Application Note
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70cm & Microwave Amateur TV Frequencies

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Licensed amateur radio operators in the USA are permitted by the FCC to transmit, live, fast-scan, color television pictures with audio in the 70cm (420-450 MHz) band and all higher frequency amateur radio bands (33cm, 23cm, 13cm, etc.). Where possible, hams in the USA have tried to adhere to the commercial broadcast and cable TV standard channels with 6 MHz channel spacing. For the 70cm band, this means using cable TV channels 57 through 61. For the 33cm (902-928 MHz) band, this means using cable TV channels 143, 144, and 145.

Commercial broadcast and CATV, NTSC, analog TV transmissions used Vestigial Upper Side Band (VUSB) modulation of the video signal with the video carrier 1.25 MHz above the lower channel edge. 25 kHz deviation FM modulation was used for the audio signal with the audio carrier 4.5 MHz above the video carrier (i.e. 5.75 MHz above the lower channel edge). All of the emitted spectrum was to be contained within the authorized 6 MHz channel. Analog TV transmitter power was specified the same as for a SSB transmitter, i.e. peak-envelope power (PEP) with the peak occurring on the sync tips.

With the transition of commercial TV broadcast from analog to digital, the 6 MHz channel widths and spacing were retained. The same frequencies and channel numbers were also retained for digital TV. In the USA, commercial broadcast digital TV (DTV) uses the 8VSB-ATSC modulation method to convey both the video and audio signals. On the cable TV systems, Quadrature Amplitude Modulation (QAM) is used with typically either 64 or 256 level. (i.e. 64QAM or 256QAM). Again, all of the emitted spectrum is required to be contained within the authorized 6 MHz channel. USA TV Amateurs are now also transitioning to digital TV. Most USA DATV hams are using the European Digital Video Broadcasting - Terrestrial, DVB-T, digital TV modulation technique on the ham bands. For DVB-T in the USA, they are adhering to maximum bandwidths of 6 MHz. Some ATV repeater groups, especially in large metro areas, are using narrower DVB-T bandwidths down to 2 MHz.

70 cm Ham TV Frequencies --- The CATV channels 57 - 61 span the 70cm ham band. Thus, many hams opt to use these same channels and frequencies for the ease in reception of analog, NTSC TV using ordinary, off-the-shelf, TV receivers. However, in certain portions of the USA, the local conventions established many years ago dictate the use of other, non-standard frequencies. The most commonly used are 426.25 MHz and 434 MHz. Also in some areas, inverted sideband, VLSB, is used. For these non-standard operations, oftentimes separate, specialized down converters and receivers are required. Where applicable, I have also listed the recommendations from the ARRL national band plans. http://www.arrl.org/band-plan

It should also be noted that when CATV modulators are used to generate a VUSB-TV signal, that some modulators also have the ability to impart frequency shifts with the throw of a slide switch to Incremental Visual Carrier (IRC) and Harmonic Visual Carrier (HRC). The IRC shift is up +125 kHz. The HRC shift is down -1.25 MHz. As an example standard CATV channel 57 = 421.25 MHz, while IRC-57 = 421.2625 MHz and HRC-57 = 420.00 MHz.

Channel Frequency (MHz)	Cable Channel Number	VUSB Video Carrier (MHz)	VUSB Audio Carrier (MHz)	DTV Carrier (MHz)	Notes:
420-426	57	421.25	425.75	423	ARRL TV repeater outputs or simplex
426-432	58	427.25	431.75	429	ARRL TV simplex
432-438	59	433.25	437.75	435	only use if 57, 58 & 60 are in use
438-444	60	439.25	443.75	441	ARRL TV repeater inputs
444-450	61	445.25	449.75	447	do not use
425-431	ham426	426.25	430.75	- na -	regional usage only
432.75 - 438.75	ham434	434.00	438.50	- na -	regional usage only

Note 1: Amateurs are not allowed to use the frequencies 420-430 MHz near the Canadian border and north of the "Line A" boundary.

33 cm Ham TV Frequencies ---- The 33cm band covers from 902 to 928 MHz and with 26 MHz has space for a maximum of four, 6 MHz TV channels. Three CATV channels land completely within the band. The ARRL recommends three TV channels on 33cm between 909 & 927 MHz. The 33cm band is more fragmented and doesn't have as much standardization among TV hams. It should be noted that the 33cm band is also an unlicensed ISM band and operations are subject to severe RFI from these other unlicensed ISM users and devices.

Channel Frequency (MHz)	Channel Number	VUSB Video Carrier (MHz)	VUSB Audio Carrier (MHz)	DTV Carrier (MHz)	Notes:
906-912	143	907.25	911.75	909	CATV-143
912-918	144	913.25	917.75	915	CATV-144 also used for FM-TV with 915 MHz carrier
918-924	145	919.25	923.75	921	CATV-145
909-915	33-1	910.25	914.75	912	ARRL channel 33-1
915-921	33-2	916.25	920.75	918	ARRL channel 33-2
921-927	33-3	922.25	926.75	924	ARRL channel 33-3

23 cm Ham TV Frequencies ---- The 23cm band is the second most popular band for ATV after the 70cm band. The 23cm band covers from 1240 to 1300 MHz and with 60 MHz has space for a maximum of ten, 6 MHz TV channels. The CATV channel designators do not extend above 1 GHz. The IF frequencies of broadcast TV satellites do straddle the 23cm band and some hams are using satellite TV receivers for this band. Analog ham TV activity on 23cm is either 12+MHz wide, AM-TV or FM-TV, typically with 4 MHz deviation and 6 MHz sound sub-carrier(s). In the USA, most digital ATV uses DVB-T. In the 23cm band, 6 MHz bandwidth DVB-T is common using the standard analog channels. In Europe, most of the ham digital TV (DTV) activity is located on this band using DVB-S modulation and low cost, satellite "Free-to-Air" (FTA) receivers. The British Amateur TV Club (BATC) also provides DVB-S & S2 gear for this band. The most commonly used frequency for FM-TV and DTV is 1255 MHz. As with 33cm, the frequencies used on 23cm are splintered and sometimes don't follow the standard table below. It should be noted that the FAA has installed new, radars in the 23cm band which will limit amateur use of certain frequencies in the vicinity of these radars. This is particularly a problem in major metro areas.

Channel Frequency (MHz)	Channel Number	VUSB Video Carrier (MHz)	VUSB Audio Carrier (MHz)	FM or DTV Carrier (MHz)	Notes:
1240-1246	23-1	1241.25	1245.75	1243	ARRL ATV #1
1246-1252	23-2	1247.25	1251.75	1249	
1252-1258	23-3	1253.25	1257.75	1255	ARRL ATV #2
1258-1264	23-4	1259.25	1263.75	1261	
1264-1270	23-5	1265.25	1269.75	1267	
1270-1276	23-6	1271.25	1275.75	1273	
1276-1282	23-7	1277.25	1281.75	1279	ARRL ATV #3
1282-1288	23-8	1283.25	1287.75	1285	
1288-1294	23-9	1289.25	1293.75	1291	ARRL experimental, simplex ATV
1294-1300	23-10	1295.25	1299.75	1297	
1240-1260					ARRL, FM-TV
1260-1270				1265	ARRL, wide-band, experimental simplex

13 cm Ham TV Frequencies ---- The 13cm band is split into two segments from 2300 to 2310 MHz and 2390 to 2450 MHz. The ARRL band plan does not allow wide-band signals, such as TV in the 2300-2310 MHz portion. It should be noted that the frequencies from 2400 to 2450 MHz, in the 13cm band are also an unlicensed ISM band and operations are subject to severe RFI from these other unlicensed ISM users and devices. In particular, there is extremely wide spread use of this band for Wi-Fi routers. The only clear region for relatively RFI free TV operation is the 10 MHz portion from 2390 to 2400 MHz. Clearly then 2.39 to 2.40 GHz should be our first choice for any TV operations at 13 cm.

9 cm Ham TV Frequencies ---- The 9 cm band covers from 3.4 to 3.4 GHz. It is currently under attack by cell phone companies and we are losing portions of this band. Check with the ARRL for the current status. The ARRL band plan allows wide-band modes (> 1 MHz), such as TV, in the segments: 3.31 to 3.33 GHz and 3.36 to 3.4 GHz, They encourage TV to use the segment 3.36 to 3.38 GHz.

5 cm Ham TV Frequencies ---- The 5 cm band covers from 5.65 to 5.925 GHz. The ARRL band plan allows wide-band modes (> 1 MHz) in two, 75 MHz, segments: 5.675 to5.75 GHz and 5.85 to 5.925 GHz. The ARRL has not specified any specific slots for ATV. It should be noted that this is another band shared with unlicensed, ISM transmitters. The ISM band is from 5.725 to 5.875 GHz. It too is being used now for Wi-Fi. To avoid 5.8 GHz Wi-Fi, we should probably first put our TV operations in the 50 MHz segments of 5.675 to 5.725 GHz and 5.875 to 5.925 GHz. Inexpensive, FM-TV transmitters for the 5.8 GHz band are available. They are designed and intended for the drone market. They presently are the most affordable way to do analog ATV.

3 cm Ham TV Frequencies ---- The 3 cm band covers from 10.0 to 10.5 GHz. The ARRL band plan allows wide-band modes (> 1 MHz) in the segments: 10.125 to 10.2 GHz, 10.2 to 10.3 GHz, and 10.375 to 10.45 GHz. The ARRL has not specified any specific slots for ATV.