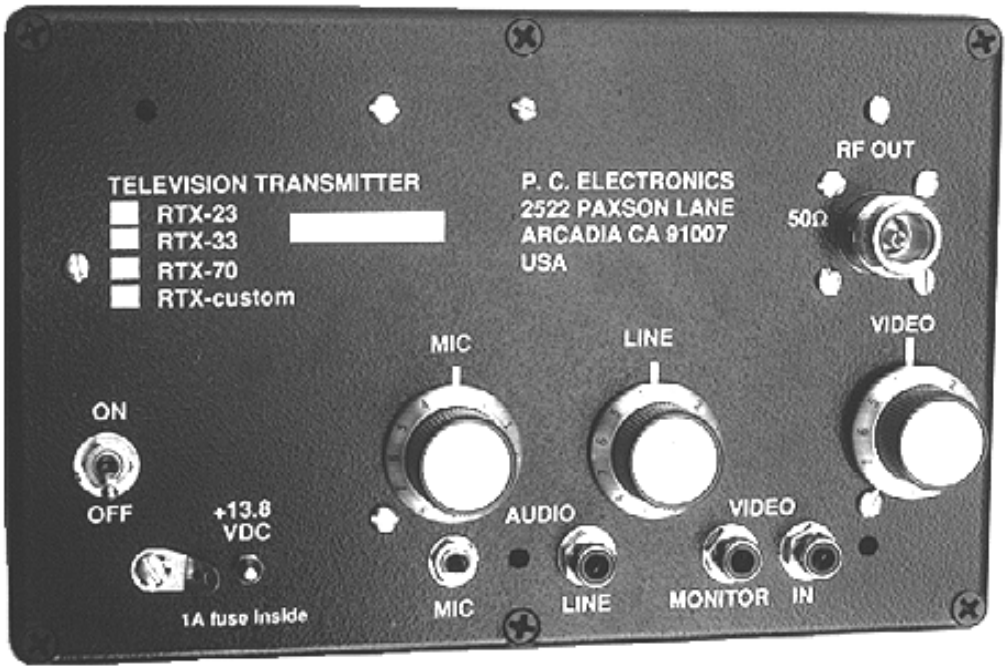
P. C. Electronics 2522 Paxson Lane Arcadia CA 91007-8537 USA
Tel: **1-626-447-4565** m-th 8am-5:30pm pst (UTC - 8) Tom (W6ORG) & Mary Ann (WB6YSS)

24 hr FAX order line 1-626-447-0489
Email: Tom6ORG@hamtvl.com Web site: http://www.hamtv.com

RTX70-1 70 CM ATV REPEATER TRANSMITTER

USERS MANUAL



The RTX70-1 ATV repeater transmitter is designed to provide over 1 Watt p.e.p. (sync tip) of video modulated RF in the 70 CM (420-450 MHz) amateur band. Any licensed Technician class or higher Radio Amateur may operate this transmitter in accordance with part 97 of the FCC Rules and Regulations. The RTX70-1 accepts U.S.A. standard composite video (1 volt pk-pk) from any source such as our ATVR series receivers, IntuitiveCircuits OSD-ID(PC) identifiers, color or black and white TV cameras or camcorders, VCRs, or computers for transmission. Audio from these sources or a low impedance dynamic mic is also transmitted on the 4.5 MHz sound subcarrier.

PLEASE read through this manual and our ATV Repeater Application Notes before plugging in an cables and attempting operation. Each connector and control is described here to enable your proper hookup and operation. Also the unique video practices associated with ATV and the 70 CM band are described. The RTX70-1 uses the TXA5-RCb transmitter board and the FMA5-G sound subcarrier board packaged in a shielded die cast aluminum box.

+13.8 Vdc INPUT FEED-THROUGH. The adjacent solder lug is for the negative power supply return lead. The two wires should go directly back to the power supply terminals. Power ground loops and video noise could result if the chassis connection to a panel or other equipment is used for ground instead of a wire, or if the + lead goes to a common terminal with other equipment not at the regulated power supply. The transmitter requires a regulated +12.0 to 14.0 Vdc at up to 500 MA. RG58 coax is suggested in high RF environments.

TRANSMIT POWER SWITCH. In the on position, the connected voltage goes to the transmitter. There is a 1 Amp fuse and a 16V protection zener inside. If connected as a repeater, this switch is left on, and voltage is switched on and off by the VOR-3 board.

MIC INPUT. The minijack accepts any low Z dynamic or low Z amplified electret mic in the range of 100 to 600 Ohms. Use only well shielded cable to prevent RF pickup hum and buzz. The Mic audio gain pot is just above the jack. Mic audio is active at all times and mixes with the line level audio to enable voice over or mixing with another source such as a two meter receiver on the local ATV coordination channel. Normal setup for 2 meter audio is 6 dB down from ATV line audio. A resistive divider may have to be made to drop the 2 meter level to the mic input level.

LINE AUDIO INPUT. The RCA phone jack accepts high level audio from the ATVR receiver, VCR, or other sources. Input impedance is 10K Ohms. Minimum input level is .1 V pk-pk. Use only well shielded cable. Set the line audio to the point where the green LED just begins to blink off, then back off a little. This should be set for 25 to 40 kHz deviation on the FMA5-G board. This level set is independent from the mic gain control.

MONITOR OUTPUT. Not available on this model.

VIDEO IN. This RCA phone jack accepts the nominal 1 V pk-pk negative going sync NTSC video into 75 Ohms. Video from an ATVR receiver, VCR, Elktronics VDG-1 video identifier, computer or camcorder can be used. Use a well shielded cable. The video gain control is above and to the right of the video in jack. To set the proper video gain level, watch the transmit video from the monitor jack on a video monitor or oscilloscope. With a good video signal plugged in that has large areas of black and white, slowly increase the video gain until the white areas seem to smear in the monitor, or limit on a scope. Then back the gain down a little so that the setting is just below the smear or limiting point.

RF OUT. The type N jack must be connected to a resistive 50 Ohm load, filter or antenna at the transmitters frequency. Use good quality 100% shielded cable such as Belden 9913 or hardline. Take great care with preparing connectors and cable. On initial turn on, do not transmit more than 10 seconds if the reflected power is more than 10% or 2:1 VSWR. You could damage the final or modulator transistor.

IF YOU BELIEVE THE RTX70-1 ISN'T WORKING, check all cables, connections, power supply, internal fuse, test point DC voltages and VSWR. If you can't determine the trouble, call us and describe the problem or ask any questions you might have. It will save us both time if we suggest some things to try that may have been over-looked, or for us to better evaluate the problem. The RTX70-1 can be repaired by us for $75 plus parts cost in a few days if we believe the problem is customer caused, or only your shipping cost to us if we determine that it was due to our workmanship and materials within a reasonable time and given circumstances. Include with the unit your name, call, street address - no PO box, and a description of the problem. Include your Visa or Mastercard numbers, expiration date, name exactly as it is printed on the card and the address where you receive the bills for this card. There is no other warranty expressed or implied. See our latest catalogue for our service and return policies.

REPEATER OR LINK SETUP

The RTX70-1 is set up ready to go if the applied DC Voltage is 13.8 and you are running without an amp. If not, see the respective sections. The chassis box may be drilled and mounted to a rack panel if desired, but keep it away from the receiver components as much as practical. Take great care with cable and connector assembly and lead dress.

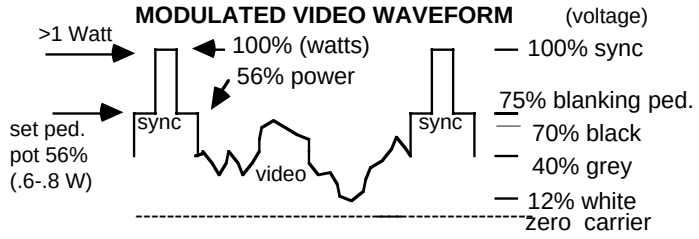
Do not transmit more than 10 seconds at a time while testing for VSWR if there is more than 10% (2:1 VSWR) reflected power at the RF output jack. Failure to do so could damage the final or modulator transistors. At any repeater or link site that is shared with any other transmitters, all transmitters must have a bandpass filter in the antenna line to prevent final amp mix generated intermod generation. A VSB filter in the antenna line is especially necessary if there are other 70 CM receivers at the same site or within about 10 miles. VSB filters made by DCI are available from us.

Make sure all equipment is well shielded and good construction practices were followed. After RF and VSWR tests are completed, connect up a video video and audio source and adjust for proper levels. Check for desense conditions by monitoring the receiver output for anything that resembles the applied video. If it does, check all connections, etc. for the possible RF paths into the receiver and take appropriate steps to improve the shielding or filtering. The transmitter must not get into the receiver via it's antenna, coax, bandpass filter or other connections.

REALIGNMENT OR TRANSMIT FREQ. CHANGE

A frequency not originally ordered with your RTX70-1 can be changed to by plugging in the new xtal and peaking with a voltmeter. The crystals are video carrier freq. /4, 5th overtone in a HC-25 holder. Push crystal all the way down into the socket, and then lift back up slightly so that the crystal can does not short out against the sockets. Refer to the KPA5-F board layout for test point locations.

Start at the oscillator and peak progressively toward the output. All peaking is done with no video connected and the 1K pedestal pot at maximum power. Use a small insulated tuning tool on the trimmer caps, and slowly rotate in the slot with very little downward pressure. The voltages shown are typical minimums. When you are done peaking all trimmers, reset the 1K pedestal pot to 75% of the value read at the RF out test point on the TXA5-RC board, or 60% of the maximum power read on a RF power meter (Bird with 2.5 watt slug). The blanking pedestal is now clamped to the proper level regardless of the applied video level.



The sound subcarrier frequency is set to 4500 kHz +/- 2 kHz by the 18µH variable inductor with a counter at the 470 Ohm resistor test point. Do not try to reset by listening to a TV set as it will give a false peak, be off in another TV, or give a crosshatch beat in color video if off frequency or injection level set too high. The amount of injection is set by the 500 ohm pot to 15 dB down from the sync tip (-15 dBc) by us with a spectrum analyzer. Deviation is adjusted to the 25 kHz broadcast standard by the op amp soft limiter.

LINEAR AMPLIFIER SETUP

This must be done to compensate for the differences between amplifier gain curves, power saturation points, and applied DC voltage. The 1K blanking pedestal pot is used to reset to the proper video to sync level and should be adjusted whenever the amplifier is put in line or the applied DC voltage is changed by more than .5 Volt , such as in going from base to mobile. If you are running the RTX70-1 without an amp from a regulated 13.8 Vdc supply you need not touch this control. This control sets the video to sync ratio by clamping the blanking power level at the set value and stretching the sync tip to maximum regardless of the video gain control or average picture contrast.

See page 6. To readjust for a different supply voltage, disconnect any video input and connect a DC voltmeter to the test point 5K monitor pot on the TXA5-RC board. The RF output must be connected to a good low VSWR antenna or dummy load with no more than .1 Watt reflected. Turn on the transmitter and set the 1K (PED) pedestal pot for max reading and then slowly reduce to 75% of that maximum value. If a RF power meter is used, set to 56% of the maximum value. When the video source is plugged back in, the test point voltage or RF Wattmeter readings will have no relevant meaning.

An external linear amplifier is set up the same way but a RF power meter must be used at the amplifier output. Use a good quality 50 Ohm interconnecting coax, short as practical, with N connectors. Use no adaptors or elbows as the are very lossy at 70 CM. Again with no video plugged in, set the 1K pedestal pot for maximum indicated RF out of the amp, and then back down to 60% of what ever the maximum reading is. With 13.8 Vdc applied, the Mirage D100ATVNR amps are usually set for 45 - 60 Watts. Sync tip power is then between 80 & 100 Watts.

The sync tip power (peak envelope power) on all linear amps will still be the max power you read before the reduction to the blanking pedestal due to the sync stretcher in the modulator. Any further reading of an "average" reading RF Wattmeter is meaningless as they do not respond normally to modulation above 100 kHz and the reading will vary depending on the picture contrast. An all white picture will give the lowest reading, and an all black one will read about the same as the blanking set up.

Other amps may be set up in the same way, but use caution when first trying them out. Video requirements are different than with any other mode. They must be driven in the linear input/output region, have a reasonable gain curve that the sync stretcher can compensate for, and have very stiff bias and collector supply voltage sources. If not the color and sync will be distorted and unstable. Tube amps usually are very linear but not always wide bandwidth. The high grid Q usually rolls off the color and sound too much. High level grid modulation is preferred in this case.

70CM FREQUENCIES AND SYSTEM CONSERNS

Other ATV repeaters and Frequency Coordination Councils are listed in the ARRL Repeater Directory. You should coordinate your repeater or link with the area coordination council to minimize interference and your own protection. There are only 2 ATV channels available in the 70 CM band without the possibility of interference with minimum 12 MHz channel spacing in the same area (same as Broadcast TV). 12 MHz or more separation is absolutely necessary with an inband repeater in order for the filters to be effective.

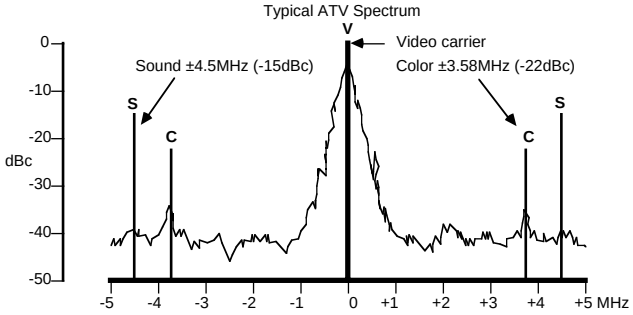
421.25 or 426.25 MHz are the most popular repeater output frequencies. It is mandatory that a good VSB filter in the antenna line to prevent intermod generation. With 421.25 MHz a 10 pole filter is suggested to keep sideband products within legal limits below the 420 MHz band edge. 427.25 MHz should not be used for a repeater output because the sound subcarrier is above the -26 dB mean power prohbited in the 431-433 MHz segment for repeaters.

With an inband 70 CM repeater you can either use a common broadband antenna and VSB duplexer or separate antennas and VSB filters. Transmitter sideband harmonics, intermods and broadband noise must be below 1 microvolt at the receiver input or your repeater will cycle on and off or have interference in the video with weaker signals. Depending on repeater amplifier gain, the separate antennas must give at least 50 to 60 dB of pattern isolation. With a single antenna and duplexer this isolation must be made up with an additional VSB filter between the RTX-70 and amp.

Split antennas must be mounted one above the other with typically more than 20 feet separation depending on their gains. You can also vary the position of one of them to find a magic null point. Transmit through the fixed transmit antenna while watching on a spectrum analyzer or other calibrated device connected to the receiver antenna coax. Have some one on the tower move the receive antenna around until a good null is found, then lock it in place. Of course if any other antennas are placed on the same tower later, you may have to repeat the procedure. Keep the two 100% shielded coaxes away from each other as much as possible to minimize crosstalk. Which antenna is placed at the highest point on the repeater site tower depends on how much power the repeater puts out compared to what the average user puts out. To make it easier on the users I suggest having the receive antenna on top.

With a duplexer you save some money with only one good antenna and feedline, but have to put some back into the additional VSB filter.

Some areas have added a crossband repeater/link 23cm transmitters to enable users seeing their own video coming back for adjustments, dedicated to weather radar or Space Shuttle video and audio when not repeating 70 CM, or linking to another area. 1253.25 MHz is the primary 23 CM AM repeater output frequency and 1252 for FM. A VSB filter on the AM output unless other band users are close by. A broader bandpass filter is sufficient in the antenna line. 1241.25 does require a VSB filter to prevent the LSB video from falling outside the band limit at 1240 MHz. 1277.25 MHz also needs a VSB filter when FM voice repeaters fill in from the bottom up starting at 1282.0 MHz.



Vestigial sideband (VSB) filtering should not be confused with SSB, it's completely different. With VSB, nothing is done to the carrier and less than 5% of the sideband power is cut off. VSB only rolls off the lower sideband starting at .75 MHz below the video carrier frequency. FCC defines VSB as having the lower color and sound sidebands down more than 42 dB below the mean power (see spectrum above and also fig. 12.61 on pg 12.48 in the 1996-2005 ARRL Handbook). The TV set IF filter does this. It is not necessary at the transmitter except in the case of a repeater near the band edge, in the presence of other transmitters with the possibility of creating transmitter intermod, or if there are other mode users near you that receive interference from your LSB subcarrier or sideband harmonics.

DX vs. POWER vs. ANTENNA GAIN.

The >1 Watt output of the RTX70-1 was chosen to provide an easy low cost entry into the world of ATV, but at the same time give flexibility to all the applications that hams might put the equipment to. One Watt connected to OAL 5L-70cm antennas for short distance video up to 5 miles with low battery drain public service applications is ideal. But for greater distance or areas of high path attenuation, it's output is matched for the best linearity drive region of the Mirage D26N (50 W) or D100TVNR (90 Watts p.e.p). The primary design difference between these amplifiers and others is the addition of various values of capacitors on the transistor bias and collector supply lines to keep the applied voltage constant under the high current swings to 5 MHz of the AM video envelope. Without these caps, the color and sync become distorted.

The Mirage D100TVNR repeater amplifier has a large enough heatsink that no direct air needs to be blown on it unless there is no system fan or convection cooling system inside of a enclosed rack. If a D26N or D100TVN is used, air must be blown directly over the heatsink fins such that the the final transistors do not heat up above 150 degrees F during long key down periods.

While it is almost impossible to predict actual ATV DX due to different terrain and conditions, the line of sight snow free picture distance can be calculated given all the controllable factors. We must know the transmitter peak envelope power (p.e.p. - sync tip), coax loss, and antenna gain over a dipole. At the receive end, we must also know the system noise figure and bandwidth. The chart below assumes the RTX70-1 transmitter, TVC-4G or TVCX-70 GaAsfet downconverter, or TC70-1d connected to a good TV set with 3 MHz IF bandwidth, 3 dB loss in coax at both ends, and snow free defined as a carrier to noise ratio of 40 dB (about 200 microvolts).

The distances in miles are shown in the order of 1.5/15/50 Watts which is the RTX70-1 by itself , driving a RFC 440 Mini-Amp (15 Watt) or Mirage D26N (50 Watt) linear amplifier. To find the possible DX under line of sight conditions find your antenna model or equivalent gain across the top. Then go down to the receive ends antenna or gain. Now read the miles that corresponds to your transmit power level.

The distance miles are in the order of 1.5/15/50 Watts.

XMIT.	3 dBd Ground Plane	8 dBd F718x 5L-70cm	16 dBd FO-25
REC.			
Gnd plane	2/6/11	4/12/21	8/26/48
5L-70cm	4/12/21	8/23/42*	16/52/95
FO-25	8/26/48	16/52/95	36/115/210

The purpose of the DX chart is to enable you to better figure what is needed in your system to have the best chance of getting good pictures where you want them. This is especially important to repeater owners or those setting up for a public service event to figure the expected area of coverage. The DB Products DB420 exposed multiple dipole array is a high gain broadband omni vertical for single antenna/duplexer inband repeaters or two Diamond F718x can be used with vertical separation of >20 ft. If a repeater is running 50 Watts to a DB420 omni, it could be snowfree to a station 42* miles away using a 440-6X beam. The distance will double or half with each 6 dB change. For instance if the repeater user mounts a Mirage KP2/70cm GaAsfet preamp at the antenna to save the 3 dB coax loss and went to dual beams for 3 more dB gain, you will be able to see the repeater at the same picture to noise ratio twice as far away, or one P unit higher at the same distance. The 3 dB more gain from dual beams puts your transmit DX 1.4 times farther. A ground plane is often made with just wire and a connector by first timers to try ATV out - See ARRL Handbook pg 20.55.

Obviously, putting most of your time and money into the antenna system pays off in both transmit a 20.5nd receive. Adding more power does nothing to improve the receive DX. If you have one of our GaAsfet downconverters (TVC-2G, TVC-4G, TVCX-70, ATVR-4, TC70-1d or TC70-10) you have a low noise figure (≈1 dB) and sufficient gain (≈25 dB) to put the receiving system at the noise floor. The theoretical noise floor for a 3 MHz wide 70CM ATV system with a perfect 0 dB noise figure is .8 microvolts (-109 dBm). So adding another preamp at the shack will do nothing but pump up your AGC on noise making you more susceptible to intermod and overload interference without improving the sensitivity. Only changing to lower loss coax or adding a good quality GaAsfet preamp at the antenna will give you a little sensitivity improvement.

If an antenna mounted preamp is added to the repeater receiver in an effort to overcome a very long feedline, you must also put the VSB filter ahead of the preamp at the repeater and fully weather proof it. It may be better to invest in larger copper hardline.

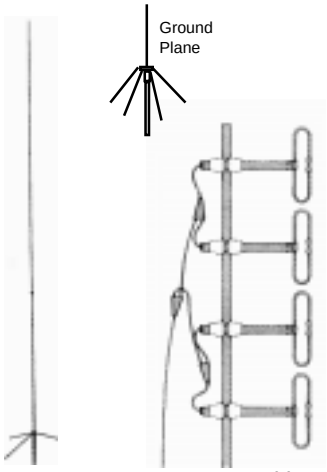
Since many paths to the repeater may not be line of sight, the distances in the chart will be lessened depending on the amount and type of trees, foliage, hills, buildings, etc., in the path. On the other hand, there is temperature inversion ducting, especially in the summer months, or knife edge refraction that can equal or better the chart estimates. The RF horizon is about 10 miles for an antenna height of 50 ft. If the other station also has an antenna height of 50 ft then you should get good results over the 20 mile path in flat terrain. Antenna height is most important at UHF (see The ARRL Antenna Book pg 1-4). Other sources of ATV information can be found in the 1994-2005 ARRL Handbook chapter12.

ANTENNA POLARIZATION

Antenna polarity must be the same in any area or you could be losing up to 20 dB by being opposite. Polarization in any area seems to be more of an emotional rather than technical decision. If most of the ATVers come from the weak signal or 432 SSB/DX group they will push for horizontal. The FMers will push for vertical. The main motivation is not to have to get separate antennas for each mode of interest.

Technically there is little difference between polarizations above 300 MHz according to a US Army study. However, below 300 MHz horizontal is generally better. Vertical polarization is preferred in areas that have a repeater or want omni directional coverage for weather radar or other public service applications due to the fact that there are many manufacturers of high gain vertical omnidirectional antennas for base station as well as mobile. Horizontal omni gain takes many more elements for the same gain as vertical and few are made commercially.

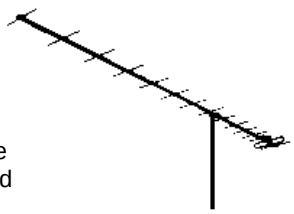
So this is a regional decision that should be made by the local ATV community. One alternative is for individual ATVers to use circular polarized antennas, which works great for all modes. There are many exaggerated claims for antenna gain and performance. When you select yours, it should have sufficient bandwidth, and go by the actual measured gains published from the various VHF/UHF Conference contests rather than advertisements and unsubstantiated articles.



F718 L or X510NJ or A 9dBd vertical omni, 15 to 17 ft. used at cross band or inband separate antenna repeaters

Broad band exposed dipole vertical 6-9 dBd omni used at inband repeaters with duplexer.

OAL 5L-70cm 8 dBd 420-450 MHz Yagi Mounts horzontal or vertical. 31” boom ideal for portable & public service uses.



DSFO ATV-25 16 dBd 420-450 MHz Yagi, 17 ft boom.