability to "aim" the antenna for maximum signal and minimize reception of multipath reflections for other directions. Any benefit that might be provided by transmitting a vertically polarized signal was not apparent.

The one exception to the general antenna types described above was the Winegard SquareShooter. Its design is shown in the photo earlier and is a log periodic style design for broadband performance. It was thought that the vertically polarized signal response would be different for this design relative to the linear array antennas. It was more sensitive to vertical polarization but the levels were still more than −10dB those for horizontal polarization.

COMPUTER MODELS

Several of the antennas were also modeled using SuperNec 2.7. The primary purpose of this exercise was to compare calculated to measured data so that any investigations into improved designs for the antennas could be accomplished quickly in the lab versus having to build a physical prototype of each antenna for testing on the model range. Examples of this data are presented below.





Zenith Silver Sensor
Measured H-Pol Azimuth Pattern

GAIN COMPARISONS

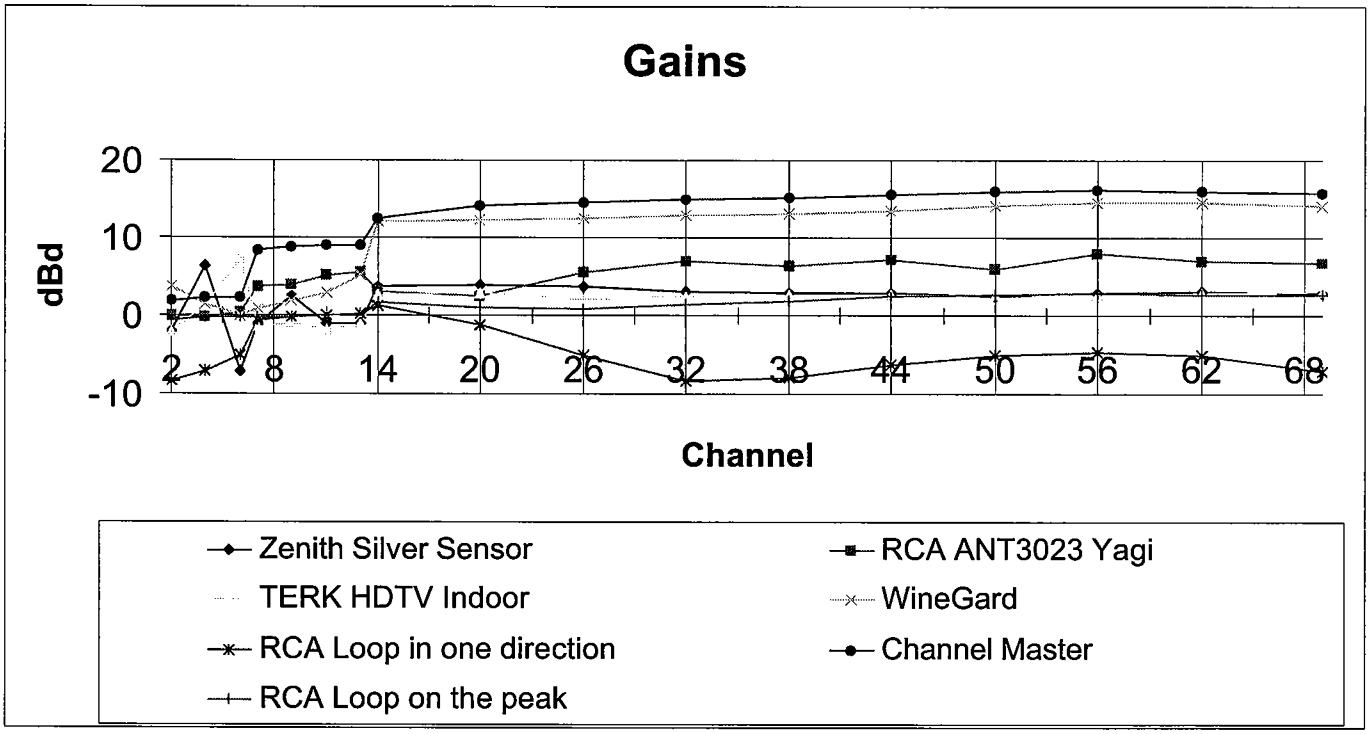
A graph showing a comparison of calculated gain performance for the antennas relative to channel is included on the next page. One of the more interesting questions that arose during this investigation was the performance of UHF specific antennas at VHF channels 7-13. Since most DTV channels presently in operation are UHF, concerns about moving back to the present High Band VHF NTSC channel later for DTV transmission and the impact on over-the-air viewers that were using UHF only receive antennas could be a critical decision point. Based on this data, small, compact designs that would be used indoors did not perform as well as the outdoor designs that used two-dimensional arrays of dipole elements. It is believed that the feed systems for these larger arrays provided additional area for current flow at the lower frequencies and therefore improved the received signal levels for channels 7-13.

Also noted is that only the larger, outdoor antenna designs will meet the 10 dB gain parameter for UHF unless an amplifier is used with the antenna. This certainly brings at least one more factor into the equation relative to the quality of the amplifier system used. That concern was not part of this investigation.

SUMMARY

Only a small sample of the measurements made is presented in this paper. Measured gains will be presented at the NAB Engineering Conference, as they were not available at the time of writing of this paper, as well as additional pattern analysis data.

It is clear that accurate measured data can provide significant insights for the broadcast engineer when responding to reception concerns by viewers. Knowledge of the effectiveness of antenna types relative to distance from the transmitting site (gain and directional characteristics), multipath rejection, and performance over multiple channel bands can be areas that will assist broadcast engineers in working with viewers to optimize reception. It is the hope of the author that the information previously presented at the 2004 IEEE Broadcast Symposium, and the information provided in this paper and at the 2005 NAB Engineering Conference will be helpful to broadcast engineers during the ongoing transition to digital television around the world.



ACKNOWLEDGEMENTS

The author would like to thank Mr. Andy Bater of Tribune Broadcasting for his support of this work and providing most of the antennas used in the testing. Also, many thanks to the Broadcast engineering staff at Dielectric Communications for their assistance in developing the test range, performing the measurements and analysis of the data.

FOR ADDITIONAL INFORMATION

Please contact:

Kerry W. Cozad
Dielectric Communications
PO Box 949, 22 Tower Road
Raymond, ME 04071

(207) 655-8133
kerry.cozad@dielectric.spx.com

ATTACHMENT 3

Performance of 5th Generation 8-VSB Receivers

Tim Laud, Mark Aitken, Wayne Bretl, K. Y. Kwak

Abstract — *There has been a focused effort within the television broadcast industry to move DTV receiver technology "state-of-the-art" forward to better deal with the more difficult and complex receiving environments faced within the TV viewing environment. In this paper, we detail the approach taken which today provides the broadcast industry with a "breakthrough" 8-VSB receiver product that has "cleared the bar" of expected performance for the simple consumer-friendly reception of over-the-air digital television in most complex environments.*

There have been many field tests and studies performed since the adoption of the 8-VSB ATSC standard. Armed with a more complete understanding of the adverse environments where prior 8-VSB receivers fell short of providing acceptable reception, it became clear that an architecturally advanced approach was needed. Having new and advanced methods of analyzing captured RF signals, coupled with new-found capabilities of more accurately defining and applying such "real world" approximations in the realm of software simulation, led to an understanding of many modeled performance capabilities prior to hardware production. A variety of tools allowed the design team to depart from the generally accepted implementations of the past, and to deal in new ways with the infinitely complex array of variable ghost delays and amplitudes required to meet the needs of broadcasters and consumer electronics manufacturers alike. Affirming knowledge about the need to deal with known interferences, resulting from an increasingly densely packed RF broadcast television spectrum is also highlighted.

Field evaluation data is presented to confirm the conclusions. Providing correlation of results with laboratory simulations and tests with those "real world" conditions in various field trials conducted by multiple parties enables this technology to achieve quick acceptance in the marketplace.[1]

Index Terms — VSB, Digital Broadcast Television, DTV Receivers

I. INTRODUCTION

EACH generation of 8-VSB demodulator has shown a performance improvement. A new generation has appeared approximately every two years since the US adoption of a digital TV standard. This paper documents some of those improvements with emphasis on the most recent step from 4th to 5th generation. Lab results are presented along with simulated and actual field results.

II. FIFTH GENERATION ADVANCES

The performance improvements of the 5th generation receiver enable reception using simple antennas such as bow ties, loops and rabbit ears. Sensitivity to antenna positioning with respect to the propagated signal will now be very low. The need to adjust the antenna when changing channels will be almost non-existent, providing viewers with the main criterion for "ease of reception".

The new equalizer architecture and algorithm enhance convergence under combinations of complex ghosts, severe ghosts and noise. Also, the equalizer architecture now supports longer-delayed ghosts and has a symmetric capability for pre and post ghosts.

The ghost cancellation circuit has several features that contribute to the enhanced performance. Initialization is based on an accurate channel impulse response estimate rather than a fixed starting condition. Dynamic ghost tracking then uses an LMS algorithm to update equalizer taps. A zero-delay trellis decoder improves the accuracy of the update estimates and improves the Doppler (rate of change) performance. Techniques for reduced noise enhancement improve accuracy.

III. EQUALIZER IMPROVEMENTS OF VARIOUS GENERATIONS

From the beginning of digital television development, it was recognized that multipath was an issue that would need to be addressed, especially for indoor reception. However, since automatic ghost canceling of the complexity required for digital reception had not been previously implemented in any analog product, there was little data on the severity and nature of the problem.

The very first generation of 8-VSB demodulators marketed included equalizers that assumed significant ghosts were within 10 microseconds of the main signal and their amplitude was no greater than half the main. Field measurements quickly showed this to be true for less than 70% of a typical TV coverage area.

A second generation design was introduced early on and used for the greatest number of field tests. Hence, most of the reception studies are based on this level of performance.

[1] Tim Laud is with Zenith Electronics Corp., Lincolnshire, IL 60069 USA (e-mail: tim.laud@zenith.com)

Mark Aitken is with the Sinclair Broadcast Group, Hunt Valley, MD 21030 USA (e-mail: maitken@sbgnet.com)

Wayne Bretl is with Zenith Electronics Corp., Lincolnshire, IL 60069 USA (e-mail: wayne.bretl@zenith.com)

K. Y. Kwak is with LG Electronics, Seoul, Korea (e-mail: kkwak@lge.com)

Contributed Paper
Manuscript received September 15, 2004

0098 3063/04/$20.00 © 2004 IEEE

Subsequent generations of demodulators were designed with longer equalizers. (See Fig. 1.) New iterations handled more ghost scenarios than the previous implementations. Each generation essentially doubled the post ghost capability, pre-ghost capability, or both. Analysis of signals at difficult sites has shown that the earlier assumption that the strongest signal occurs among the first arrivals is often incorrect. Therefore, the 5th generation has added the capability to handle 50 microsecond pre-ghosts or post-ghosts.

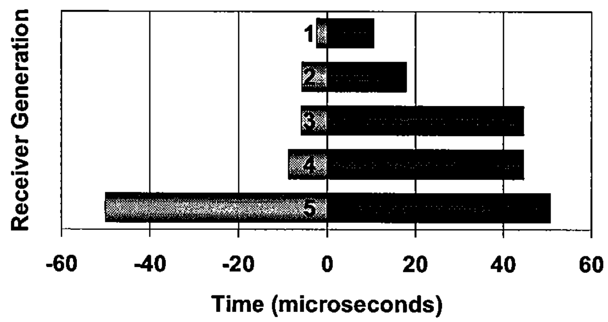


Fig. 1. Length of equalizer capability for each generation of 8-VSB receiver .

In addition to ghost delay lengths, it was recognized that improvements in ghost amplitude handling were necessary. While the original assumption that the first signal arrival from the transmitter would be the strongest seemed reasonable, it is a poor fit to the scenario of indoor and "concrete canyon" reception. In these cases, the direct path from the transmitter is frequently blocked and the initial wave may be much smaller than the reflections. To address this, each generation improved the algorithm for ghost cancellation. This allowed reception in an increasing number of locations. Whereas the early equalizers could handle only a 50% amplitude ghost, the latest implementations can handle a reasonable ensemble of 100% ghosts. (See Fig. 2.)

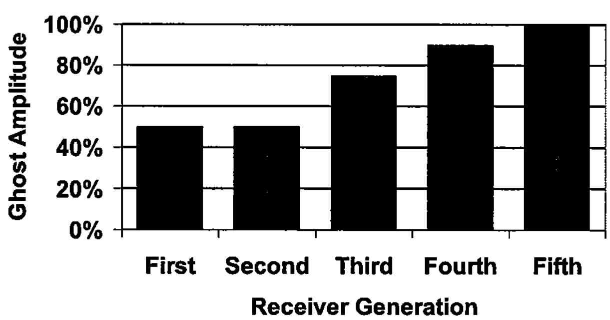


Fig. 2. Maximum ghost amplitude handling for each generation of 8-VSB receiver.

IV. Laboratory Tests

From Figs. 1 and 2, it is easy to see that the new equalizer architecture of the 5th generation is a big step forward. To characterize this improvement in performance, each generation of hardware has been tested in the laboratory against several ghost ensembles. Each ensemble typically has been composed of 6 signals (a limitation of the test apparatus) of varying amplitudes and delays. The most common ensembles used in recent tests are listed in Table 1 [1]. Ghost complexity generally increases from the top to the bottom of the table.

ATTC D was defined early in the U.S. DTV trials. The ghosts are relatively simple and low energy.

Brazil A is a minor variation on ATTC D.

Brazil B includes a few strong ghosts at moderate delays.

Brazil C and D represent indoor scenarios of very strong, close-in ghosts. Brazil D is primarily pre-ghosts.

Brazil E represents an unusual but possible extreme case in a single frequency network. Three signals of equal strengths are separated by one microsecond.

The CRC ensembles consist of a number of strong and moderate ghosts of short delay plus one of long delay.

The results of each generation's performance against these ghost scenarios are summarized in Table 1. (First generation hardware is no longer maintained or tested since its marginal performance is well documented.) The 5th generation chip exhibits a clear breakthrough in laboratory ghost performance.

	2nd	3rd	4th	5th Gen
ATTC D	Pass	Pass	Pass	Pass
Brazil A	Pass	Pass	Pass	Pass
Brazil B	Fail	Fail	Fail	Pass
Brazil C	Fail	Fail	Pass	Pass
Brazil D	Fail	Fail	Fail	Pass
Brazil E	Fail	Fail	Fail	Pass
CRC 3	Fail	Fail	Fail	Pass
CRC 4	Fail	Fail	Fail	Pass

Table 1. Ensembles used to measure equalizer performance have been collected from international test labs.

A better understanding of real world performance requires field testing. However, the variations in field conditions from time to time make it impossible to repeat a measurement, so that field test must use a large number of measurements and analyze the results statistically. A few years ago, methods of recording and playing back the RF signal found in the field were developed. This allows the repeated and comparative testing of demodulator designs. During field tests conducted by MSTV (Association for Maximum Service Television) in Washington DC and New York City, RF captures were taken at difficult locations. Fifty of these captures are called out in the ATSC (Advanced Television Systems Committee) Recommended Practice A/74: Receiver Performance Guidelines [2].

The 4th and 5th generation receivers were tested against these RF captures. Note that the captures may have multiple impairments, e.g., noise and/or interference, in addition to ghosting. The results are shown in Fig. 3. The number of failures was cut by a factor of 5. Keeping in mind the known extreme difficult nature of these captures, with this degree of improvement, field performance enhancement should be quite dramatic. While these RF captures can provide an understanding of performance within the specific channel bandwidth captured, interference and noise within the adjacent spectrum, must be factored in to adequately understand other "real world" performance parameters.

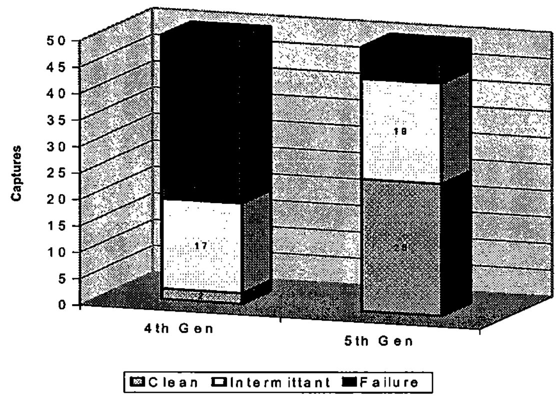


Fig. 3. Performance of 4th and 5th generation receivers against RF captures.

V. FIELD TESTS

At some point in the reiterative design/review/improvement process, it is necessary to assess "real world" performance. It is not possible to assign totally objective criteria to define the many variables associated with field test sites. However, statistical analysis of reception success and the analysis of captured spectrum data do allow an understanding of varying degrees of difficulty. Well-documented sites and areas that have historically been "difficult" provide a good place to assess relative performance of generations of receiver technologies.

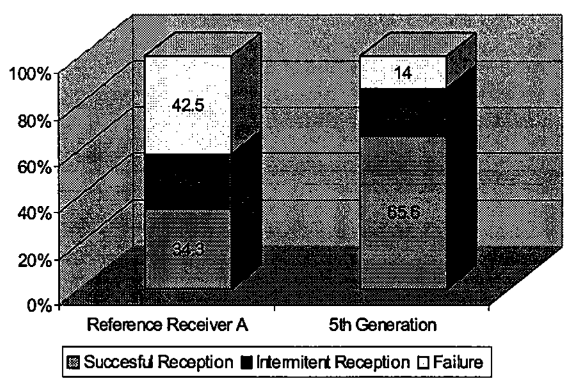


Fig. 4. Field Reception Results in Washington DC.

The 5th generation receiver was tested in Washington DC during the summer of 2003 by MSTV at numerous known difficult locations. Many of these locations have been identified since the second generation receivers were field tested. A reference receiver of understood and documented performance was tested simultaneously to provide a ready "benchmark". This provides a good measure against the recent state of the art. In Fig. 4, it can be seen that the number of reception failures was reduced by a factor of 3.

Similarly, independent tests were performed by the Communications Research Center in Canada during 2004. The results were presented at the SET conference in Brazil of August 2004 [3]. The improvement in reception vs. a reference receiver is shown in Fig. 5. Data shown here is for a single transmitter and a directional receiving antenna.

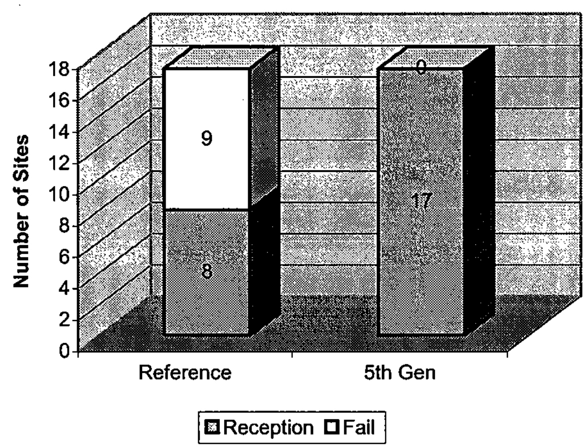


Fig. 5. Field Reception Results in Ottawa, Canada.

A structured series of tests in well-documented difficult environs in and around Baltimore was conducted in the Spring of 2004[2]. Based on the performance of earlier generations of products, many of these documented sites are challenging to earlier generations of receivers, and present an opportunity for side-by-side "real world" testing. All of the sites chosen had signal strength well above the minimum required by the receivers under test, so that the effects of ghosting and interference were dominant.

Earlier evaluation had also made note of some performance issues associated with adjacent channel interference, both first and second. (Channel 46DT is adjacent to Channel 45 NTSC and Channel 52DT is close to Channel 54 NTSC as shown in Fig. 6).

The test setup included a tunable band-pass-filter with moderate rejection characteristics (~35MHz bandwidth) that could be adjusted to identify possible effects of these adjacent (and other) sources of interference. While both 2nd and 4th generation receivers were positively influenced by use of the bandpass in a small number of locations, it was difficult to

[2] Tests were conducted by engineers from Sinclair Broadcast Group and Zenith Electronics Corp.

determine any significant impact on the performance of the 5th generation product. This improvement may be attributable to differences in RF tuner performance in addition to characteristics of the demodulator integrated circuits.

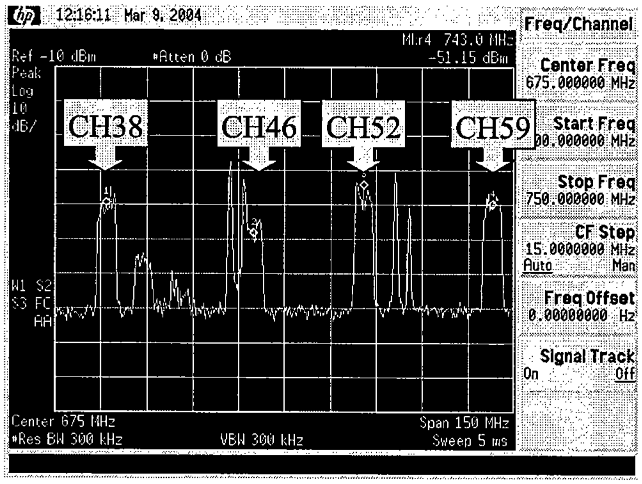


Fig. 6. Baltimore Spectrum

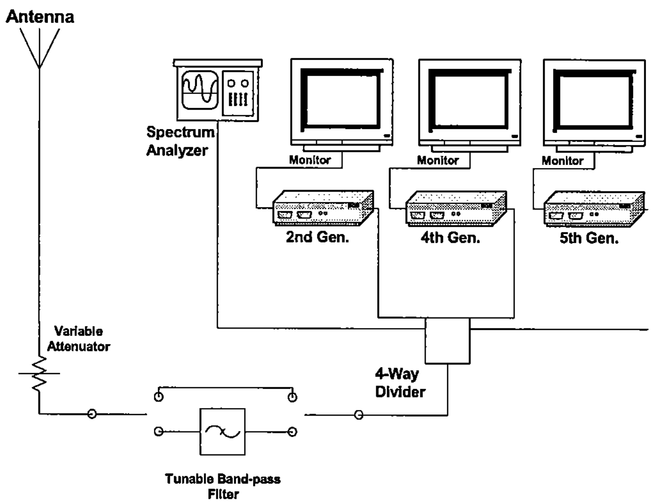


Fig. 7. Simplified Test System Diagram

Multiple sites were chosen, and a comparative test was conducted noting the received/displayed video performance as primary indicator. The system illustrated in Fig. 7 was used to provide simultaneous display of the receiving characteristics of three generations of receivers. Calibrated spectrum power and shape were recorded, showing amplitude/frequency variations. This setup allows study of the effects of various site-specific variables (such as antenna orientation/placement, traffic and path attenuation.) and resulting impact on reception. The following is a simplified version of the test procedure:

1. Arrive at selected location and set the receiving antenna/tripod at a fixed test position. (The location of the tripod was random to the extent that the vehicle could be parked legally and safely).
2. Connect the selected TV antenna (simple bowtie at 2m height) to the system as indicated in Fig. 7.
3. Orient the antenna for maximum integrated power on an available DTV broadcast. (In this case channel 38 with a center frequency of 617 MHz was used)
4. Record the reference values, and note presence (or lack) of video output from DTV receivers. Note site-specific variables and note impact on reception

Several antenna types were used at various locations, but a simple "bowtie" antenna was used for all of the comparative tests of "ease of receivability." This simple antenna provides a broad incidence of reception (mostly non-directional) at UHF frequencies, providing a means to assess the ability to receive multiple channels without a need to adjust receiving antenna pointing. This is important in the simple home receiving environment.

There was good correlation with results obtained in prior tests at the same locations with both the 2nd and 4th generation receiver products. This provided a way to gauge the real performance differences with the 5th generation product. The results in Fig. 8 indicate performance enhancements in the 5th generation product that closely match the expectations as a result of the previous promising laboratory and simulated environment tests.

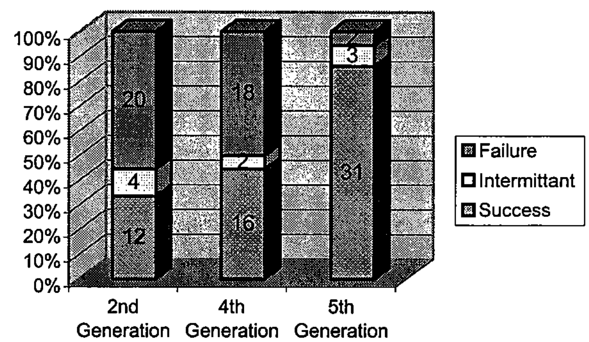


Fig. 8. Baltimore "Ease of Reception" Test Results

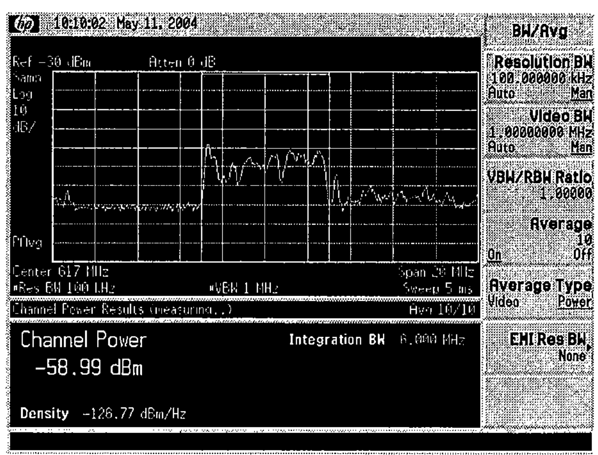


Fig. 9. Example Spectrum, DTV CH. 38

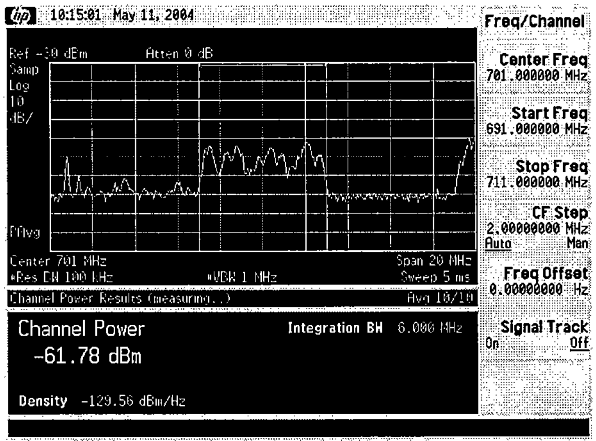


Fig. 10. Example Spectrum, DTV CH. 52

Even in some of the most difficult sites, with multipath very evident in the spectrum (Fig. 9 and Fig. 10), reception was possible with the 5th generation receiver.

VI. Future Enhancements

Improvements in receiver performance beyond fifth generation are still possible. Improvements are planned for equalizer convergence speed, particularly to address the portable environment. Adjacent channel interference can be addressed in two ways. Changes in tuner AGC methodology can address overload conditions experienced with the more densely packed broadcast spectrum. The effects on reception of digital stations can be reduced by operating them at full licensed power, especially when they are in a spectrum with powerful adjacent or nearly adjacent analog stations.

VII. Conclusion

Because of the need to free up spectrum for a variety of interests and uses, an increasing burden has been placed on all involved in the FCC mandated DTV transition. Because of the "all or nothing" nature of digital reception, digital TV must provide excellent reception even where analog reception is poor, in order to facilitate the transition for the large number of receivers that use over-the air reception. This is beyond the requirements originally proposed at the inception of digital television, but it is being met by 5th generation designs.

Development of the successive generations of demodulators has depended on a cooperative effort of broadcasters and receiver designers to better understand expectations, identify the real world problems associated with digital terrestrial transmission/reception and define test protocols that more fully represent that real world (for example the ATSC recommended practice A/74).

Proper matching of the application design efforts to the discovered realities of digital terrestrial reception has resulted in 5th generation hardware that clearly supports identified needs of the digital transition.

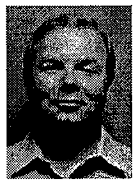
References

[1] Communications Research Centre Canada, "Results of the Laboratory Evaluation of Zenith 5th generation VSB Television Receiver for Terrestrial Broadcasting," http://www.crc.ca/en/html/crc/home/research/broadcast/rtnt , Appendix A, September 2003.

[2] Advanced Television Systems Committee, "ATSC Recommended Practice: Receiver Performance Guidelines," http://www.atsc.org/standards/practices.html, Annex A, June 2004.

[3] Communications Research Centre Canada, "Results of the Laboratory Evaluation of Zenith 5th generation VSB Television Receiver for Terrestrial Broadcasting," http://www.crc.ca/en/html/crc/home/research/broadcast/rtnt, September 2003.

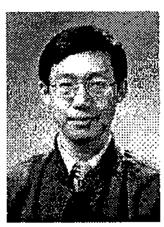
Biographies



Timothy Laud (M'74) is a Senior Member of the Technical Staff for Zenith Electronics Corporation. Tim attended Purdue University where he received his BSEE in 1975 and MSEE in 1976. After a brief period at Motorola, Tim joined the Zenith R&D team in 1980. He has been involved in the development of VSB and E-VSB since their inceptions.

Mark A. Aitken is Dir. of Advanced Technology, Sinclair Broadcast Group. Educated at Springfield Technical Community College with continuing education in Eng. Mgmt. at Rensselaer Polytechnic Institute, he represents SBG within many industry related organizations including ATSC. Mr. Aitken is a member of AFCCE and IEEE, involved with advanced digital television systems design and implementation.

Wayne Bretl is a Principal Engineer in the R&D Department at Zenith Electronics. He received the BSEE from Illinois Institute of Technology in 1966, and joined Zenith in 1975. He holds over 15 patents in television technology and related areas. He is a member of IEEE, SMPTE, AES, and SID, and represents Zenith in ATSC and a number of professional and industry associations.



Kook Yeon Kwak has been developing technology and ASICs for VSB, QAM and COFDM as a research fellow in the DTV laboratory of LG Electronics since 1999. He joined LG Electronics in Korea in 1979. He received the B.S. degree in electronic engineering at National Seoul University in Korea in 1979, the M.S. degree in electrical engineering from KAIST in Korea in 1984, and the Ph.D. degree in electrical engineering from Polytechnic University in NY in 1995.

Robinson Telephone

"Communicate, don't ex-communicate"

From the Desk of:

Paul Robinson

RECEIVED & INSPECTED

MAY 2 5 2005

FCC - MAILROOM

"Above all else... We shall go on..."
"...And continue!"

Transmittal Letter

DOCKET FILE COPY ORIGINAL

To the Secretary, Federal Communications Commission:

Enclosed are 5 copies of my reply to the Commission's inquiry in docket 05-182, "Technical Standards for Determining Eligibility For Satellite-Delivered Network Signals Pursuant To the Satellite Home Viewer Extension and Reauthorization Act."

Sincerely Yours,

Paul Robinson

Paul Robinson
"A computer programmer and
Notary Public in and for the
Commonwealth of Virginia, at large"
General Manager
Robinson Telephone Company

No. of Copies rec'd 0+5
List ABCDE

4300 S. 35th Street #A-2 ● Arlington, VA 22206-1834 ☎ 703 931 1147

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Technical Standards for Determining Eligibility For Satellite-Delivered Network Signals Pursuant To the Satellite Home Viewer Extension and Reauthorization Act	)))	ET Docket No. 05-182

Response by

May 18, 2005

Paul Robinson
General Manager
Robinson Telephone Company of the National Capital Area
4300 35th Street South #A-2
Arlington, VA 22206-1834

Telephone 703-931-1147

In the Commission's request for comments, it raises a number of issues which are significant to the carriage of digital signals from a distant market into an area which may or may not be served with a satisfactory quality signal even within the grade-b contour of a local station. Among the issues the commission has raised, or apparently has raised, is whether a statistical estimate or computer-based analysis system is adequate for determining signal strength for grade-b coverage or whether other methods are necessary.

In this respondent's opinion, more needs to be taken into account than the theoretical or expected reception level which general engineering estimates would apparently indicate is adequate to supply a level of signal adequate for reception.

While the Commission has provided that for certain classes of communications, local authorities (including land owners and condominium associations as well as cities and states, by statute) may not prohibit or restrict the use of certain devices (such as small satellite dishes), or require use of someone else's facilities (such as in the case of use of unlicenced wireless spectrum for construction of computer networks), there are permissible restrictions such as not permitting device installation in areas the party wishing to install the device does not have ownership or control over (such as making it permissible to prohibit installing a satellite dish in a common area of a condominium complex.)

The issue of where a digital antenna may be installed as well as the type of antenna which may be installed is relevant. Antennas do not always vary in quality simply on the basis of price; sometimes inexpensive antennas from one manufacturer may do a better job at providing an adequate quality signals over antennas from other manufacturers which are more expensive.

Also, while engineering analysis may dictate that signal quality is adequate in a specific area, a pure engineering analysis may miss real world conditions that dictate otherwise.

It is one thing to determine that by engineering analysis that an area is reasonably within a satisfactory quality grade-b signal, it's another to discover the engineering analysis is flawed because it presumes customers can install outdoor antennas, a practice which may not be available.

Measurements may, and in fact should, take into account differences between densely populated urban areas, and lightly populated rural areas.

The Commission should take into account the classification of the general environment of a particular class of coverage, in that, for example, in a dense urban area, most people may be living in multi-story apartment buildings or in condominium complexes and may be unable to install an external antenna, either because they have no access right to any outdoor space (as in the case of someone living in a condominium that has no private yard) or because they have no outdoor space at all (someone living in a multistory apartment building without a balcony.).

Where engineering estimates would probably show that yes, a satisfactory quality signal is available within the grade-b contour, such estimates must take into account that for a particular area, most if not all antennas may be indoor only. If a person lives in a multi-story building and their apartment does not have a balcony, an external antenna clearly is impossible and this should be taken into account.

In allowing a station to exclude distant signals the onus should be on the local station to show that it is able to supply adequate signal quality within the grade-b contour on the basis of actual measurements that realistically match real-world conditions of a majority of persons who would allegedly receive their signal.

In determining signal measurement, an equivalent number of actual measurement points should be required relative to some percentage figure relative to the general population of the area which it is claimed by the station to be able to receive its signal, and the reception points should be such that they are in multiple areas of the grade-b contour region, such that whatever measurement is made is a fair representation of what generally should be expected of persons using receiving equipment in the grade-b region.

For example, if an estimate of 1% of the population of the grade-b contour is considered what is necessary to be selected, and the estimated population of that particular region, based on engineering estimates of signal strength, indicates that 150,000 people live in that region, then the station should be required to collect 1500 measurements. Such measurements, ideally, would be from the fringe points of what is claimed to be the edge of the grade-b contour, as well as measurements within the contour. Quite possibly, a random selection of points may be more appropriate.

Such measurements, where made, should be as close to real-world conditions as would be expected, presumably, by asking residents who live at the selected or computed points, to allow the party performing the measurements to do so from within their home. It is quite likely that people will be delighted to participate, as most people would prefer to have someone see if they are not receiving adequate reception. As such testing probably would run no more than 5 minutes or so, the request would not be overly burdensome for the home's resident.

In the conducting of such tests, a range of antennas should be required. The Commission should survey electronics, home repair and television stores, either by visit, by examining regular advertising materials, or by telephone call, the range and price of available antennas suitable for this purpose.

The Commission should probably perform an engineering analysis of several brands and types of antennas, with a view in most cases to using the least expensive model of antennas that are generally available for commercial purchase, as well as the antennas that tend to be of less quality over higher quality.

The Commission should then show which brands of antennas it used and recommend these for testing purposes.

The reason for this rationale is that most people purchasing electronic equipment are not technically sophisticated. They will probably presume all antennas are the same and purchase either the least expensive or that are the least intrusive looking in terms of appearance.

Also, if testing is done with inexpensive and low quality antennas, and the quality of reception levels are still adequate, then anyone using more expensive or higher quality antennas could reasonably be expected to have equal or better results.

Stations may also be permitted to use more expensive and/or better quality antennas in addition to the above testing factors to show that their signal is reasonably accessible, as long as the price of the antenna is within a reasonable range of typical prices for retail purchase of antennas.

The same provisions should apply to digital receivers and digital television sets.

The commission should also examine issues of the difference between reception using a digital to analog adapter, and an actual television set capable of digital reception, as there may be differences between reception in both cases even where the two devices come from the same manufacturer.

Also, it should be noted most people are unlikely to be willing to discard perfectly satisfactory analog television sets in order to purchase expensive digital televisions that currently do not really provide any significant improvement in picture quality at this time.

The Commission should also provide for the invalidation of a station's claim of adequate reception based on some criteria showing the data provided to have too much error. For example, if a third party takes similar measurements at identical or near-identical points as the station did, and finds that over some number of measurements provide lower quality or unsatisfactory quality signal (for example, let's use 5%, meaning that of the 1500 measurement points given in the above example, if more than 5% are incorrect, or 75 do not provide the same reading) then the station's measurement claiming satisfactory quality signal levels are being received in the grade-b contour should be considered invalid and a privilege to exclude distant signals be revoked for some period, until new measurements which correct these errors has been made and recertified by the station or the company that performed the tests for the station.

The period could be some factor such as six months from when a new measurement causes decertification of a station's test results, or until new results are certified, whichever is later. This would give an incentive for stations to make sure the evidence they provide is correct, as if it is found to have errors, they lose the privilege of mandating exclusivity from distant signals for at least six months.

A third party should be permitted to present the evidence to the Commission which will then allow the television station to rebut such evidence provided to show otherwise. In the event the station does not satisfactorily rebut the evidence, the original test shall be considered invalid and distant stations may be received by persons in the area where the failed test occurred.

The Commission may set range limits for invalidating test results, such that where a test is made it may simply invalidate those areas of grade b coverage and points beyond them until 6 months later or a recertified test result is made, whichever is later, or it may invalidate the entire test, or whatever it determines is the best choice under the circumstances.

Also, the results of such tests and any potential defeating claims should be considered part of the material made available by a station as part of its license and other records that are subject to public inspection in order that other parties have access to the data the station is using in the event they wish to confirm whether the test results available are or are not valid..

Respectfully Submitted,

Paul Robinson

Paul Robinson
"A computer programmer and Notary Public
in and for the Commonwealth of Virginia, at large."
General Manager
Robinson Telephone Company

May 18, 2005

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Technical Standards for Determining Eligibility	)	
For Satellite-Delivered Network Signals Pursuant	)	ET Docket No. 05-182
To the Satellite Home Viewer Extension and	)	
Reauthorization Act		

June 17, 2005

Response by:

Viamorph, Inc.
200 Innovation Blvd. Ste. 211
State College, PA 16803

Telephone 814-689-1729

Peter Bradshaw, Director of Business Development
John Ross, Vice-President for Research and Development
David Koller, Senior Systems Engineer

Viamorph, Inc. submits these comments in reply to the Notice of Inquiry ET Docket No. 05-182, In the Matter of Technical Standards for Determining Eligibility For Satellite-Delivered Network Signals Pursuant To the Satellite Home Viewer Extension and Reauthorization Act.

About Viamorph

Viamorph Inc. is a manufacturer and licensor of antenna technologies with applications in digital television. Viamorph is introducing to the consumer marketplace a new class of antennas that automatically adjusts their electrical shapes in response to changes in environment and signal conditions so as to maintain optimal performance at all times. This new technology, which we call DiSA™ (Digital Smart Antenna), is embodied in an antenna that can change virtually all of its electrical characteristics including gain, pattern and beamwidth. DiSA™ antennas operate in conjunction with receiver resident software which performs the signal analysis and controls the antenna configuration.

Introductory Comments

In order to assess the DTV experience from the consumer viewpoint, Viamorph conducted an extensive review of the comments available at numerous internet fora such as www.avsforum.com and product reviews at sites like www.circuitcity.com. As it is rare for reviewers to state all the particulars of their equipment and location etc., our methodology was necessarily simple - we assigned comments and reviews into broad subjective categories. Nonetheless, we believe that those sources are a wealth of valuable qualitative information regarding the DTV experience. In addition, we distributed a more structured questionnaire via a few of the fora. Our comments are based in part on the conclusions derived from all of those activities.

Some results of our research:

- For any particular antenna, customer reviews ran the gamut from very negative to very positive. A negative review is one in which the reviewer makes an explicit recommendation against the product and/or reports less than complete ability to receive all the local stations. While reviewers rarely indicated whether they were in urban, suburban or exurban environments we note that many reviewers indicated an ability to receive all the analog signals available to them but not all the digital signals.
- Many reviewers reported complete satisfaction with their antennas, stating they were able to receive all the available digital signals with minimum effort.
- Reviewers frequently report the need to make nearly continuous adjustments to their antennas, especially (but not only) when changing channels.
- Many reviewers have tried at least two antennas, some going through three or more, and still had varying degrees of success.
- Conflicting reviews were prevalent. For every antenna recommendation other reviewers reported that it didn't work for them.

We are also pleased to provide the Commission with comments due to a study conducted by Viamorph's Vice-President of Research and Development, John Ross, Ph.D., PE. Dr. Ross is an expert in applied electromagnetics and specializes in computer analysis, and design of vehicular antennas, wideband, and re-configurable antennas. While Dr. Ross was able, eventually, to receive *most* of the available DTV channels in Salt Lake City, Utah, it is clear that the level of expertise and effort required to do so is beyond the vast majority of consumers.

We also recommend Dr. O. Bendov's 1999 paper "On the Validity of the Longley-Rice (50,90/10) Propagation Model For HDTV Coverage and Interference Analysis" which documents the numerous shortcomings of the ILLR and the 50/90/10 methods. The paper is available at http://www.dielectric.com/broadcast/longley-rice.asp. His conclusion: "Analysis of the available field test results coupled with key theoretical considerations shows that a modification of the LR model will be required before it could be effectively used for HDTV coverage and interference prediction." The consumer experience has shown that this conclusion may be an understatement.

Among our conclusions based on the above, we believe that any predictive model must include methods to account for the wide and frequently unpredictable performance of the antennas available to consumers.

Comments to the specific items of the Notice

The Commission states in item 6 of the Notice, "*These criteria presume that households will exert similar efforts to receive DTV broadcast stations as they have always been expected to exert to receive NTSC analog TV signals.*" Our research indicates the level of effort (and not incidentally, expense) required for consumers to receive DTV signals OTA is often considerably greater than that required for analog signals. In our comments below we supply considerable justification for this conclusion.

With regard to item 7 of the Notice, Dr. Ross supplies the following comment:

> *This seems to be a significant issue based on my experience here in downtown Salt Lake City. My existing analog television service is very good. These signals are received via a directional outdoor antenna (with rotator). Despite the fact that the system performs very well for analog television, it did not perform well with a DTV receiver. Specifically, I found*

that the first time I connected the receiver to this antenna system the DTV receiver did not find a single one of the 10 available stations during the channel scan process.

With regard to item 9 of the Notice , our research indicates that aiming and antenna directivity issues are critical for many, if not most, consumers. Consider this typical comment at www.avsforum.com:

Some around here (No Va) can use the wider beam to get Balt and Wash without a rotator. Others will suffer multipath from that. Bite the bullet and call in the pros.

Respondents to our questionnaire also typically indicated the need to reorient their antenna in order to receive various channels and even then, respondents were frequently unable to receive all the DTV channels in their area.

Consider too, the article by Philip Yam in the June 2005 issue of *Scientific American* magazine, subtitled 'Receiving HDTV over the air takes luck and lots of patience'. The article opens

Keep the antenna level. Rotate it 90 degrees. Move it a few inches to the left. Stand to the right. Hold it a bit higher & there--nope. Try again.

We conclude that a fixed antenna is not a viable DTV antenna solution for many consumers. We further note that aiming is more difficult for DTV than for NTSC. According to the FCC's definitions, the difference in Signal-to-Interference ratio (SIR) between an unusable and a (merely) passable NTSC picture is approximately 20 dB. This allows a consumer to see gradual improvement or reduction in picture quality as he makes antenna adjustments, and makes it easy for him to optimize antenna orientation. In ATSC, the difference in SIR between an unusable and an excellent picture is less than 5dB, which makes it difficult for the consumer to see the effect of his antenna adjustments. As the consumer adjusts his antenna to receive a signal, he will often see no picture until he happens to orient the antenna in a direction in which the SIR exceeds Threshold of Visibility (TOV), and once this happens he may have no way of maximizing the SIR above TOV. As a result, the antenna may be oriented in a direction where the SIR is marginally above that required for TOV, and any reduction in signal strength due to the motion of people or vehicles, or changes in atmospherics will cause a loss of picture. And, of course, this adjustment procedure must be repeated for ATSC channels received from different directions. Frequently, the aiming operation must occur every time the viewer changes the channel.

With regard to items 10 and 11 of the Notice, we believe that the assumptions regarding the receiving system are unrealistic. We are unaware of any antenna available to consumers to date, at any price, which is optimized on a channel by channel basis as is the test antenna. Additionally, assuming optimal antenna orientation necessarily implies a rotor or other consumer controlled pointing mechanism. We have commented elsewhere that antenna aiming is considerably more important and difficult for DTV than for NTSC. The assumption that a receiving antenna may be optimally oriented is therefore unrealistic.

We also note that the gain of an antenna is additionally dependent on the intended frequency and bandwidth of operation. The Commission is aware that reception of distant signals usually calls for an antenna system with multiple elements, each designed for use at certain frequencies. For example, many, if not most, outdoor antenna installations incorporate separate elements for UHF and VHF reception. While those antennas are designed to provide the best gain performance in the intended *band* of operation, their gain performance at any *particular* frequency is lower than an optimal antenna *for that particular frequency*. The assumption that the receiving antenna is optimally chosen for frequency is therefore also unrealistic.

With regard to item 11 of the notice, Viamorph is introducing to the consumer marketplace a new class of antennas that automatically adjusts their electrical shapes in response to changes in environment and signal conditions so as to maintain optimal performance at all times. This new technology, which we call

DiSA™ (Digital Smart Antenna) is embodied in an antenna that can change virtually all of its electrical characteristics including gain, orientation and pattern as required. DiSA™ antennas operate in conjunction with receiver resident software which performs the signal analysis and controls the antenna configuration. The DiSA™ antenna solves most of the other thorny problems inherent in making a predictive model which must of necessity include consideration of antenna characteristics.

The Commission is aware of the fact that currently available antennas are designed for optimal operation at certain frequencies and bandwidths. An antenna designed for distant reception of low VHF signals will most likely not have sufficient gain to receive distant UHF signals. This fact explains the widespread usage of multiple element antenna systems with, for example, both log-periodic and bow-tie elements. Due to its unique properties, the DiSA™ antenna operates efficiently across a wide frequency band. We are currently using prototype models which demonstrate wide tunable bandwidth. One typical example proved usable from 50 MHz to over 800 MHz. Thus the consumer will need only one DiSA™ antenna regardless of ultimate broadcaster channel elections.

The DiSA™ antenna can be "pointed" to virtually any azimuth entirely by controlling internal switches – the antenna does not physically move. This azimuthal selection can be accomplished in milliseconds. This feature re-enables the viewer to channel surf as he no longer needs to get up to adjust the antenna each time he hits a button on the remote. In essence, the DiSA™ finally brings the convenience of the remote control to OTA DTV. The DiSA™ antenna thus avoids both the added expense of a rotor mechanism and the consumer effort of manual pointing.

The DiSA™ antenna form factor is amenable to indoor or outdoor mounting. The "standard model" today is a flat, rectangular package about 60 cm by 40 cm (approximately 23 inches by 16 inches) on a side and only 10 cm (less than two inches) thick. The DiSA™ antenna technology can be even be non-planar. We ask the Commission to note that indoor mounting necessarily implies lower gain and also entails yet another level of variability due to the various construction materials that might be encountered such as the wire plaster backer used in many older, exurban homes.

Viamorph believes that the term 'performance' should not be limited to strictly technical characteristics but should also include considerations of price, convenience, range of applicability and so on.

Concluding Comments

We believe that any predictive model must include methods to account for the wide and frequently unpredictable performance of the antennas available to consumers. It is our opinion that an accurate model would have to encompass extremely detailed geographical, botanical, atmospheric and other data. Due to the complexity and the lack of data such an effort seems impracticable. If such a model could be created, we estimate the uncertainty would be on the order of 10 dB or more.

We are convinced that no model which does not account for, in some way, the receiving antenna characteristics, is doomed to make grossly inaccurate predictions. Supposing a model were to be created as in the above paragraph, coupling its uncertainty with the wide range of antenna operation and placement factors produces a model with such a great degree of uncertainty as to be essentially useless.

We are pleased to bring the fact of an entirely new antenna technology to the Commission's awareness. Viamorph will be happy to provide additional information at the Commission's request.

Respectfully submitted,

Peter Bradshaw