Over-the-Air Television Antennas

34th Annual Trenton Computer Festival
Sat 25 Apr 2009

John DeGood
nu3e@arrl.net

Why Over-the-Air DTV?

- Free (important during a recession!)
  - 1-time cost for antenna installation
  - No recurring cable or satellite charges
- Highest quality picture
  - Many cable and satellite signals are further compressed (transmitted at a reduced bitrate)
- It's fun to experiment with antennas and reception
- Less prone to reception outages than cable or satellite

What You Need To Receive DTV

- Cable, FIOS, Satellite
  - Unaffected by June 12 transition date
  - Note: Analog signals are gradually being deprecated on cable systems
    - Cable subscribers will eventually require a set-top box, integrated “clear QAM” tuner, or CableCARD to receive most channels
- Over-the-Air
  - Newer TV with ATSC tuner
  - DTV Converter Box
  - Very likely a better antenna!

North American TV Frequencies

- VHF low-band (channels 2-6)
  - 54-88 MHz
- VHF high-band (channels 7-13)
  - 174-216 MHz
- UHF band (channels 14-51)
  - 470-698 MHz
- UHF band (channels 52-69 – until 12 June 2009)
  - 698-806 MHz
- UHF band (channels 70-83 – until 1982)
  - 806-890 MHz

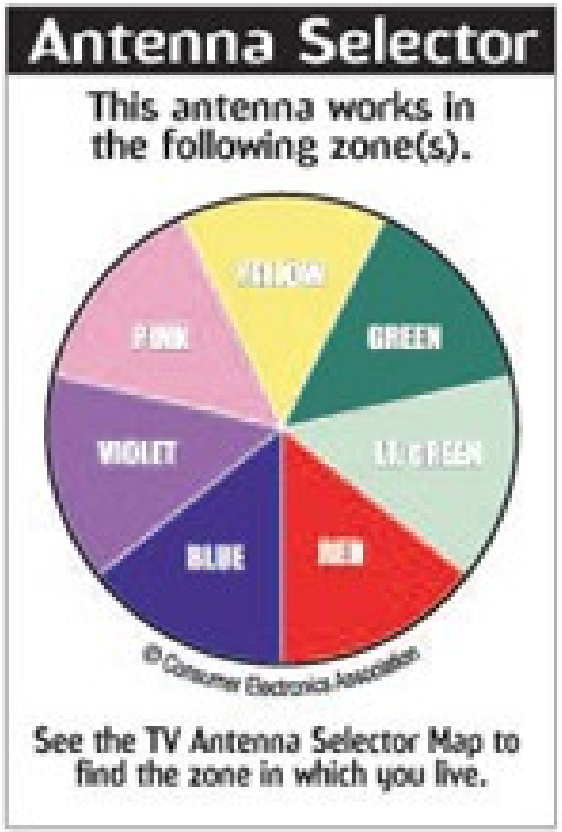
Types of Antennas

- Outdoor / Indoor
- Directional / Omnidirectional
- Large / Medium / Small
- UHF / VHF High / VHF Lo
- Amplified / Passive

Antenna Selection Resources

- Consumer Electronics Association
  - http://www.antennaweb.org/
- TV Fool
  - http://tvfool.com/

CEA Television Antenna Marks



CEA-2028 (ANSI) standard

CEA-2032 (ANSI) standard

Outdoor Antenna Color Coding

- Multidirectional
  - Yellow (small)
  - Green (medium)
  - Light green (large)
- Directional
  - Light green (small with pre-amp)
  - Red (medium)
  - Blue (medium with pre-amp)
  - Violet (large with pre-amp)

○ Show All Stations ◉ Show Digital Stations Only ○ Show Analog Stations Only

DTV	Antenna Type	Call Sign	Channel	Network	City, State	Live Date	Compass Heading	Miles From	Frequency Assignment
•	yellow uhf	WGTW-DT	48.1	TBN	BURLINGTON, NJ		247°	26.7	27
•	yellow uhf	WUVP-DT	65.1	UNI	VINELAND, NJ		247°	26.7	66
•	yellow uhf	WPSG-DT	57.1	CW	PHILADELPHIA, PA	Jun 12, 2009 (post-transition)	247°	26.7	32
•	yellow uhf	KYW-DT	3.1	CBS	PHILADELPHIA, PA		248°	26.9	26
•	yellow uhf	WPVI-DT	6.1	ABC	PHILADELPHIA, PA		248°	26.9	64
•	yellow uhf	WNJT-DT	43.1	PBS	TRENTON, NJ		94°	7.4	43
•	yellow uhf	WUVP-DT	65.1	UNI	VINELAND, NJ	Jun 12, 2009 (post-transition)	247°	26.7	29
•	yellow uhf	WPPX-DT	61.1	ION	WILMINGTON, DE	Jun 12, 2009 (post-transition)	247°	26.7	31
•	yellow uhf	WPHL-DT	17.1	MNT	PHILADELPHIA, PA	Jun 12, 2009 (post-transition)	247°	26.8	17
•	yellow uhf	WCAU-DT	10.1	NBC	PHILADELPHIA, PA	Jun 12, 2009 (post-transition)	247°	26.7	34
•	yellow uhf	WYBE-DT	34.1	PBS	PHILADELPHIA, PA	Jun 12, 2009 (post-transition)	247°	26.7	35
•	yellow uhf	KYW-DT	3.1	CBS	PHILADELPHIA, PA	Jun 12, 2009 (post-transition)	248°	26.9	26
•	yellow uhf	WTXF-DT	29.1	FOX	PHILADELPHIA, PA	Jun 12, 2009 (post-transition)	247°	26.8	42
•	yellow uhf	WNJT-DT	43.1	PBS	TRENTON, NJ	Jun 12, 2009 (post-transition)	94°	7.4	43
•	yellow uhf	WPSG-DT	57.1	CW	PHILADELPHIA, PA		247°	26.7	32
•	yellow uhf	WPPX-DT	61.1	ION	WILMINGTON, DE		247°	26.7	31
•	yellow uhf	WPHL-DT	17.1	MNT	PHILADELPHIA, PA		247°	26.7	54
•	yellow uhf	WTXF-DT	29.1	FOX	PHILADELPHIA, PA		249°	26.1	42
•	yellow uhf	WYBE-DT	34.1	PBS	PHILADELPHIA, PA		247°	26.7	34
•	green vhf	WPVI-DT	6.1	ABC	PHILADELPHIA, PA	Jun 12, 2009 (post-transition)	248°	26.8	6
•	green vhf	WHYY-DT	12.1	PBS	WILMINGTON, DE	Jun 12, 2009 (post-transition)	247°	26.8	12
•	lt green uhf	WHYY-DT	12.1	PBS	WILMINGTON, DE		247°	26.8	50
•	red uhf	WCAU-DT	10.1	NBC	PHILADELPHIA, PA		247°	26.7	67
•	violet vhf	WBPH-DT	59.1	FMN	BETHLEHEM, PA	Jun 12, 2009 (post-transition)	315°	38.3	9
•	violet uhf	WNJS-DT	22.1	PBS	CAMDEN, NJ	Jun 12, 2009 (post-transition)	194°	37.2	22
•	violet vhf	WNJB-DT	8.1	PBS	NEW BRUNSWICK, NJ		47°	29.8	8

Note:

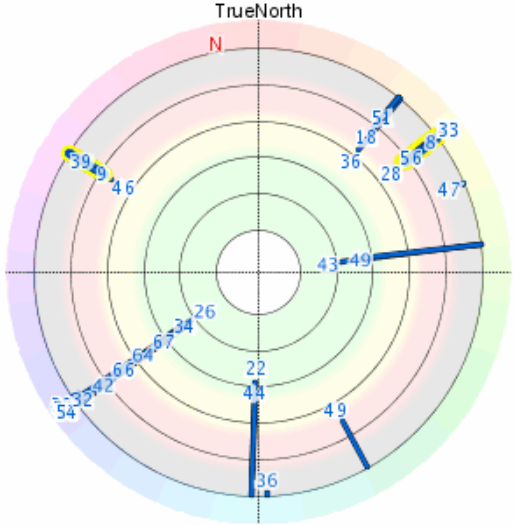
The above listing is a conservative prediction of stations received. Depending on the specifics of your installation, you may be able to receive stations that do not appear in this list.

AntennaWeb.org, 25 Apr 2009, TCNJ (08628), 25 feet

TCF Demo

Digital Only

TrueNorth



Search Criteria

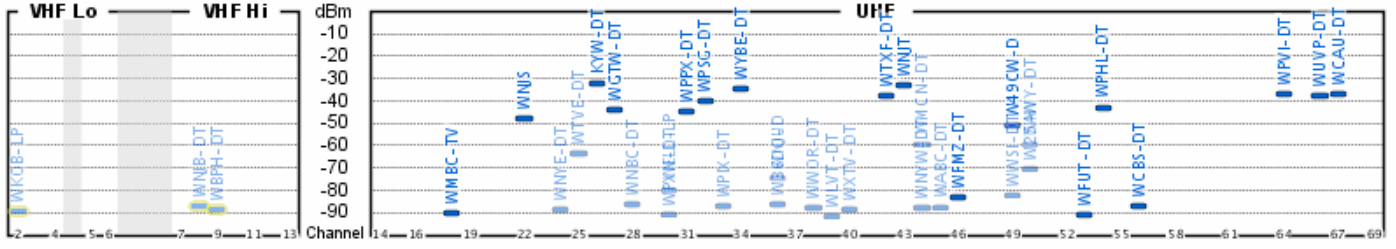
Zipcode 08628
Height: 25.0 ft.

db datecode
200904170029

www.tvfool.com

Callsign	Channel Real	Channel (Virt)	Netwk	Signal NM(dB)	Signal Pwr(dBm)	Path	Dist miles	Azimuth True	Azimuth (Magn)
KYW-DT	26	(3.1)	CBS	58.6	-32.3	LOS	27.2	235°	(247°)
WNJT	43	(52.1)	PBS	57.5	-33.3	LOS	7.2	83°	(95°)
WYBE-DT	34	(35.1)	Ind	56.0	-34.9	LOS	27.0	234°	(247°)
WCAU-DT	67	(10.1)	NBC	54.0	-36.8	LOS	27.0	234°	(247°)
WPVI-DT	64	(6.1)	ABC	53.7	-37.1	LOS	27.2	235°	(247°)
WUVP-DT	66	(65.1)	Uni	53.4	-37.5	LOS	27.0	234°	(247°)
WTXF-DT	42	(29.1)	Fox	53.3	-37.5	LOS	27.1	234°	(247°)
WPSG-DT	32	(57.1)	CW	50.5	-40.4	LOS	27.0	234°	(247°)
WPHL-DT	54	(17.1)	MyN	48.0	-42.8	LOS	27.0	234°	(247°)
WGTW-DT	27	(48.1)	Ind	47.0	-43.9	LOS	27.0	234°	(247°)
WPPX-DT	31	(61.1)	ION	45.9	-45.0	LOS	27.0	234°	(247°)
WNJS	22	(23.1)	PBS	42.7	-48.2	LOS	37.5	182°	(194°)
W49CW-D	49			39.5	-51.4	LOS	7.2	83°	(95°)
WMCN-DT	44	(44.1)	Ind	31.6	-59.3	LOS	37.5	182°	(194°)
WHYY-DT	50	(12.1)	PBS	31.5	-59.3	LOS	27.1	234°	(247°)
WTVE-DT	25	(51.1)	Ind	27.4	-63.5	LOS	27.0	234°	(247°)
W25AW	50	(25.1)		20.5	-70.4	LOS	23.7	235°	(248°)
WNJU	36	(47.1)	TEL	16.4	-74.4	2Edge	47.7	39°	(52°)
WELL-LP	30	(45.1)		11.2	-79.7	LOS	27.0	234°	(247°)
WWSI-DT	49	(62.1)	TEL	8.8	-82.1	LOS	50.6	151°	(163°)
WFMZ-DT	46	(69.1)	Ind	7.6	-83.3	2Edge	38.5	302°	(315°)
W36DO-D	36	(53.1)		4.5	-86.3	1Edge	27.0	234°	(247°)
WNBC-DT	28	(4.1)	NBC	4.5	-86.4	2Edge	55.1	53°	(65°)
WCBS-DT	56	(2.1)	CBS	4.1	-86.7	2Edge	55.1	53°	(65°)
WNJB-DT	8	(58.1)	PBS	3.6	-87.3	2Edge	55.4	53°	(65°)
WPIX-DT	33	(11.1)	CW	3.4	-87.4	2Edge	55.1	53°	(65°)
WABC-DT	45	(7.1)	ABC	3.3	-87.5	2Edge	55.1	53°	(65°)
WWOR-DT	38	(9.1)	MyN	3.1	-87.8	2Edge	55.1	53°	(65°)
WNYW-DT	44	(5.1)	Fox	2.8	-88.1	2Edge	55.1	53°	(65°)
WBPH-DT	9	(60.1)	Ind	2.4	-88.4	2Edge	38.5	302°	(315°)
WXTV-DT	40	(41.1)	Uni	2.3	-88.6	2Edge	55.1	53°	(65°)
WNYE-DT	24	(25.1)	Ind	2.0	-88.8	2Edge	55.4	53°	(65°)
WKOB-LP	2	(42.1)		1.5	-89.3	2Edge	55.1	53°	(65°)
WMBC-TV	18		Ind	0.6	-90.2	2Edge	52.6	38°	(51°)
WPXN-DT	30	(31.1)	ION	0.2	-90.7	2Edge	55.1	53°	(65°)
WFUT-DT	53	(68.1)	Tel	0.1	-90.7	2Edge	55.5	53°	(65°)
WLVT-DT	39	(39.1)	PBS	-0.6	-91.5	2Edge	38.5	302°	(315°)
WNET-DT	61	(13.1)	PBS	-10.9	-101.7	2Edge	55.1	53°	(65°)
WNJN	51	(50.1)	PBS	-11.2	-102.0	2Edge	52.7	38°	(51°)
WNAI-LP	41	(41.1)		-11.3	-102.1	LOS	27.0	234°	(247°)
WJZ-DT	38	(13.1)	CBS	-17.0	-107.9	Tropo	116.1	236°	(249°)
WNUV-DT	40	(54.1)	CW	-17.4	-108.2	Tropo	116.0	236°	(249°)
WLNY-DT	47		Ind	-18.8	-109.6	Tropo	109.5	67°	(79°)
WMGM-DT	36	(40.1)	NBC	-18.9	-109.7	Tropo	79.4	178°	(190°)
WTBY-DT	27	(54.1)	Ind	-20.2	-111.1	Tropo	96.2	29°	(41°)
WSAH-DT	42	(43.1)	Ind	-20.3	-111.1	Tropo	117.6	50°	(62°)
WMAR-DT	52	(2.1)	ABC	-20.6	-111.4	Tropo	116.1	236°	(249°)
W45CP	45	(45.1)		-21.3	-112.2	2Edge	66.4	161°	(174°)
WRNN-DT	48		Ind	-21.4	-112.2	Tropo	96.1	29°	(41°)
WASA-LP	25	(64.1)		-21.6	-112.4	2Edge	55.4	53°	(65°)
WUSA	34	(9.1)	CBS	-21.8	-112.7	Tropo	150.0	232°	(245°)

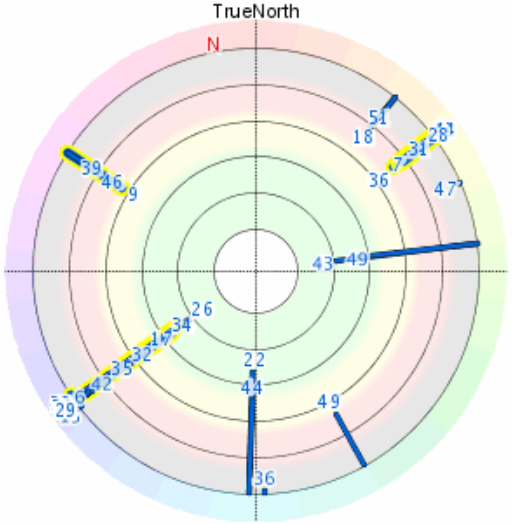
c = Co-channel warning a = Adjacent channel warning



TVFool.com, 25 Apr 2009, TCNJ (08628), 25 feet

TCF Demo
Digital Only

TrueNorth



Search Criteria

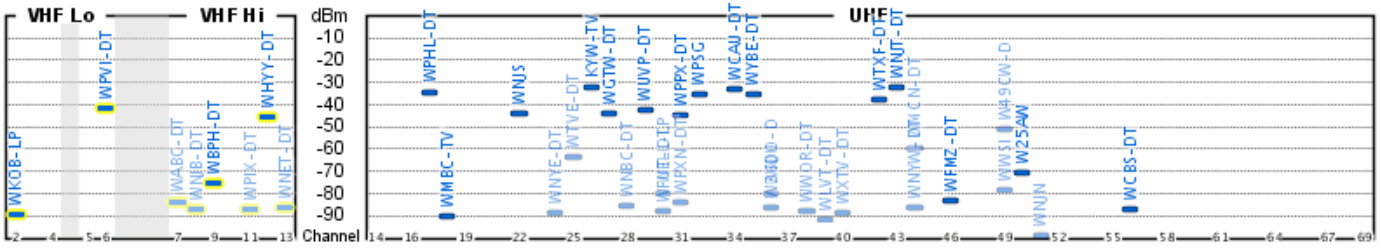
POST-TRANSITION
Zipcode 08628
Height: 25.0 ft.

db datecode
200904170029

www.tvfool.com

Callsign	Channel Real	(Virt)	Netwk	Signal NM(dB)	Pwr(dBm)	Path	Dist miles	Azimuth True	(Magn)
KYW-TV	26	(3.1)	CBS	58.7	-32.2	LOS	27.2	235°	(247°)
WNJT-DT	43	(52.1)	PBS	58.6	-32.3	LOS	7.2	83°	(95°)
WCAU-DT	34	(10.1)	NBC	57.5	-33.3	LOS	27.0	234°	(247°)
WPHL-DT	17	(17.1)	MyN	56.7	-34.2	LOS	27.1	234°	(247°)
WPSG	32	(57.1)	CW	55.5	-35.3	LOS	27.0	234°	(247°)
WYBE-DT	35	(35.1)	Ind	55.3	-35.5	LOS	27.0	234°	(247°)
WTXF-DT	42	(29.1)	Fox	53.3	-37.5	LOS	27.1	234°	(247°)
WPVI-DT	6		ABC	49.2	-41.7	LOS	27.0	235°	(247°)
WUVP-DT	29	(65.1)	Uni	48.6	-42.2	LOS	27.0	234°	(247°)
WGTW-DT	27	(48.1)	Ind	47.0	-43.9	LOS	27.0	234°	(247°)
WNJS	22	(23.1)	PBS	46.9	-43.9	LOS	37.5	182°	(194°)
WPPX-DT	31	(61.1)	ION	45.9	-44.9	LOS	27.0	234°	(247°)
WHYY-DT	12	(12.1)	PBS	45.6	-45.2	LOS	27.1	234°	(247°)
W49CW-D	49			39.5	-51.4	LOS	7.2	83°	(95°)
WMCN-DT	44	(44.1)	Ind	31.6	-59.3	LOS	37.5	182°	(194°)
WTVE-DT	25	(51.1)	Ind	27.4	-63.5	LOS	27.0	234°	(247°)
W25AW	50	(25.1)		20.5	-70.4	LOS	23.7	235°	(248°)
WBPH-DT	9	(60.1)	Ind	15.3	-75.5	2Edge	38.5	302°	(315°)
WWSI	49	(62.1)	TEL	12.7	-78.1	LOS	50.6	151°	(163°)
WELL-LP	30	(45.1)		11.2	-79.7	LOS	27.0	234°	(247°)
WNJU	36	(47.1)	TEL	10.7	-80.2	2Edge	55.1	53°	(65°)
WFMZ-DT	46	(69.1)	Ind	7.5	-83.4	2Edge	38.5	302°	(315°)
WABC-DT	7	(7.1)	ABC	7.3	-83.6	2Edge	55.1	53°	(65°)
WPXN-DT	31	(31.1)	ION	7.1	-83.8	2Edge	55.1	53°	(65°)
WNBC-DT	28	(4.1)	NBC	5.0	-85.8	2Edge	55.1	53°	(65°)
WNYW-DT	44	(5.1)	Fox	4.6	-86.2	2Edge	55.1	53°	(65°)
W36DO-D	36	(53.1)		4.5	-86.3	1Edge	27.0	234°	(247°)
WNET-DT	13	(13.1)	PBS	4.4	-86.4	2Edge	55.1	53°	(65°)
WCBS-DT	56	(2.1)	CBS	4.1	-86.7	2Edge	55.1	53°	(65°)
WPIX-DT	11	(11.1)	CW	4.0	-86.8	2Edge	55.1	53°	(65°)
WNJB-DT	8	(58.1)	PBS	3.6	-87.3	2Edge	55.4	53°	(65°)
WWOR-DT	38	(9.1)	MyN	3.1	-87.8	2Edge	55.1	53°	(65°)
WFUT-DT	30	(68.1)	Tel	2.6	-88.2	2Edge	55.1	53°	(65°)
WXTV-DT	40	(41.1)	Uni	2.2	-88.6	2Edge	55.1	53°	(65°)
WNYE-DT	24	(25.1)	Ind	2.1	-88.7	2Edge	55.4	53°	(65°)
WKOB-LP	2	(42.1)		1.5	-89.3	2Edge	55.1	53°	(65°)
WMBC-TV	18		Ind	0.6	-90.2	2Edge	52.6	38°	(51°)
WLVT-DT	39	(39.1)	PBS	-0.6	-91.5	2Edge	38.5	302°	(315°)
WNJN	51	(50.1)	PBS	-7.9	-98.7	2Edge	52.6	38°	(51°)
WNAI-LP	41	(41.1)		-11.3	-102.1	LOS	27.0	234°	(247°)
WMAR-DT	38	(2.1)	ABC	-17.0	-107.9	Tropo	116.1	236°	(249°)
WNUV-DT	40	(54.1)	CW	-17.4	-108.2	Tropo	116.0	236°	(249°)
WLNY-DT	47		Ind	-18.8	-109.6	Tropo	109.5	67°	(79°)
WMGM-DT	36	(40.1)	NBC	-18.9	-109.7	Tropo	79.4	178°	(190°)
WFDC-DT	15	(14.1)	Uni	-18.9	-109.8	Tropo	150.6	232°	(245°)
WJZ-TV	13	(13.1)	CBS	-19.9	-110.7	Tropo	116.1	236°	(249°)
WTBY-DT	27	(54.1)	Ind	-20.2	-111.1	Tropo	96.2	29°	(41°)
WSAH-DT	42	(43.1)	Ind	-20.3	-111.1	Tropo	117.6	50°	(62°)
WPMT	47	(43.1)	Fox	-20.4	-111.2	Tropo	95.2	260°	(272°)
WTTG-DT	36	(5.1)	Fox	-20.7	-111.5	Tropo	149.9	233°	(245°)
W45CP	45	(45.1)		-21.3	-112.2	2Edge	66.4	161°	(174°)

c = Co-channel warning a = Adjacent channel warning



TVFool.com, 12 Jun 2009, TCNJ (08628), 25 feet

Full-Size Outdoor Antenna Sources

- Local
  - Radio Shack
- Mail Order
  - http://solidsignal.com/

Outdoor Antennas

Outdoor Antennas

- Advantages
  - Best performance
  - Easy to add rotation
- Disadvantages
  - Aesthetics
  - Restrictive covenants (see following slide)
  - Cost
  - Weather damage & degradation
  - Difficult & risky installation

FCC Preemption of Restrictions

As directed by Congress in Section 207 of the Telecommunications Act of 1996, the Federal Communications Commission adopted the Over-the-Air Reception Devices (“OTARD”) rule concerning governmental and nongovernmental restrictions on viewers' ability to receive video programming signals from direct broadcast satellites ("DBS"), broadband radio service providers (formerly multichannel multipoint distribution service or MMDS), and television broadcast stations ("TVBS").

The rule (47 C.F.R. Section 1.4000) has been in effect since October 1996, and it prohibits restrictions that impair the installation, maintenance or use of antennas used to receive video programming. The rule applies to video antennas including direct-to-home satellite dishes that are less than one meter (39.37") in diameter (or of any size in Alaska), TV antennas, and wireless cable antennas. The rule prohibits most restrictions that: (1) unreasonably delay or prevent installation, maintenance or use; (2) unreasonably increase the cost of installation, maintenance or use; or (3) preclude reception of an acceptable quality signal.

Effective January 22, 1999, the Commission amended the rule so that it also applies to rental property where the renter has an exclusive use area, such as a balcony or patio.

http://www.fcc.gov/mb/facts/otard.html

Amplified Omnidirectional

Channel Master SMARTenna Tv Antenna

Provides excellent 360 degree television reception. Range of 30 miles for UHF and 45 miles for VHF. Equipped with internal UHF/VHF amplifier with FM trap. Includes C-UL and UL approved AC power supply and injector.

Omnidirectional Amplified Antenna. Great for suburban/metro area reception. Antenna allows reception of stations from different directions. Eliminates the use of rotator systems and allows better reception in weak locations and boosts the signal from the antenna. Accepts up to 1.5 inch OD pipe mast (not includes). Not recommended for areas with high multipath problems.

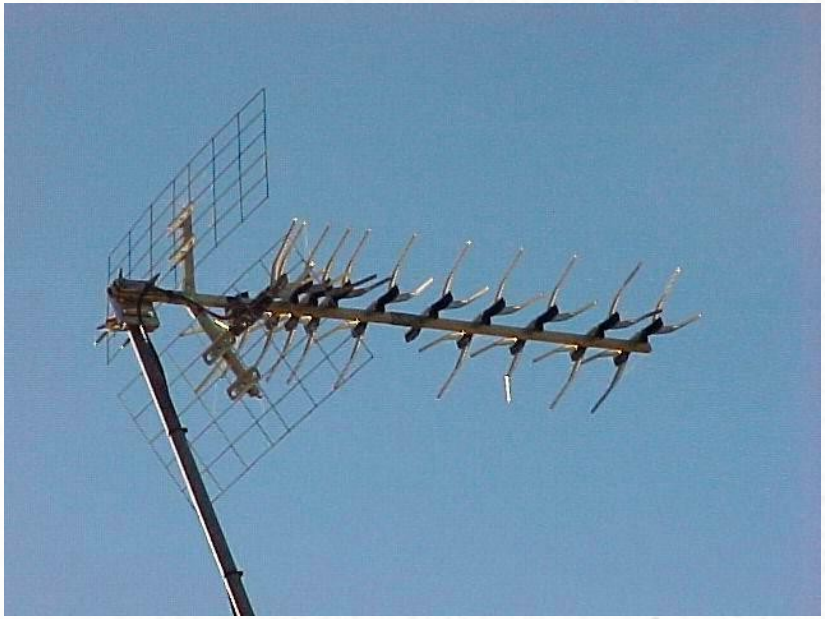
Amplified Near-Omnidirectional

Model DAE-100C
UHF/VHF/FM Active color antenna

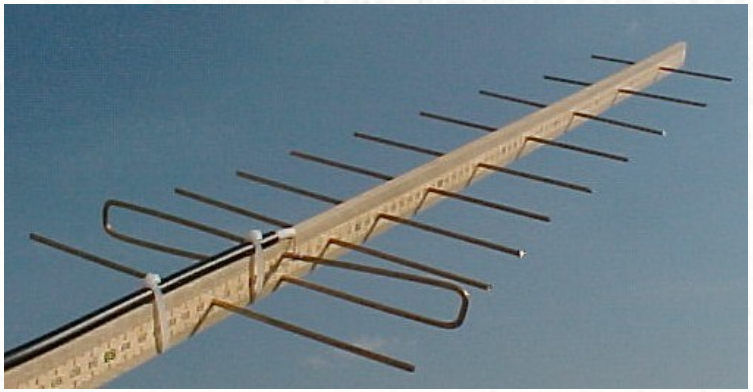
15-24dB. VHFand UHF signal amplifier
For use on rooftop, Van, Motorhome or boat
Do not use in urban area.

Power supply (PS-200C) : 12 VDC or 110 volts 60Hz.

UHF-Only Antennas



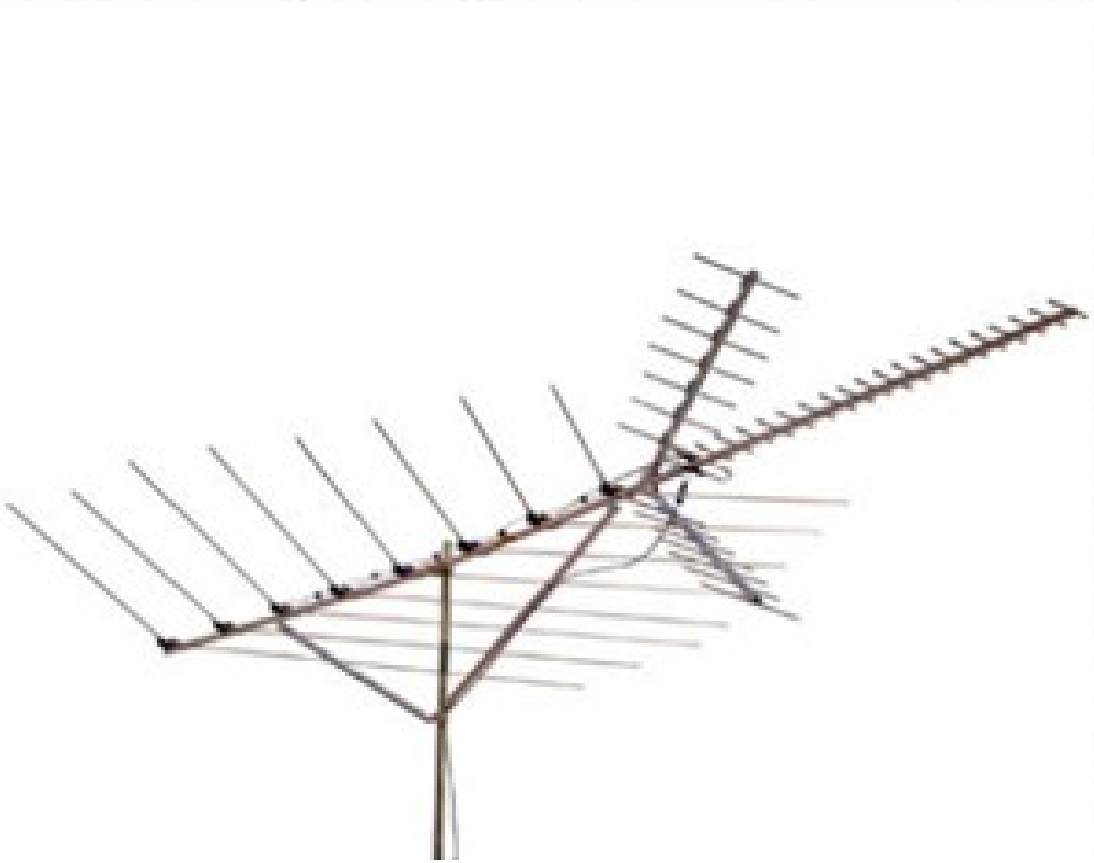
Corner-Reflector



Homebrew Yagi-Uda

Bow-Tie

“All Channel” UHF-VHF-FM



Installation Considerations

- Mast
  - Rooftop/tripod/side-of-home/free-standing
  - Guy wires if needed
  - Dangers: falls and powerlines!!!
- Feedline
  - Good quality coax, weatherproof connections
- Preamplifier
  - For weak signals, install at antenna
  - For distribution loss, install before signal degradation is too great

Attic Antennas

- Advantages
  - Better performance
  - No weather damage or degradation
  - Less injury risk...but don't fall through ceiling!
- Disadvantages
  - Performance may be degraded by nearby objects
  - Truss construction can make installation challenging
  - Rotation not be possible with trusses

Indoor Antennas

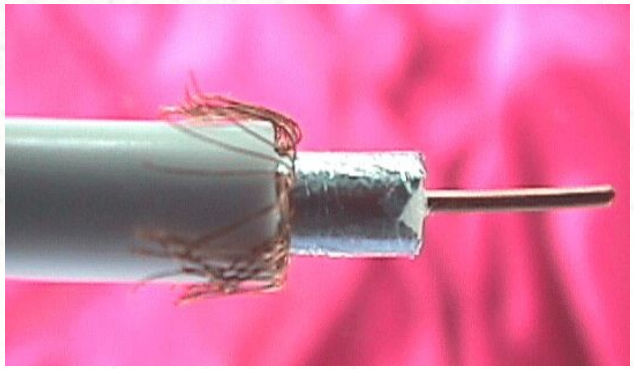
- Advantages
  - Lowest cost
  - Easiest installation
- Disadvantages
  - Worst performance
  - Interference from people and nearby objects

300 Ohm Balanced "Twin Lead"

- 300 ohm "twin lead" should be avoided
  - Less loss than coax when dry
  - More loss than coax when wet
  - Weather degradation
  - Unshielded
  - Must carefully avoid routing near

75 Ohm Coaxial Cable

- OTA TV and satellite coax standard is 75 ohm
  - Loss increases with frequency: worst at UHF!
- RG-59
  - Less expensive, often low quality
  - Higher loss
  - Avoid!
- RG-6
  - Less loss
  - Required for satellite systems



F-Type Coaxial Connectors

- Spin-on
  - Most costly connector
  - No-tool installation, but poor mechanical and electrical integrity. Avoid!
- Compression
  - More costly connector
  - Compression tool is reasonable cost
- Crimp
  - Least costly connector
  - Good connection requires costly pro crimp tool

F-Type Coaxial Connectors

Screw-On

Compression

Crimp

F-Type Connector Installation Tools

Professional Crimp Tool

Economy Crimp Tool

Compression Tool

Economy Coax Stripper

Typical UHF/VHF Splitter

Combining OTA and Satellite

- Receive local stations over-the-air
- Receive premium stations via satellite
  - Dish Network or DirecTV
- Coaxial cable alternatives
  - Use separate cables for satellite and OTA
    - More wires
  - Combine / separate signals using *diplexers*
    - Cost of diplexers
    - Some signal loss

Typical Satellite-OTA Diplexer

Important DTV Points to Remember

- Many digital stations will move to different channel numbers after transition
  - Rescan for new channels, repeat periodically after transition
- Post-transition Philadelphia area reception will still require a VHF/UHF antenna
  - VHF: 6, 12
  - UHF: 3 (real 26), 10 (real 34), 17, 23 (real 22), 29 (real 42), 35, 52 (real 43), 57 (real 32), etc.