Spring 2003

Volume 16 - No 2

ISSN 1042-198X
USPS 003-353

SINGLE ISSUE
$5.50 USA
$6.00 CANADA
$8.00 ELSEWHERE

Amateur Television Quarterly

Ron Cohen - K3ZKO
A.T.N.A. President enjoying his ATV

Want to launch a balloon?
Here is how Jim Meehan, W6XE did it

Amateur TV Contest

Explore Directional Antennas
by Mike Collis, WA6SVT

Airborne ATV For A Regional Fire Agency
by Ray Grimes, W6RYS

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AMATEUR TELEVISION QUARTERLY

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Amateur Television Quarterly (ISSN 1042-198X) is published quarterly, in January, April, July, and October for $20.00 per year by Harlan Technologies, 5931 Alma Dr., Rockford, Illinois 61108-2409. Periodicals Postage Paid at Rockford, IL and additional mailing offices. POSTMASTER: Send address changes to: Amateur Television Quarterly, 5931 Alma Dr., Rockford, IL 61108.

Amateur Television Quarterly is available by subscription for $20.00/yr in the USA; $22.00/yr in Canada; $29.00/yr elsewhere. Single issues $5.50/USA; $6.00/Canada; $8.00 elsewhere.
Send all address changes to:
Amateur Television Quarterly,
5931 Alma Dr., Rockford, IL 61108

Amateur Television Quarterly

TABLE OF CONTENTS

Editors Notes

I would like to again thank all the wonderful people writing the articles for ATVQ! It is amazing that the good material just keeps coming in.

I would also like to make a SPECIAL RECOGNITION to TOM O'HARA, W6ORG, as I did a search the other day and found that Tom has written over 100 articles for ATVQ. I am sure that he has written many more that he has not received credit for as well, but the Cumulative Index Of Articles lists him as author more than 100 times. How about EVERYONE send Tom an email (tom@hamtv.com) and tell him THANKS!

I was surprised to see that Tom wrote more articles than did Henry Rue, AA9XW, but I may be fooled as Henry did not always put his name on articles that he has written. Of course, Henry has written a great many also. Thanks to both of you for your support!

Shari and I will be at the Dayton Hamvention again this year. I have not heard where our inside booth is located yet. As you have noticed, we are making Name Tags to help supplement the magazine. When we go to hamfests, we do not sell many subscriptions as, I believe, the typical ham, not unlike myself, wants to save that $20 for some piece of junk in the flea market that they can not live without. Lucky for us, the subscriptions do come in later from those that are interested. But, I wanted something that would at least help pay for the booth space.

So, maybe you need an ATV name tag. Here are a couple of samples that can be made. See more on the web or at the booth. See you in Dayton.

ATVQ

Gene Harlan - WB9MMM

Balloon V1.0

Jim Meehan - W6XE - Email: jmeehan @vpizza.org
59 Cazneau Avenue
Sausalito, CA 94965

This is the story of how I designed, built, launched, and recovered a high-altitude weather balloon. Actually, the term "weather balloon" might be a bit of a misnomer, because aside from the physical latex balloon, and the payload's ability to measure temperature, this project bears little resemblance to a traditional weather balloon. The design and engineering process encompassed more disciplines than anything I'd ever undertaken before — system engineering, software design, hardware design, basic electrical concepts, radio and RF engineering, and even some plumbing.

I have two aims in writing this article. The first is to share the story of Balloon v1.0, which I think is one of the coolest things I've ever done, and the second is to provide information (or pointers to information) that might be useful to other would-be balloon builders. Non-technical readers may want to read the first two or three sections and then skip down to the section titled "The Launch." If you're really impatient, you might want to go straight to the gallery of aerial photos or the gallery of launch and recovery photos.

The Idea

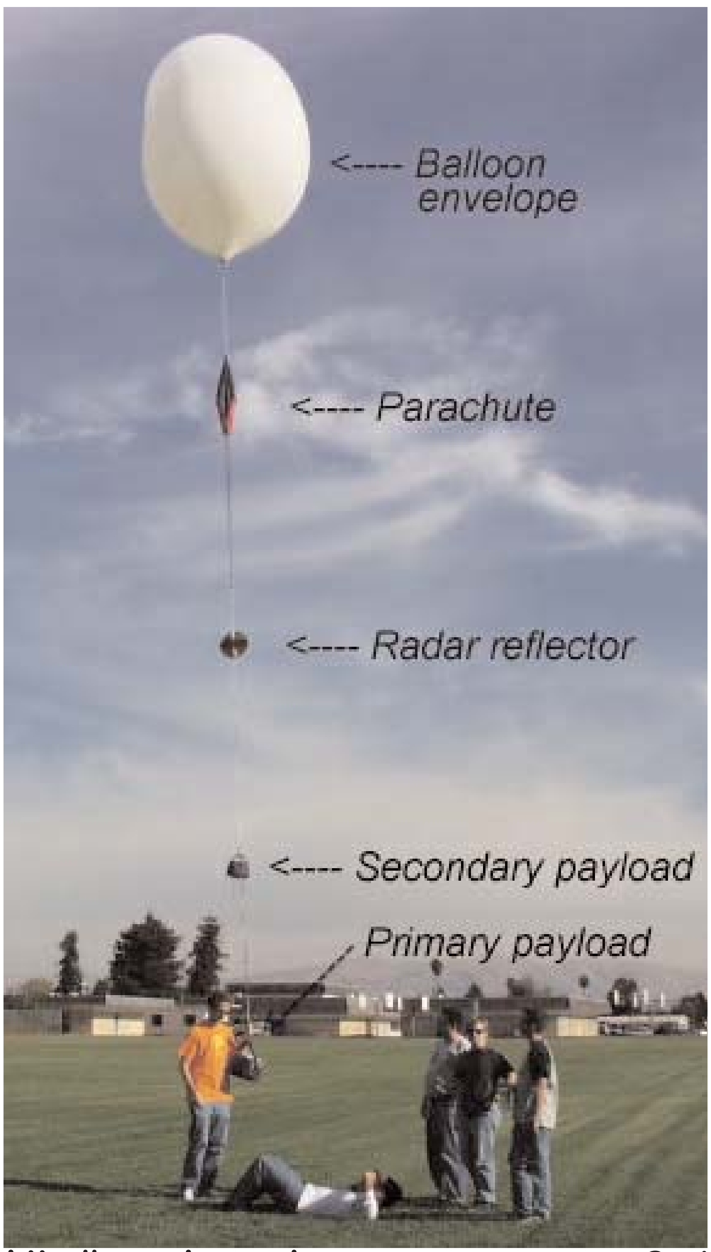
I would say that I am very driven to solve problems. That's been apparent since I was very young. If there was something around the house that needed to be fixed or wasn't right (at least in my mind), I couldn't think about anything else except solving that problem. My father would sometimes call this a "wild hair." I guess you could say that building and launching a weather balloon became a wild hair of mine, because once the idea came to me, there wasn't anything that was going to stop me from doing it.

The idea came to me in late August, and was inspired by a number of different factors. Several years ago, someone had given me 5 or 6 helium balloons for my birthday. After floating around the house for several days, I decided that it was time for them to go, but rather than just popping them and throwing them away, I thought I'd perform an experiment. I wrote out several index cards saying "This balloon was launched from Sunnyvale, CA on January XX. If you find it, please e-mail..." and then weatherproofed the cards with packing tape and attached them to the balloons. After I let all the balloons go outside the front door, I promptly forgot all about it, until several days later I received an e-mail from a guy in Dixon, CA (90 miles away) who had found one of the balloons in his backyard! I tucked the success of that experiment away in the back of my head for further pursuit later.

Unemployment was also a major factor. After being out of work for more than two months, my creative, engineering side was screaming for something more than searching Internet job sites and watching MSNBC. I'd had for a while a mental list of things that I'd do if I had more free time, and so far, the only thing on that list that I'd accomplished was taking my set of golf clubs (which I'd never used) down to the driving range and hitting some golf balls. Surely I could think of something better to occupy my time.

I had started reading a really excellent biography of Benjamin Franklin called "The First American" by H.W. Brands. If you've never read about Franklin, I highly recommend Brands' book. I think that reading about Franklin's lifelong passion for experimentation and invention reawakened my own passion, because not long after I started reading the book, I had a dream about building a weather balloon. The dream was fairly detailed. There's a movie called "Explorers" where this kid, Ben (played by a young Ethan Hawke) has a dream in which he's flying over a schematic diagram of some circuit. Upon waking, he draws what he remembers of the circuit and gets his genius friend, Wolfgang (played by a young River Phoenix) to help him build it. Once built, the circuit creates a spherical floating force-field which they discover can be used as a sort of conveyance... well anyway, that's getting a little off topic, but I remember seeing that movie when I was younger and thinking that no one has dreams that full of technical detail. But my dream about the balloon was nearly like that. Several of the ideas about the base system, communications subsystem and imaging came directly from the dream.

When I woke, I told my girlfriend, and then several other people, that I'd had a dream about building a weather balloon, and that I was going to do just that. I'm not sure how many people believed that it would actually happen, even after I started building it. I think a lot of people had a hard time understanding why I would want to undertake a project like this when they (and even I) could see no practical purpose or application. But I'm a firm believer that the truest forms of experimentation and invention have no purpose — it's pure curiosity and challenge.



Overall Design

I had a pretty good idea of what I wanted the balloon to do. First and foremost, I wanted it to calculate and report its position so it could be tracked and recovered. I also thought it would be pretty cool to capture images during the flight. Remote sensing of environmental variables (temperature at the very least) would also add some interest to the experiment. Finally, I wanted all of the components to be digital and integrated into a single system if possible.

In researching the construction of high-altitude balloons, I learned that they usually have two major parts — the flight system and the payload(s). The flight system is basically everything that is not a payload, and usually consists of the actual latex balloon (sometimes called the "envelope"), a parachute, a radar reflector, and nylon cord to connect it all together. Flight systems may also have a cut-down device to separate the parachute and payload from the envelope, although flights typically continue until the balloon reaches an altitude where the decreasing outside pressure causes the envelope to burst. Balloons usually have parachutes that are unfolded and bear the weight of the payloads for the entire flight. A loop at the top of the parachute is connected to the envelope, and the payloads are connected to the shroud lines at the bottom of the parachute.

Regulations

At this point you may be asking "Is it legal to launch a balloon like this?" and "Aren't there permits required for this?" Many other people asked the same questions when I told them about the balloon. The answers are, yes, it's legal, and no, permits are not required, as long as the balloon falls under certain size and weight limits.

Part 101 of the FAA Regulations covers balloons, kites and rockets. The first section of Part 101 spells out exactly which kinds of devices the rest of Part 101 applies to. Regarding "unmanned free balloons," Part 101 applies if the balloon:

(i) Carries a payload package that weighs more than four pounds and has a weight/size ratio of more than three ounces per square inch on any surface of the package, determined by dividing the total weight in ounces of the payload package by the area in square inches of its smallest surface;

(ii) Carries a payload package that weighs more than six pounds;

(iii) Carries a payload, of two or more packages, that weighs more than 12 pounds; or (iv) Uses a rope or other device for suspension of the payload that requires an impact force of more than 50 pounds to separate the suspended payload from the balloon.

I took this to mean that the notification, marking, and design regulations in the rest of Part 101 did not apply if I designed my balloon to fall below all of these limits. To verify this, and find out if there were other regulations and procedures the FAA did want me to follow, I placed several phone calls to various FAA divisions and facilities. There was a lot of phone tag and run-around involved, and I eventually came to the conclusion that most people at the FAA were pretty clueless about unmanned free balloons. This was confusing to me, because the National Weather Service launches nearly 60 weather balloons every day, so it seemed the FAA should be well familiar with the practice. After getting no satisfactory answers to my questions, I decided to follow as many of the Part 101 regulations as practicably possible (even though it seemed I was not required to) and to place a call to the FAA NOTAM (Notice to Airmen) number for Northern California on the morning of the launch.

Flight Computer

In an integrated system like the one I decided to build, the flight computer controls just about every function of the payload. I'd read about some other groups that had built and launched balloons using a Basic Stamp from Parallax. I looked closely at the capabilities of the Basic Stamp and Basic Stamp II, but ultimately decided that they weren't flexible enough to do all the things that I wanted the flight computer to do, although I did end up using a Basic Stamp as the relay controller and A/D input (more about that later). Eventually, I came to the conclusion that the balloon should run Linux, that way I'd be able to have the flight computer do just about anything I wanted. From some previous projects in wireless networking, I was aware of a very small, lightweight, single-board computer which is manufactured by Soekris Engineering. I chose their net4511 board, which has an AMD 486/100 processor, 32 MB RAM, a mini-PCI slot, a PC card slot, a compact flash slot, two Ethernet ports, and a serial port for $200.

Getting Linux installed and all of the hardware supported was more of a challenge than I expected. After mucking around with several different Linux mini-distributions, I settled on Bering, which has its roots in the Linux Router Project. Bering is really intended to be a turnkey distribution for an embedded Linux router or firewall, but it's suitable for most projects requiring a robust, flexible mini-OS.

The Soekris boards have a BIOS that supports a serial console because they have no video or keyboard support. This made the OS installation a little more challenging. I had no luck with Syslinux, which is the default boot loader for Bering, and I got frustrated with Lilo as well. I eventually got the system to boot using Grub. The compact flash card shows up as an IDE device to the kernel, so the boot process is pretty straightforward once you actually get the kernel going. Bering creates a RAM disk at boot time and decompresses a series of package files into it, and the OS runs from the RAM disk from then on. Compact flash is reasonably fast, so I probably could have changed the start-up scripts to just run the OS from the CF card, but as it turned out, I didn't need the extra RAM, and figured everything would probably run faster from a RAM disk, so I just left it that way.

The one thing that the Soekris boards are missing is a USB port. This was a problem, since most of the webcam-type devices I was considering for imaging had USB connections. I also knew that I'd need more than just the single serial port on the Soekris board, and USB-to-serial adapters seemed like the only realistic way to get them. The solution was a PC card that provided two USB ports. I had doubts about whether the Linux kernel would have support for a device like this, but a few kernel recompiles later, I had it working perfectly. In addition to the standard usb-ohci module, I also needed to compile in kernel Cardbus support, which is a feature in the later 2.4 kernels.

The final task in getting the base system up and running was to install the natsemi.o module for the two Ethernet ports and install OpenSSH. Once this was complete, I could easily log in and transfer files to the system without using the slow serial port.

I also stopped at this point and made an archive of the Bering distribution with my changes to it, in case anyone else wanted to use Bering on a Soekris board. It's available upon request.

Tracking Subsystem

Although I was designing the balloon to perform many functions, the primary mission objective was to recover the payload. Visually tracking the balloon is possible with a pair of binoculars on a clear day, even up to 100,000 ft., but not very high-

tech, and it's easy to lose, even if you take your eyes off of it for only a second.

GPS is the obvious choice for tracking. The cost of handheld GPS devices has come down dramatically in the past few years, making it feasible to put one in a balloon experiment that could potentially be lost. A bit of research turned up the GPS-35 made by Garmin. Garmin makes the GPS-35 for OEM applications — it has no display, only serial output in standard NMEA format. I chose the GPS-35-HVS which operates on a 6-40 VDC power source. I ordered the unit from GPS City for $180, and it came with no manual and no serial connector — just a pigtail. Fortunately, there's good documentation on Garmin's website, so I was able to solder on a connector without too much difficulty. I connected it to the Soekris board via an IOGear USB-to-serial adapter from Fry's, which is supported by the usb-serial.o and pl2303.o Linux kernel modules.

I spent a fair amount of time getting intimately familiar with the NMEA-0183 standard for GPS serial output and writing a Perl script to parse it. While this worked, doing it in Perl placed a lot of load on the processor, because the GPS unit sends a new series of text strings every second. After a little searching I found gpsd which is written in C and does the same job much more efficiently. It also acts as a TCP daemon, allowing multiple local or remote programs to connect and receive position data.

I/O Subsystem

I had originally thought about not including this component in the first balloon, but decided that it wouldn't be too hard to build and would add some functionality that's both necessary and cool. Basically, the I/O subsystem allows the flight computer to control some relays and sensors. The controller is built around a Basic Stamp 1 module and carrier board from Parallax. The module and carrier board go for about $34 and $15 each at most electronic supply shops.

The Basic Stamp 1 is a microprocessor with 8 I/O pins and can be programmed in a BASIC-like language using free software provided by Parallax. The carrier board has a 3-pin programming header that connects to your PC using a cable you can make yourself or buy. Each of the 8 I/O pins can be used for TTL or serial (up to 2400 baud) input or output, and you can even change a given pin from input to output or TTL to serial during the execution of your program.

The first two I/O pins are used for serial transmit and receive and are connected to the flight computer via another USB-to-serial adapter. The next three pins are used to control relays, using this reference design for a relay controller. Two of the relays are used to switch a strobe light and piezo beeper to help locate the payload during descent and after landing. The third relay switches current to the cut-down device, which is simply a piece of nichrome wire (like the kind in a toaster) wrapped around the nylon rope that attaches the balloon envelope to the top of the parachute. The wire heats up and melts through the rope in 5-10 seconds when the current is switched on.

The last three I/O pins interface with a Linear Technology LTC-1298 12-bit, 2-channel A/D converter. Parallax has a nice application note with a schematic and sample code for interfacing the LTC-1298 with the Basic Stamp. EME Systems has a lot of information on their web site about using a Basic Stamp and A/D converter with various types of environmental sensors. I decided to use a couple of Analog Devices AD590 temperature sensors to measure the internal and external temperature of the payload. EME has a nice overview of the characteristics of the AD590 and how to connect it to an A/D converter. I was able to order free samples of both the LTC-1298 and AD590 from their respective manufacturers' websites.

In the picture above, the AD590 is the small metal can at the top center of the board. Below it are three transistors that switch the relays, which are the red objects hanging off the sides of the board. To the right of the AD590 is a 2-pin header for connecting the external AD590. Three more headers are along the left side of the board for connecting the relay-controlled devices. The LTC-1298 A/D converter is at the bottom center of the board, half-hidden by jumpers. Finally, the Basic Stamp itself plugs into the board in a vertical position on the right side.

The last step was the software. The code for the Basic Stamp (relay2.bas) was fairly straightforward. I just merged the example code from the relay controller and LTC-1298 application note, with a few minor modifications. The code for the flight computer (admon.pl) is a simple TCP daemon written in Perl. The script listens for connections on TCP port 7070, and passes text to and from the serial port. This allows multiple local or remote programs to interface with the I/O controller.

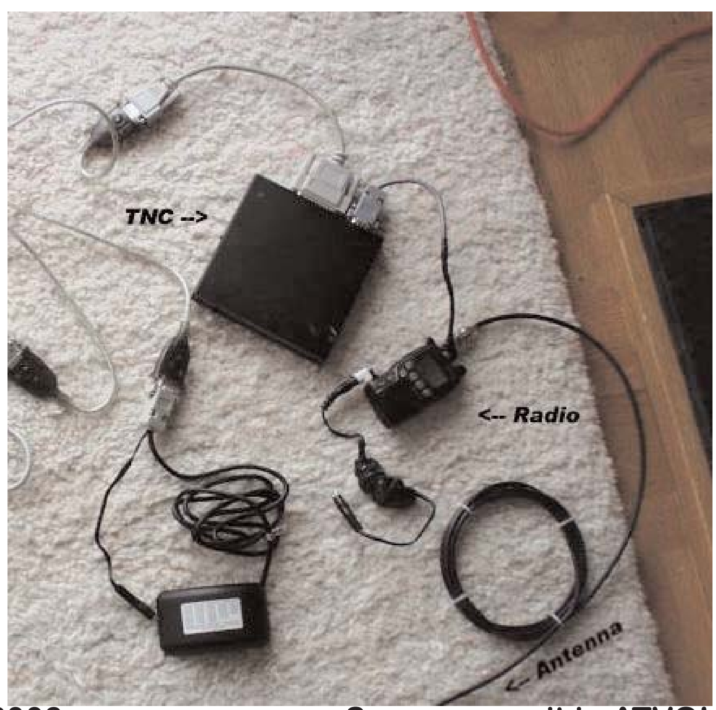
Communications Subsystem

From the beginning, I knew I wanted the balloon to have robust communication capabilities. That was one of the benefits of selecting the Soekris/Linux combo for the flight computer. But what to use for the actual communication interface? Some initial thought was given to 802.11b gear, especially since I have some previous experience with long-distance 802.11b links, and Linux has ample support for it. Range becomes an issue however. At 100,000 ft., the balloon would be nearly 19 miles from the ground. While off-the-shelf 802.11b gear is capable of spanning that distance with external antennas, they need to be carefully aligned, and are probably too heavy for the balloon to lift (not to mention the FAA weight limits). Clearly I'd have to find another solution.

One of my past interests and hobbies had been amateur (ham) radio. I'm firmly convinced that if you were a geek before the invention of the PC, and especially before the invention of the transistor, you found ham radio. I found it somewhat after those events and got my first amateur radio license (call sign N9OYP) in 1992 when I was 15 years old. The advent of the Internet has somewhat diminished the magic of talking to someone halfway around the planet (potentially using equipment you've built yourself), but I still find it truly captivating. Check out the website of the American Radio Relay League (ARRL) if you're interested in learning more about amateur radio.

Shortly after receiving my license I discovered packet radio, which eventually became my introduction to the Internet. Amateur packet radio is actually rather similar to Ethernet. The cables are replaced with radio waves, the NIC with a TNC (terminal node controller), and the hardware MAC addresses with amateur radio call signs. Packet radio is much slower of course. Some amateurs are starting to use 9600 bps packet radio, but most communication is still at 1200 bps. Tucson Amateur Packet Radio has a lot of good information on packet radio at their web site.

A lot of packet radio activity happens on the amateur 2-meter band (144-148 MHz). You can get a lot of distance out of a very modest 2-meter transmitter and omni-directional antenna. I remembered using a Radio Shack HTX-202 handheld transceiver with an external whip antenna on the roof at my parents'



house to connect to the packet node at Harper Community College, 20 miles away. 50 miles probably would not have been a stretch. This seemed like a good option for getting telemetry from the balloon.

I still had the Radio Shack HTX-202 and BayPac BP-2 modem. The BP-2 is not really a TNC though — it's just a radio modem and transmit/receive switch, and relies on PC software to handle the rest of the TNC functions. It's also really only designed to work well with DOS applications. The BP-2 is actually a hack and uses the RTS and CTS lines of the serial port to get data into the PC since packet radio is asynchronous communication. Decoding the serial data from the RTS and CTS lines is a real-time process, so modern multi-tasking OS'es don't do a good job of it. There is a Linux driver for the BP-2, but it requires that you disable the standard serial driver, which was not an option.

A newer, full-featured TNC seemed to be the solution, so I purchased a Kantronics KPC-3+ for $180 from Ham Radio Outlet. The TNC connects to the Soekris board via another USB-to-serial adapter, and to the radio via the mic and speaker jacks. My old HTX-202 was usable, but it picked up a lot of interference from the Soekris board. I eventually got a Yaesu VX-1R handheld transceiver for $130. It's much smaller and lighter than my old HTX-202 and has a much better receiver. It outputs 1 watt with an external 6 VDC power source. I debated about what to use for the antenna since the included rubber ducky antenna would clearly not be sufficient. In the end I constructed a j-pole antenna for 2 meters using twin-lead TV antenna cable.

Amazingly, the Linux kernel has included support for amateur packet radio AX.25 protocol since pre-version-1.0 days. AX.25 is a variant of good old X.25. There's a fairly well written Linux Amateur Radio AX.25 HOWTO that explains most of what you'll need to do. There's an ax25.o module for protocol support, and an mkiss.o module which supports the generic KISS packet mode of most TNCs. The TNC is configured as a network interface, just like an Ethernet or PPP interface, but using a utility called "kissattach." There are a set of daemons (ax25d and axspawn) that listen for inbound AX.25 connections and spawn a shell or other program, which I set up to allow me to log in to a shell on the flight computer.

One of the more recent developments in packet radio is Automatic Position Reporting System (APRS). APRS is a format for transmitting location data (usually GPS derived) via AX.25 packet radio. APRS stations periodically transmit an AX.25 packet that includes, at a minimum, latitude and longitude, and may also include altitude, speed, heading, other telemetry, and comments. This was the perfect solution for the balloon to report its tracking and telemetry data. I spent some time getting familiar with the APRS Protocol Reference and then wrote a Perl script (aprs.pl) to implement APRS on the flight computer. The script opens TCP connections to the gpsd daemon and admon.pl I/O daemon (see above) to get position and temperature data, formats that into an APRS string, and then calls the "beacon" utility included with the Linux AX.25 tools to transmit it via the TNC and radio. The script went through many revisions to fix bugs and improve performance.

At the receiving end, I used a piece of software called APRSPoint which runs on top of Microsoft MapPoint. APRSPoint receives APRS packets via a second radio and TNC set connected to the serial port of the tracking station (in this case, my laptop). It creates a new icon on the MapPoint map for each station it receives a location report from. You can also set it to create a new icon for each report (as opposed to moving an existing icon) so you can track the progress of one or more stations. This would be perfect for the tracking the balloon.

As an afterthought, I decided to make a small secondary payload package containing nothing but a Standard C558A handheld transceiver, also from my early amateur radio days. This radio is dual-band and can receive and transmit on the amateur 70 cm band (430-450 MHz) as well as the 2-meter band. It can also be set to cross-band repeater mode so that a signal received on one band is automatically retransmitted on the other band. The secondary payload would serve two purposes. Firstly, it would be an interesting experiment in a high-altitude voice repeater, enabling long-distance voice contacts between two parties on the ground. It would also serve as a backup signal source so we could locate the balloon using radio direction finding techniques if the primary tracking system failed.

Imaging Subsystem

I had originally thought that taking pictures from the balloon would be one of the easier functions to design and implement, but it actually turned out to be the most difficult and most frustrating. I came very near to giving up on digital photography for the balloon altogether and just triggering an auto-advance 35mm camera with the relay controller. In the end, I did get digital imaging working, but my confidence in Linux support for video and camera devices was very much shaken.

My first thought was to use a USB webcam. This would have the added advantage of being able to take short movie clips. Linux has support for some USB webcams via the Video4Linux subsystem. Unfortunately, almost all of them have CIF resolution (360x288) sensors, which I thought would give poor results. A notable exception was the 3Com HomeConnect webcam, now discontinued. The datasheet claimed a 1024x768 sensor, so I picked one up on eBay for $70. Unfortunately, the 3Com HomeConnect Linux driver only supports CIF-like resolutions, and the coloring seemed to be quite a bit off, so it was back to the drawing board.

The next attempt was with a Belkin USB VideoBus II and a miniature video camera from SuperCircuits. The VideoBus II takes standard 1V peak-to-peak video input (the same as your VCR or video game console) and allows still image or 30 frame-per-second video capture. The Linux USBVision driver claims support for this device, but I couldn't get it to work despite many kernel recompiles, adding extra debugging printf's to the code, and several e-mail exchanges with the authors. Eventually I gave up on this solution as well.

At this point I turned to digital still cameras. There are more manufacturers and models in this space than I can count, but the requirements in this case narrowed the field pretty quickly. The camera had to be small and lightweight to keep the payload under 6 pounds, it had to have USB, and the USB interface had to support remote control of the camera so I could have the flight computer trigger the camera to take a picture. gphoto2 supports image retrieval from most digital cameras with USB or serial connectivity, and remote control of those models that support it, so I used the gphoto2 source as a guide to which cameras might be suitable. Unfortunately, nearly all of the cameras that seemed to support USB remote control were too big and heavy to include in the balloon payload.

The exceptions seemed to be several cameras in Canon's PowerShot line. Canon's website lists a remote control feature for the Windows software that they include with the camera, and after borrowing a PowerShot, I discovered that it works quite well. This was encouraging because gphoto2 lists "experimental" remote control support for Canon PowerShot cameras. However, after much tweaking of the gphoto2 code and some e-mail exchanges with the author of the gphoto2 PowerShot driver, I learned that "experimental" meant "not working." This was probably just as well, since all of Canon's PowerShot cameras are really too expensive to risk losing if the balloon wasn't recovered.

While shopping at Fry's, I ran across the Aiptek Pencam Trio VGA. I remembered seeing this camera as supported by gphoto2, but had discounted it because I considered it to be in a class of "toy" digital cameras that would not give good results. But for $49, it was hard not to at least try it out. The pictures from the 640x480 CMOS sensor were surprisingly good, despite the rather noticeable fisheye effects from the small lens. Best of all, it was, by far, the smallest and lightest imaging device I'd tried. gphoto2 support for taking and retrieving pictures was decent, although slow. I eventually ditched gphoto2 for a smaller, faster utility called pencam2 which supports only Aiptek Pencams and other devices with the same chipset.

The last step was to automate the picture-taking process. I wrote another Perl script (picture.pl) that calls pencam2 once per minute to take a picture, retrieve it from the camera and save it as a ~1 Mb PNM file. The script then gets the current time, position and altitude from gpsd and labels the image in the lower right corner using ppmlabel. Finally, the image is converted to a ~100 Kb JPEG with pnmtojpeg, given a unique file name, and moved to a directory on the compact flash card. ppmlabel and pnmtojpeg are both from the netpbm suite of image manipulation utilities.

Miscellaneous

Just a few odds and ends that didn't seem to fit anywhere else.

The only feasible power source is batteries. Unfortunately, batteries are heavy, so you want to use batteries with a high power-to-weight ratio. There's really only one choice — Lithium batteries. Not to be confused with the more common Lithium-ion rechargeable batteries. Lithium batteries are not rechargeable, but have a much better power-to-weight ratio than any consumer-type battery. They also perform very well at low temperatures and have an extremely long shelf life. These features make them popular for military applications. I obtained a couple of military surplus BA-5513 Lithium battery packs from S&G Photographic Equipment. Check out this page for a listing of all the military surplus battery packs they have. The BA-5513 contains (10) 3-volt, 7.5-amp-hour(!!) Lithium batteries that are each about the size of a standard "D" cell. The two packs I received from S&G had a manufacture date of October, 1986 printed on them, so I was very skeptical at first. However, after stringing five cells together to create a ~15 volt battery pack and running all of the balloon components on it for 6+ hours, I was convinced that they were good enough. Every payload component was capable of running from a 12-15 VDC power source, except the Yaesu VX-1R radio. The radio uses a 12-to-6 volt converter cannibalized from the cigarette lighter adapter that came with it.

The balloon itself is from Kaymont. There are a couple of other companies that make latex meteorological balloons, but Kaymont seems to be the market leader. You can also sometimes find them as military surplus on eBay. I used a 1500 gram sounding balloon which go for about $60 each.

The parachute is from Rocketman Enterprises and is intended for model and experimental rocketry use. I got their R7C standard chute although I probably could have used the R9C size because the second payload and radar reflector brought the weight of the whole flight string just above 8 pounds.

The payload containers are soft-sided, insulated lunch bags from Target. They serve the dual purpose of providing some padding for the contents and also shielding the gear from the low temperatures of the upper atmosphere. I also put additional foam padding inside the container.

The radar reflector is from West Marine. It's basically foam board covered with thick, radar-reflective aluminum foil. All of its surfaces are at right angles to each other which also increases the radar reflectivity. I wanted to make sure that the balloon would show up on FAA radar so that no planes would fly into it.

There was also one other piece of code that I wrote in Perl for the flight computer (flight.pl). This was an attempt at creating some basic "flight logic" but as you will read below, I'm not sure if any of it worked. The script performs a number of functions:

On start-up, continually check gpsd for GPS lock. When lock is achieved, turn on the piezo beeper for a few seconds. (acts as a "start-up OK" signal)

Save the coordinates of the start-up location

Periodically compute the distance between the current location and the start-up location. If it's greater than 100 miles, activate the cut-down device. (prevents a "runaway balloon" if we can't establish communication to manually activate the cut-down and the balloon doesn't reach burst altitude).

Periodically check if a file named "/etc/cut-down" exists. If it does, activate the cut-down device. (allows the cut-down to be remotely activated by logging in and doing a "touch /etc/cut-down")

If the altitude has reached at least 17,000 ft and then drops below 17,000 ft, activate the strobe, and toggle the piezo beeper on and off. (makes it easier to visually and audibly track the balloon during descent and after landing)

The Launch

After nearly two months of almost-daily work on the balloon, I set a launch date of November 3, 2002. I had started to become rather reluctant to actually set a date and launch it, because I feared that the whole thing would be a disastrous disappointment if it was lost, crashed or otherwise failed. However, after all that work, I couldn't just put it all away and not launch it, especially since many of my friends were very interested and excited to see it go up.

I'd decided to launch from Newark, CA for a couple of reasons. Some friends own a house there which would make a good base of operations, and it's near several parks that would make good launch sites. It was also far enough from the coast that there would be ample time to terminate the flight and still have the balloon come down over land if it looked like the flight path would take it west out over the Pacific.

On the morning of the launch, we waited for all six participants to arrive at my friends' house and then proceeded to the launch site. We decided to take two cars on the adventure because we had enough hardware to set up two laptops as tracking stations. I gave everyone a brief tutorial on APRSPoint and set up the radio gear in the other car, and then unloaded all of the gear into the park to begin set-up. I'd rented a K-size (219 cu. ft.) tank of helium the day before, which took two people a lot of effort to get out into the field.

In hindsight, I probably could have completed more of the assembly before the actual morning of the launch. The payloads, parachute and radar reflector were not yet assembled into a flight string, nor had I weighed it all to see how much lift the balloon would need to generate. Once all of the components that would be attached to the balloon were connected, we weighed it all using a spring scale. Another spring scale was attached between the balloon and its anchor during filling so we could determine how much lift it was generating. I had read that 1 lb of free lift (total lift minus weight of flight string) equals an ascent rate of approximately 1000 ft/min. With a projected maximum altitude of 100 Kft, that would give an ascent time of 100 minutes, with a descent time of approx. 30 minutes, which would be just about right.

Filling the balloon was less of a challenge than I expected. I'd realized early on that a standard helium tank regulator with a bend-over rubber nozzle would take forever to fill the balloon, not to mention the difficulty of holding a 6-foot-diameter balloon generating 10 lbs of lift on said nozzle. Instead, I got a standard industrial gas regulator to which we could attach an air hose. The other end of the hose was attached to a homebrew assembly of PVC pipe that could be inserted into the neck of the balloon and then secured with zip ties. It also served as an attachment point for the anchor while we were filling the balloon. All in all, it was pretty slick and made filling the balloon very easy.

While the balloon was filling and the final assembly of the flight string was taking place, I was doing a final systems check of the payload functionality. One of the first realizations was that the alligator clips I had been using for connecting the battery would probably not remain attached during descent and landing. A quick trip back to the house for a soldering iron and some solder fixed that problem. We packed the payload back up and added a conspicuous sign that read "Harmless Amateur Radio Experiment," lest some farmer see the payload land in his field and, fearing some terrorist device, call the authorities.

The final preparation was to start up APRSPoint on the tracking station and make sure that we were receiving position reports and telemetry. I had verified with another handheld radio that the payload was in fact transmitting, but I wanted to double-check that the APRS beacons were being correctly decoded and that the data made sense. It's a good thing too, because the position reports had the balloon somewhere over the Atlantic Ocean! A quick comparison of the coordinates reported by the balloon with those on my handheld GPS showed a formatting error of the APRS string being transmitted by the balloon.

At first I was completely baffled. I had tested the operation of my APRS script pretty thoroughly, even taking the balloon payload on a drive around the city to make sure everything was okay. It took us quite a while to figure out what the actual problem was. It turned out to be a location-dependent bug. If the minutes field of the latitude or longitude was a single digit, the script should pad the value with a zero. But a coding error in a printf statement caused the script to omit the leading zero, resulting in APRSPoint reading the string as 12 degrees, 2x.xx minutes... instead of 122 degrees, 0x.xxx minutes.

Fixing the bug took almost as long as finding it, and by this time it was approaching 2 pm. I was starting to fear that we would be searching for the payload in the dark. But everything seemed to be functioning correctly now, and all seemed ready for a launch. We quickly packed up the remaining launch site gear, and after a few photos and final check, I released the balloon.

My first gut reaction was, “Uh oh, it’s not rising fast enough.” I had images of the balloon hovering just above ground through the middle of the soccer match at the other end of the field and then crashing miserably in the row of trees just beyond. That fear was quickly put to rest though as the balloon passed well above the soccer match and the trees. We watched for about 10 minutes as it headed due east and continued to rise. The winds were very light, so it was not moving very fast. A quick check of the telemetry showed that the ascent rate was about 600 ft/min, which was quite a bit slower than what we were shooting for, but we could afford a longer ascent time because it seemed the light winds would not carry the balloon very far. I had also feared that we would lose communication after it had traveled only a short distance, but this fear too eased as the balloon got further and further away.

At this point we all hopped in the two cars and started heading south as the balloon followed the east shore of the bay toward Sunnyvale. I had forgotten to look on a weather site and check the direction of the jet stream, so there was some uncertainty about the projected flight path. As the balloon reached the very south tip of the San Francisco Bay, it slowed to a stop, rising almost straight up for nearly 20 minutes. We stopped our pursuit temporarily and parked for a bit to see which direction we’d need to go next.

Eventually the balloon rose into the jet stream (which we’d discovered via newspaper was flowing due south that day) and continued south over San Jose. At an altitude of about 45 Kft, the flight path took a sudden turn to the east over the hills to the east and just south of San Jose. There were no roads in this direction that would allow us to track the balloon with any kind of speed, so it was agreed that one car would head north and then east on I-580, and the other car south and then east on CA-152 and meet up somewhere along I-5 in the Central Valley, depending on the course of the balloon.

I was in the car on the south route, and we continued to receive position reports with no problems the entire way. I was amazed how far a 1-watt transmitter can reach when there are no obstructions. We were at least 25 miles from the balloon during some points of the trip. I was also monitoring the temperature telemetry we were receiving. While the outside temperatures dipped as low as -40 F, the inside temperature of the main payload never dropped below 90 F, due to the heat generated by all the components and the insulation provided by the lunch bag.

The sun was starting to set as we approached I-5 on CA-152. The balloon was only at about 60 Kft, and I realized that it would not reach the projected burst altitude of 100 Kft until well after dark. The decision was made to activate the cut-down device, with the hope that we might be able to visually track the descent in the remaining daylight. I was a little disappointed that it wasn’t going to reach the full, desired altitude, but I would be even more disappointed if we couldn’t recover the payloads due to darkness.

Up until this point, I had not made any attempt during the flight to log in to the flight computer. I had assumed that since we were still receiving position reports and telemetry with a very strong signal, that the balloon would be able to hear us just as well. This turned out not to be the case however. I didn’t get a single response to a connection request in nearly 15 minutes of attempts. There could have been any number of reasons for this: mis-adjustment of the audio volume on the radio, RF interference from the flight computer, or interference from other amateur radio activity on the frequency that I’d chosen. This last possibility seems the most likely, as I received an e-mail later that evening from another amateur radio operator inquiring about the packet radio activity on the frequency that he and some other operators (unbeknownst to me) frequently use for voice.

In any case, it became clear that I would not be able to activate the cut-down device, so the chase continued. As we turned north onto I-5, we made contact with the other chase team who was already heading south on I-5 toward us. The balloon was still heading due east, and it appeared that it would cross the freeway about halfway between the two teams, so we started to plan which exit would be best to start heading east across the Central Valley.

Just then though, a position report came in with an altitude lower than the previous one. The previous report was 79,809 ft, and the new one was 72,896 ft. It took me a second to realize that the balloon was on its way down, and another second to realize that a 7000 ft/min descent was way too fast. At that speed, it was going to create a small crater. Another fear came into my mind as well. With the current flight path, it seemed possible (but statistically unlikely) that the balloon could land right *on* the freeway, which would be really bad. I was picturing a major pile-up on I-5, caused by the remains of my experiment, with my name and contact info prominently displayed on the outside.

I put those fears aside for the moment though, because my primary concern was being close enough to the landing spot to see the balloon on it's way down. This would make locating it much easier. The descent rate had slowed quite a bit to just a couple of thousand ft/min as the air pressure increased and the parachute became more effective, but was still faster than expected. We exited I-5 at CA-140, headed east, and then took a left onto the first road heading north, as it now appeared the balloon would land just to the east of I-5 and north of CA-140. Neat rows of trees stretched out into the distance on either side of the road — an orchard of some kind, it seemed. Open farmland would have been a more ideal landing spot, but at least the rows were wide and the trees relatively small.

At this point, the balloon had fallen below 17 Kft, so the flight control script should have turned on the strobe and beeper. We stopped and got out of the car, and began to scan the sky for any signs. Twilight was rapidly fading, so seeing the strobe or hearing the beeper was our only hope for manual tracking at this point. I kept an eye on my laptop as the altitude continued to decrease. On the APRSPoint map, the balloon crossed right over the road we were on, but there was still no sign of it. A position report came in at 8471 ft., and then nothing. After several minutes had passed with no further reports, we decided it must have landed. The descent had taken only 20 minutes after an ascent of 2 hours.

We calculated what seemed to be a reasonably accurate position for the landing site by extrapolating the flight path out to zero elevation. Certainly the range of the transmitter would be reduced if the antenna was lying on the ground, and there were obstructions (like rows of trees) obscuring the signal, but it appeared that we were close enough to still be receiving position reports even if we were off in our calculation. And we should definitely be able to hear the beeper — in testing, it was nearly as loud as a smoke alarm. The fact that the last position report was at 8500 ft. was also confusing. We should have had direct line-of-sight to the balloon for several more reports after that.

I began to despair that we had not completely fixed the position reporting bug, and that we were really quite far away from the actual landing site, or that the impact had completely destroyed the payload. The other team spread out into the orchard to begin a manual search, which I expected to be fruitless (pun intended :)). Just then, I remembered the secondary payload. It was quite a bit more sturdy and well padded than the primary payload, so it should have survived *any* impact. I quickly tuned a handheld radio to the frequency of the radio in the secondary payload and keyed up. There it was! I heard the characteristic squeal of feedback as my own signal was repeated back to me. This gave me new hope that we were indeed close to the landing spot.

While I had thought of using the signal from the secondary payload as a backup means to locate the balloon, I hadn't actually brought any radio direction finding equipment with me to make use of that capability. Perhaps because I didn't own any. We quickly devised a direction-finding scheme using the equipment we had, however. I keyed up the handheld radio, while another team member held the antenna of a receiver close to himself, using his body to shield one side of the antenna from the signal coming from the balloon. As he slowly rotated 360 degrees, I watched the signal strength meter on the receiver and took note of the bearings that showed the maximum and minimum signal strength. We repeated this procedure at a couple of other points along the road and got an approximate bearing for the direction of the signal.

I went out into the orchard and redirected the search party toward the area where the signal seemed to be coming from, and then returned to the car to see if we could get a more accurate bearing. Before I got there though, I heard yelling from out in the orchard. The landing site had been found! One of the searchers' flashlights had glinted off the radar reflector. They found the entire flight string, with all the components still attached, lying between two rows in the orchard.

Post-Flight Analysis

Initial inspection showed no major damage to any of the components. It looked like most of the remains of the balloon envelope were still attached to the top of the parachute. This was unexpected, because the envelope was supposed to "shred" into many pieces upon bursting. With the large mass of latex still attached at the top, it appeared that the payloads and/or parachute had spun rapidly on descent because the nylon cord and parachute shroud lines were tightly coiled. This could explain the faster-than-expected descent, if the envelope remains or twisted lines had caused the parachute not to open fully.

Opening the primary payload also revealed no damage, except for a crack in the mini-PCI connector on the Soekris board. This was not critical however, since I had no mini-PCI card installed. The error light was also lit, indicating some kind of hardware problem. This would explain why the position reports had stopped, and the strobe and beeper not functioning. A power cycle of the Soekris board cleared the error light, however, and it booted up normally. Perhaps a brief power interruption at impact had caused the fault?

Most importantly, the compact flash card seemed intact, so we should have all of the images acquired by the Aiptek Pencam. Unfortunately, neither of the laptops had devices to read the images off the card, so we'd have to wait until we got home.

After some pictures of the landing site and the search team, we decided we'd done all the analysis we could at the site. We packed up all of the parts and headed home. Everyone was tired and was anxious to see the pictures.

Further examination the next day revealed the cause of the failure. In the payload, the battery pack was placed on top of the Soekris board, which was on top of the TNC. The battery pack is relatively heavy, and its downward force on the Soekris board at impact is what caused the crack in the mini-PCI connector. It

also caused some of the sharp solder points on the bottom of the board to puncture the bubble wrap I was using for insulation and make contact with the metal case of the TNC. This created a short that the Soekris board detected as a hardware fault and halted the system. If I'd put more padding between the components in the payload, we probably would have continued to get position reports after landing.

The imaging part of the experiment turned out far better than I could have hoped for, and many of the shots are really amazing.

I've made a gallery of the best pictures. I've edited these to adjust the contrast and hue, and also label some of the landmarks that are visible. There's also an archive of all the raw images. During the latter part of the ascent, most of the images are quite washed out due to a thin layer of clouds. Motion blur from spinning is evident in many of the shots taken during the descent. The time, position and altitude of each shot is displayed in the lower right corner, as overlaid during the flight by my script. It's interesting to compare the shots taken from the balloon with the satellite imagery or maps on Microsoft's Terraserver.

Here's a map showing the flight path taken from a screen capture of the APRSPoint/MapPoint display.

I created several graphs from the telemetry data, showing altitude over time, temperature vs. altitude, and several other comparisons. You can switch graphs with the tabs along the bottom. The raw data is shown in the last tab. The graph display is from Microsoft Excel's "save as HTML" feature, which seems to work well with Internet Explorer. My apologies if it doesn't work so well with other browsers.

Finally, there's also a gallery with launch and recovery photos. They were taken with two different cameras, so they are not in chronological order.

Acknowledgements

There are so many people who made this crazy project possible and I would like to express my sincere thanks to them all:

Steve R. — for the great photos and in general supporting my crazy ideas

Brian S. — for the good suggestions during the design and construction phase, and superb engineering skills during the balloon inflation

Ray W. — for his unbridled enthusiasm for this project and excellent printf debugging skills

Carrie N. — for her general help getting the launch off the ground, navigating one of the chase vehicles, and all the pictures of my ass

Tony F. — for being the last-minute solder savior and general set-up help

Martin H. — for his helpful RF and antenna suggestions and ideas

All of the amateur balloon experimenters who came before me, whose hard-won experience and informative web sites made this project all that much easier.

And last but not least, my girlfriend Nina. Without her support and encouragement, all of this would have been nothing more than a really geeky dream.

Sam and the team at gallery of aerial photos
http://vpizza.org/~jmeehan/photo/index.cgi?album=20021103-balloon-highlights&mode=view

gallery of launch and recovery photos.
http://vpizza.org/~jmeehan/photo/index.cgi?album=20021103-balloon-v1.0-ground&mode=view

archive of all the raw images
http://vpizza.org/~jmeehan/photo/index.cgi?album=20021103-balloon-v1.0&mode=view

Part 101 of the FAA Regulations
http://www.chem.hawaii.edu/uham/part101.html

Basic Stamp
http://www.parallax.com/

Soekris Engineering
http://www.soekris.com/

Bering
http://leaf.sourceforge.net/mod.php?mod=userpage&menu=904&page_id=21

Linux Router Project
http://www.linuxrouter.org/

Grub
http://www.gnu.org/software/grub/

Garmin
http://www.garmin.com/

GPS City
http://www.gpscity.com/

IOGear USB-to-serial adapter
http://www.iogear.com/products/product.php?Item=GUC232A

gpsd
http://freshmeat.net/projects/gpsd/?topic_id=20

relay controller
http://www.rentron.com/pc-relay.htm

Linear Technology LTC-1298
http://www.linear.com/prod/datasheet.html?datasheet=293

EME Systems
http://www.emesystems.com/

Analog Devices AD590
http://www.analog.com/productSelection/pdf/1186_b.pdf

EME has a nice overview of the characteristics of the AD590
http://www.emesystems.com/OL2heat.htm#AD590

code for the Basic Stamp (relay2.bas)
http://shark.dls.net/~jmeehan/balloon/relay2.bas

code for the flight computer (admon.pl)
http://shark.dls.net/~jmeehan/balloon/admon.txt

website of the American Radio Relay League (ARRL)
http://www.arrl.org/

TNC (terminal node controller)
http://www.packetradio.com/tnc.htm

Tucson Amateur Packet Radio
http://www.tapr.org/

BayPac BP-2
http://www.tigertronics.com/bp2info.htm

Kantronics KPC-3+
http://www.kantronics.com/kpc3+.htm

Ham Radio Outlet
http://www.hamradio.com/

Yaesu VX-1R
http://www.yaesu.com/amateur/vx1r.html

j-pole antenna for 2 meters
http://www1.vcars.org:8040/CARL/J_Pole2M.html

Linux Amateur Radio AX.25 HOWTO
http://en.tldp.org/HOWTO/AX25-HOWTO/

Automatic Position Reporting System
http://web.usna.navy.mil/~bruninga/aprs.html

APRS Protocol Reference
ftp://ftp.tapr.org/aprssig/aprsspec/spec/aprs101/APRS101.pdf

then wrote a Perl script (aprs.pl)
http://shark.dls.net/~jmeehan/balloon/aprs.txt

APRSPoint
http://www.aprspoint.com/

Microsoft MapPoint
http://www.microsoft.com/office/mappoint/

radio direction finding
http://members.aol.com/homingin/

3Com HomeConnect Linux driver
http://homeconnectusb.sourceforge.net/

Belkin USB VideoBus II
http://catalog.belkin.com/IWCatProductPage.process?Merchant_Id=1&Product_Id=88962

Linux USBVision driver
http://www.emuit.com/webcam.html

gphoto2 supports image retrieval
http://www.gphoto.org/gphoto2/

Canon's PowerShot line
http://www.powershot.com/powershot2/home.html

Aiptek Pencam Trio VGA
http://www.aiptek.com/products/pencams/trio-vga.htm

utility called pencam2 which supports only Aiptek Pencams
http://stv0680-usb.sourceforge.net/

I wrote another Perl script (picture.pl)
http://shark.dls.net/~jmeehan/balloon/picture.txt

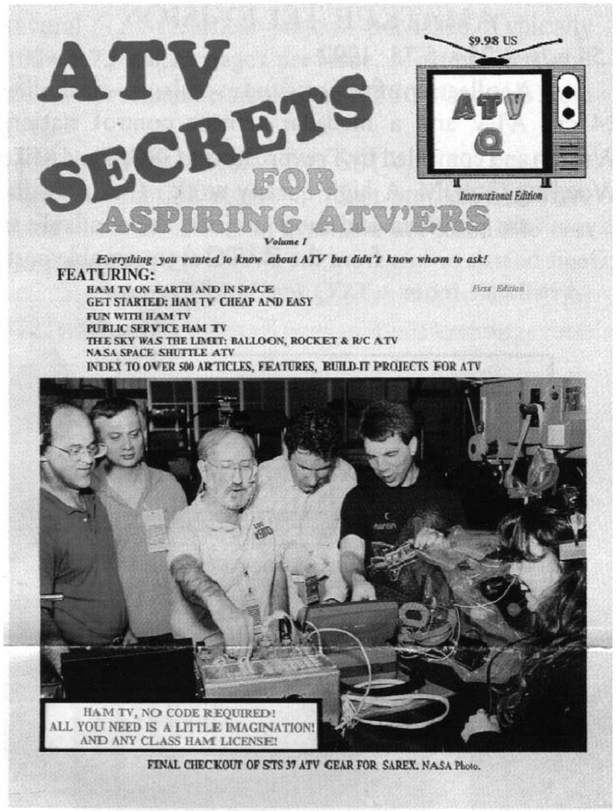
ppmlabel and pnmtojpeg are both from the netpbm suite of image manipulation utilities
http://netpbm.sourceforge.net/

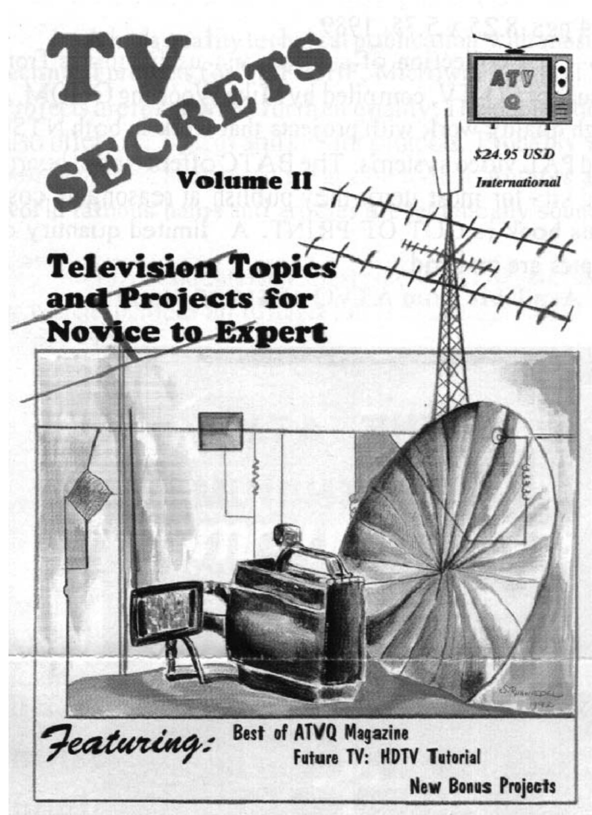
S&G Photographic Equipment
http://www.sg-photo.com/

Check out this page for a listing of all the military surplus battery packs
http://www.sg-photo.com/batteries.htm

Balloon V1.0 to page 48

Do you have these yet?





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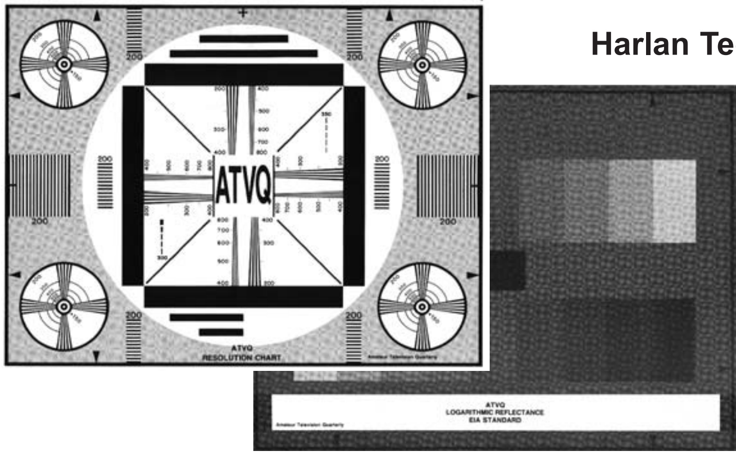

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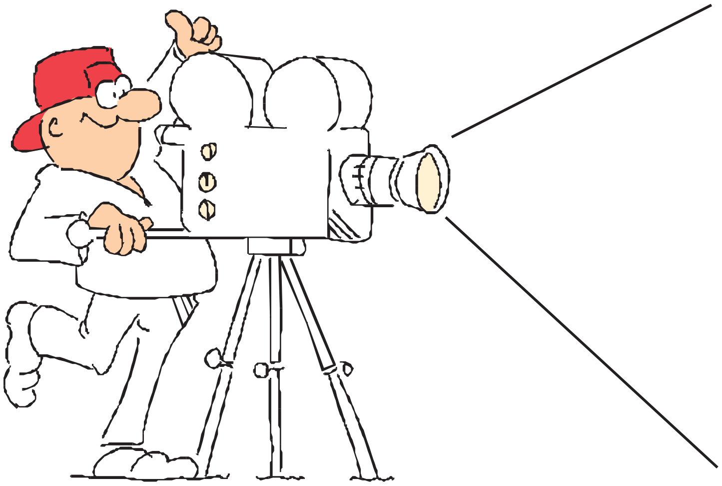

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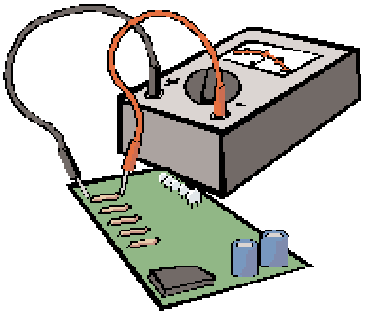

Sparks from the Bench

by Ron L. Sparks - AG5RS - Email: atvq@sparkles.com
P.O. Box 945
Katy, TX 77492

Grounds for Action
Regular Featured Column!

Okay, I officially give up trying to keep a consistency about the topics for this column. If you have been looking at the planned topics and keeping track you will appreciate that following specific projects around here is like watching ping pong balls in a blender – no easy task. As always, I will get back to the CarCam eventually, just not this month. The things that get attention on "Sparks' Bench" are the things that are most pressing from a time and importance standpoint and this column is consistent with that trend.

Ground is Ground...?

Just about the time I started to pull the CarCam out and begin work on it, two things happened that gave me the nerve to tackle a serious and controversial subject for this issue. Grounds, RF Safety, and Lightning Protection are matters that have caused some of the most passionate and heated battles in my career. There are about as many opinions on these subjects as there are experts to voice them. Because of that a whole set of practices and, sadly, mythologies have cropped up regarding the issue of grounds.

The first thing that happened was the completion of the HATS repeater project and its placement back on the site with the antennas. That required that we look at both our activities from an RF Safety viewpoint and at the same time consider lightning protection and grounding. So I was involved on that train of thought when an associate came to me with a problem that one of our mutual clients had.

This client had a transmitter and antenna installed on a high rise building and they could not get a decent antenna match. Things were so bad that they were blowing out finals and resorting to some pretty desperate measures to keep things on the air – unsuccessfully. When my friend had been discussing the matter with the local support staff they had told him, "Why do you keep harping on what kind of grounding connections we have? We are hooked to the building steel and that is fine. After all, a ground is a ground!"

I just wanted to put my head in my hands and cry, or scream! This had come from a person in the commercial field who certainly should have known better. My friend was equally stunned. There is a huge difference between a DC ground and one for a few Megahertz. To make a long story short, I modeled the total system including the building frame and variable ground points where it actually was in contact with the ground and found that the "floating" ground visible to the transmitter was way out of whack. My friend then made the appropriate recommendations for changing the grounding system and tuning it out. Once this was done the system came up on the air at a nice operating efficiency. A little conventional tweaking to the antenna side and everything was running the way it was supposed to for the first time in years (or maybe ever).

Why Bother

So what does all this have to do with the average ham? Lots. If you have only a few watts or fractions of a watt, the total system efficiency is critical or you just cannot "get out". If you have a kilowatt of power you might be able to overcome an inefficient system somewhat, but you will have RF all over the shack. And, if you have an improper ground you can be inviting disaster in the form of lightning and/or electrical problems.

Grounds are for your personal safety, the protection of your equipment, and are the other half of your antenna. Without proper attention these things will cause you to get hurt, to fry your gear, or at the very least to spend hours trying to find out why you are interfering with your neighbor's TV but not able to pick up your signal at the end of the block.

How Much is Enough?

In a little bit I will discuss ways to evaluate your systems, but first we need to set out some ground rules (pun intended). In "real life" I consult on Safety and Environmental matters in addition to electronics. One question that always arises, and is ***very*** difficult to answer, is "How safe is safe enough?" Or on the environmental side, "How clean is clean enough?" When we talk about grounding you can, quite rightly, ask the same question, "How grounded is 'well grounded'?"

Sadly, the answer depends entirely on your situation so there is no universal, fixed solution to apply. I recommend that you set a goal of achieving each of these objectives:

- Low I*R drop at power frequencies (DC-120Hz)
- Reasonable isolation of items potentially exposed to lightning
- Low impedance ground at each of the operating fre quencies you use
- "Single point" grounding

- Understanding grounds, the types of grounds, lightning protection basics, and RF Safety

You will know you have properly set up your system when you are knowledgeable and comfortable that you have a better ground system than you once thought you needed.

Your reward will be improved safety (which is hard to measure) and a better signal and improved reception (both of which are easy to measure).

Key Points and Myths

Let's consider each of the types of grounds separately first and then combine them into one system. But first, let's clarify one area that gives rise to a lot of confusion and myth. The terms Neutral and Ground are no longer interchangeable. When I was just learning electronics the terms were pretty much the same. Some time in the 1950's or 1960's the requirements for premises electrical wiring in the United States changed from a single wire system return to a two wire return, and at that point the terms became totally different.

Here in the U.S. we use a system, which comes from a transformer secondary that is 240 volts. It is center tapped and the tap is connected to the earth. This lead is directly connected to your distribution panel and is called Neutral. Therefore either leg of the transformer provides 120 volts to Neutral. As a safety measure, a separate Ground lead was then run from earth to the third prong of your outlets.

In much of the rest of the world, there is no center tap on the 240 volt transformer and one leg is connected to earth and called Neutral. The safety lead we call Ground is typically called Earth in those countries. So remember, Neutral is ***not ever*** to be used as a Ground or Earth. It is a myth that any of these leads: Ground, Earth, or Neutral are suitable as general-purpose grounds.

In my opinion you should treat the Neutral just like any other Line (Mains) lead. I always treat it as a coincidence that it is close to earth potential. Also, since the Ground or Earth line is in your outlets for safety I do not consider it a good place to get a ground for your equipment either. You will see why a little later when we discuss skin factors.

For the purpose of discussion I will limit the types of ground to the following:

- RF Grounds
- Power Grounds
- Signal Grounds
- Lightning Grounds
- Earth Grounds

Each of these types of ground is designed to perform a different action, even though they share common objectives. In my opinion, the ideal ground for an installation is one that performs each of these grounding purposes without conflicting with any others.

RF and Power Grounds

For example, a #2 THWN cable might be a great power ground, but it could also be miserable for a 1.2 GHz ATV transmitter and antenna. As you go up in frequency, less and less of the current flows in the middle of a conductor and more on the outside. This is measurable and known as the skin effect. Because of this skin effect a fat cable is a big waste of copper at high frequencies. That also shows up in some unexpected ways.

As an example, a typical lightning bolt will have a power spectrum that goes well above 1 MHz (- 3 dB point). A typical discharge still has over 12% of its power above 4 MHz. A good rule of thumb for copper wire is that the *critical depth* (δ) is about 6.6 cm divided by the square root of the frequency. Below 2δ the current flow is down to only 13.5% of the total. So if we use 4 MHz as our frequency then that means that at least (12.5% * (1-13.5%)) or 10 % of the power in a lightning strike will flow in only the top 2δ=(2*6.6/(4,000,000)) or 0.07 mm (0.003 inches) of the conductor. That is only about 3/1000ths of an inch of ***any*** copper conductor carrying 1.8 ***kilo-amps***! I have used some simplifications to get to that number, but it makes the point. That is why lots of grounds for RF and lightning are copper straps. With a strap you get more surface area for the same weight of copper (i.e., cost).

So, for Power grounds you need to calculate the possible current and then find the number of square millimeters (or other equivalent) that you need to keep the I*R drop to an acceptable minimum.

For RF grounds, you should consider the skin effect for sizing requirements and then model the ground system to optimize efficiency and radiation pattern. There are lots of great modeling programs available now and each has its own strengths and weaknesses. I personally use four separate modeling programs on complex problems. One is good at developing wire frame models, one is good for total system analysis, one is good at optimizations, and one is good for complex shapes like cones and helices.

Another myth is that models will predict the effect of grounds that are above the earth. All of the models within the ham and small commercial budget are based on a calculating engine called the Numerical Electromagnetics Code and is often abbreviated with its version number like NEC-2. I should not be confused with the National Electrical Code, which is usually abbreviated as simply N.E.C. NEC-2 and NEC-4 cannot accurately handle elevated radials. Other than maybe some super secret military system, I doubt that there are many that can.

So how do you model the RF ground? You treat it as if it were a conductor between the source and earth. Like the problem I described above with the building, the building became one leg of a very bizarre dipole with its "far end" connected to earth through some lumped resistance.

Lightning and Earth Grounds

I do not have near enough space to do justice to a discussion of Lightning and Earth grounds. If I were sent to a desert island and could only take a couple of books with me, one would certainly be "*The 'Grounds' for Lightning and EMP Protection*" by Roger Block and available through PolyPhaser Corporation. As books go the price seems a bit steep and the size a bit small, but do not let that deter you. This is an excellent reference that you really need to properly design a ground for Lightning protection. It is also great for planning your Earth grounding system. The Earth grounding system is the physical connection between your system and the earth. This is often a simple ground rod, but can be a group of ground rods, wires, or plates. As with lightning, it can seem pretty arcane without a good reference book.

The N.E.C and Signal Grounds

When you have completed your plans for all four of the above grounds, it is time to make them all "match up". This is probably the source of most of the controversy and myth. You would not believe the number of times that someone has told me, "You cannot do that. It is against the code;" and been completely wrong. Really, this is often like a religion where people who have never read the book keep quoting it to support their points. One test I often use is to ask them who is the publisher and maintainer of the N.E.C. If they do not know that the N.E.C. is a subset of the National Fire Protection Association standards and recommended practices, then I take their quotes with a grain of salt.

I would not propose that you study the N.E.C, except as a cure for insomnia, but there are a few simple rules that you can follow and be comfortable that you are not in gross violation. First, and foremost, all grounds should be connected to a single point. What that means is that when you draw a schematic of all the grounds in your house and shack there should be no loops. It should be a pure tree, in which all paths run back to a single point. Second, as discussed above, do not use the power distribution Neutral or Ground for other grounding.

Third, when in doubt get professional help. Many Registered Professional Engineers are hams too and they will often give you advice on a courtesy rate. Be a little cautious of Master Electricians since they are not required to understand RF. On the other hand, they are a gold mine of information about obscure local codes that have been added over and above the N.E.C.

Finally you can consider your Signal Grounds. I lump audio, video, digital, telephone, DSL, etc. into this category. If you were able to get a pure single point ground, you will most likely not have trouble with the signal grounds. But since the world is not ideal, you will occasionally find loops in the grounding system schematic. Often these loops are on the Signal Grounds.

For example, a piece of audio gear has its chassis connected to the Ground pin of the 120 volt receptacle. Another piece of gear is also connected in the same way. When you connect the audio lead between the two pieces, you get a second path from one chassis to the other. This creates a loop. If you have a little less than perfect connection in any part of this loop and then induce a current in it, say from a transmitter nearby, then a current begins to flow in the loop and you get weird things going on. This can be hum, static, erratic behavior, and other odd effects.

One way to eliminate the loop is to break the ground shield at one end of the audio lead. While that may solve the problem, it does so by allowing the two chassis to be at different voltages. That can be a shocking situation (wow this topic sure lends itself to puns). A better way to solve the problem is with transformers and/or differential audio connections, but that is a topic for the future.

What Next

Whew! If you have survived to this point you know you need to design your grounds as completely as you design your antennas. Certainly you can hook a transmitter to a light bulb or barbwire fence and get a signal to propagate, but it will not be very effective for ATV with our QRP level power. The same is true of the other half of your antenna. Just plugging the bits together and using 16 gauge Hookup wire for grounds might work, but you will be lucky if it works well.

If you want to do things right, buy yourself a good lightning book like the one mentioned above and study it. Then sit down and draw a schematic of your shack's ground leads. Do not forget there are many: computers, radios, audio, antennas, batteries, chargers, power supplies, internet, telephone, modem, etc. Next find your official single point ground and go to work with improvements from there.

Grounds are not glamorous, but they certainly are important. I think that if you spend a little time on them you will be pleased with the improvements you notice in signal quality, sound purity, and overall safety. Maybe by next time I will have the new "Sparks' Bench" well grounded and running. Then it will be time for something else. Who knows, it might even be the CarCam. Until then be safe, have fun, and stay grounded (sorry, I just couldn't resist).

ATVQ

LET'S EXPLORE DIRECTIONAL ANTENNAS

Our Third in a Series on Antennas

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Crestline, CA 92325

In our previous two articles in the series we explored vertical and horizontal omni directional antennas. This article we will explore the multi element Yagi-Uda and Curtain Collinear Arrays. We will also cover basic Parabolic Dish Antennas.

THE DIPOLE:

The centerpiece of most antennas is the dipole, it is 1/2 wavelength total length at design frequency with a beam width of 78 degrees at the – 3 dB point with the radiation minimum off the ends of the dipole. (See figure #1) The dipole can be fed in a number of ways but the simplest way is divide the dipole into

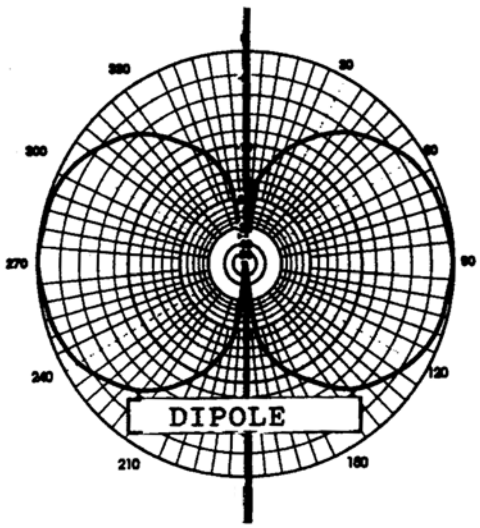

Figure 1

two ¼ wave in line rods or wires, this presents a 73 ohm balanced connection. A 75-ohm coaxial transmission line with a 1:1 balun or a 4:1 balun with 300 ohm balanced transmission line can be used for a simple connection. Bandwidth can be increased by using larger diameter rods with an increase in impedance or by using a folded dipole design. Folded dipoles are actually two dipoles separated slightly and shorted together on the ends and fed in the middle of only one dipole. (See figure #2) An interesting feature of folded dipoles is the increased feed impedance by up to a factor of 10. The factor is determined by the difference in size and spacing of dipoles.

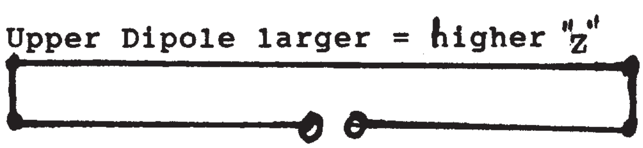

Figure 2

THE YAGI :

Adding a reflector approximately ¼ wave behind the dipole will increase the gain of the dipole by about 3 dB. The reflector is usually a rod or wire that is slightly (about 5 %) longer than the dipole. Adding one or more elements slightly shorter about ¼ wave in front of the dipole will also increase the gain by about 3 dB. By adding both a reflector and director to the dipole will make a more directive array known by the name Yagi-Uda or just Yagi (See figure #3). More directors can be added for more gain and directivity.

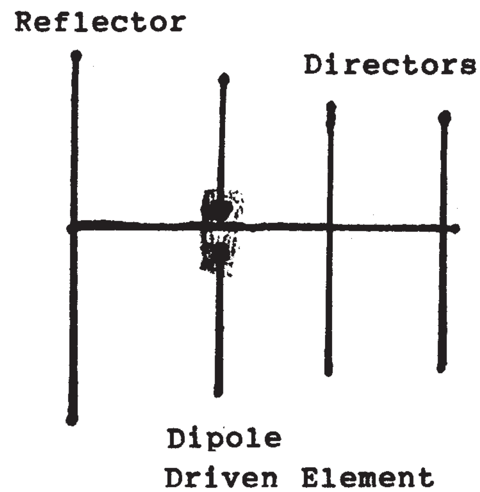

Figure 3

STACKING YAGIS:

Stacking yagi antennas (also applies for most types of directional antennas) is straight forward, and is accomplished be feeding each antenna in phase usually done with equal lengths of transmission line (see figures #4 and #5) There are two popular ways to stack yagis with phasing coax. Two 75-ohm equal odd ¼ wavelength (remember the velocity factor of the coax in your calculations) coax jumper cables connecting two 50-ohm antennas to a coax "T" connector to a 50-ohm feed line. Stacking four 50-ohm antennas together is done with four 50-ohm lines of equal length by connecting the two left antennas to a "T" connector and the same for the right two antennas. Then use the 3rd "T" connector to connect the right and left antenna sets together with ¼ wave 50-ohm lines.

An alternate way to connect 50-ohm antennas is with equal lengths of 50-ohm coax to a ¼ wave transmission line impedance transformer, this is also known as the power splitter. The splitter will be different impedance depending on the number of antennas connected but usually 2, 3, or 4 per power splitter. The

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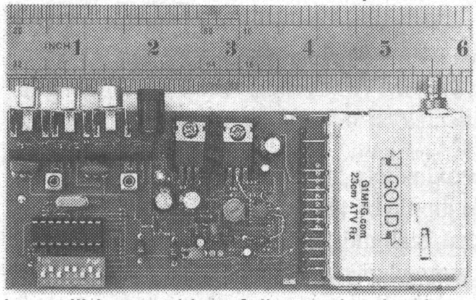

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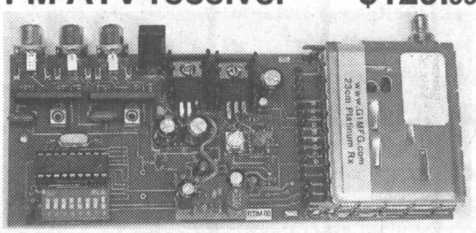

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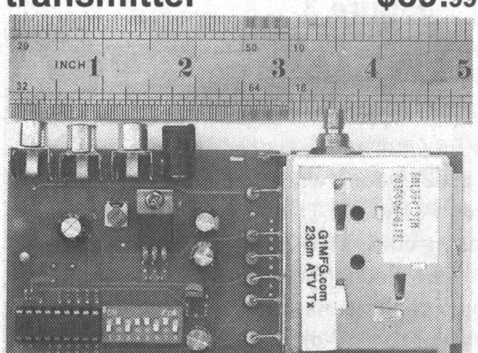

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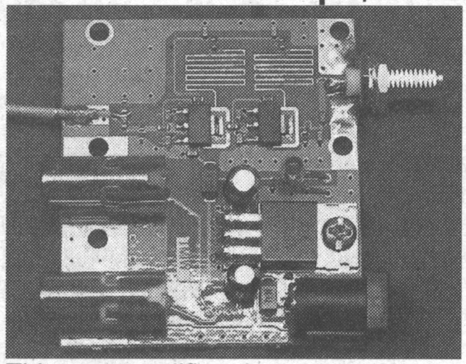

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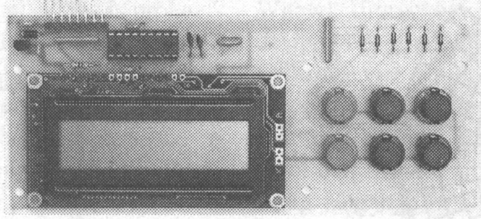

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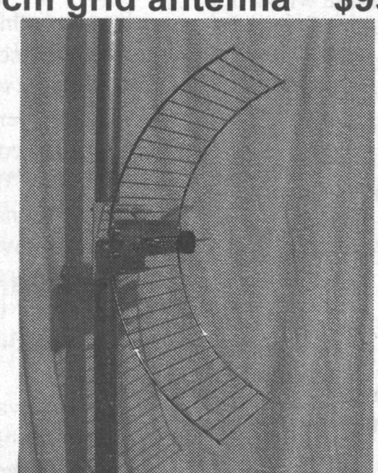

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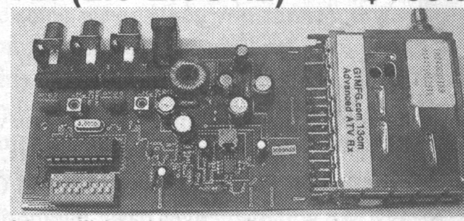

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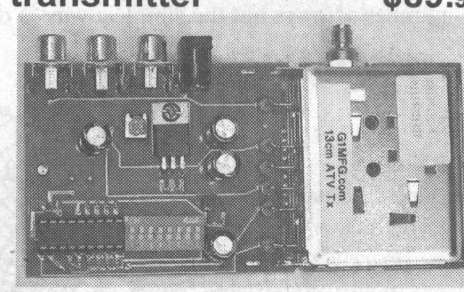

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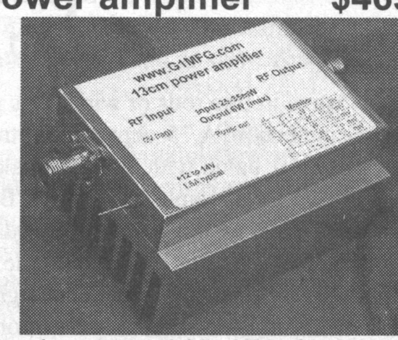

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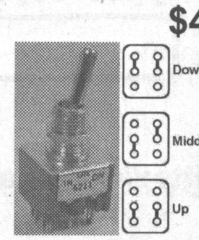

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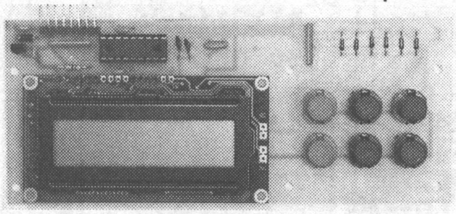

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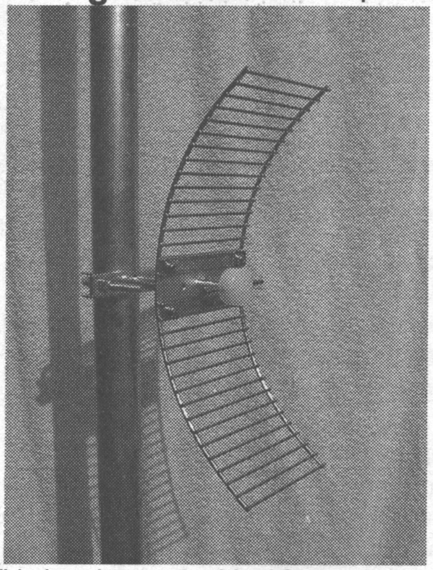

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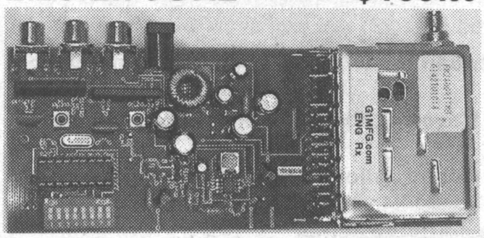

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The best way to order is to buy online from our web site at **www.TVHAM.com.** We aim to dispatch within 24 hours, and delivery usually takes 4-6 working days. All prices include shipping and handling.

We can accept personal checks, subject to a $20 processing fee. *<u>Please email us for details before sending a check.</u>* Our mail address is PO Box 12, Hedge End, SO32 2AA, UK. We give a full one year parts & labour warranty on all our built & tested products (return to base basis), excluding damage caused by misuse.

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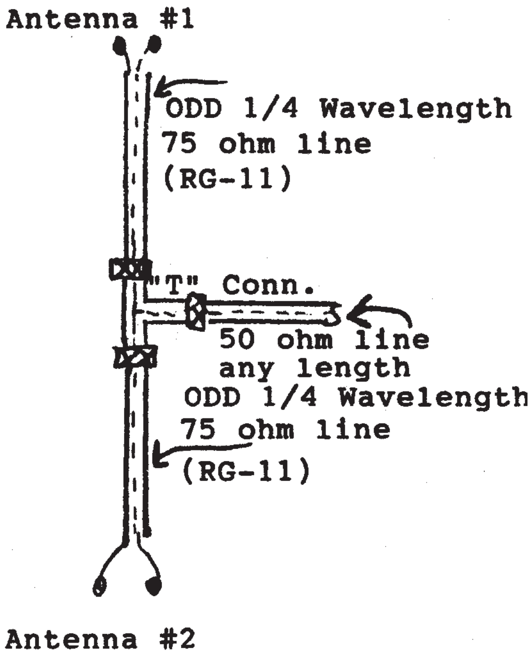


Figure 4a

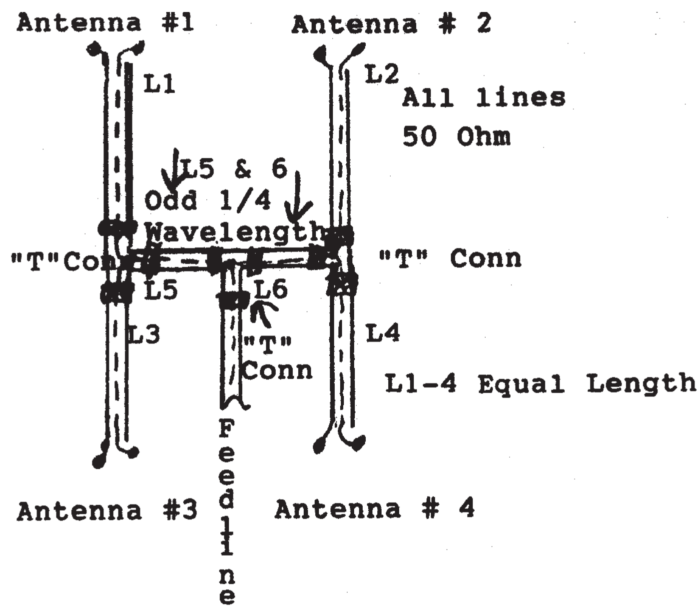
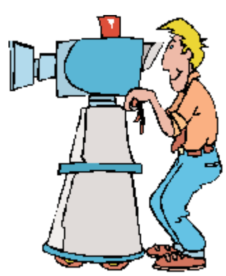


Figure 4b

formula for figuring out ¼ wavelength is 2976 divided by the frequency in MHz. When the ¼ wavelength is for coax multiply the ¼ wavelength by the velocity factor of the coax, see the manufacturers specifications for the cable you are using to get the velocity factor (measured in %). The stacking distance varies from one antenna model to another. Check with your manufacturer for recommended spacing. Most Yagi antennas are spaced about ½ of the boom length. Stacking too close will give reduced gain. The gain will gradually increase to nearly 3dB over a single as the spacing is increased to optimum then rapidly fall past optimum due to the main lobe splitting into two lower main lobes.

Very high back lobe suppression (front to back ratio) can be accomplished by stacking one yagi (See figure #6) or other identical directional antenna with antenna number one ¼ wave physically in front of the 2nd antenna and feed the 1st antenna with an additional ¼ wavelength (remember the velocity factor or the coax in your calculations) to delay the signal by 90 degrees. This places the signal received on the front of both antenna in phase giving a 3 dB increase. The signal received off the back of both antennas is 180 degrees out of phase thus canceling the signal. Fine-tuning to maximize the null can be accomplished by



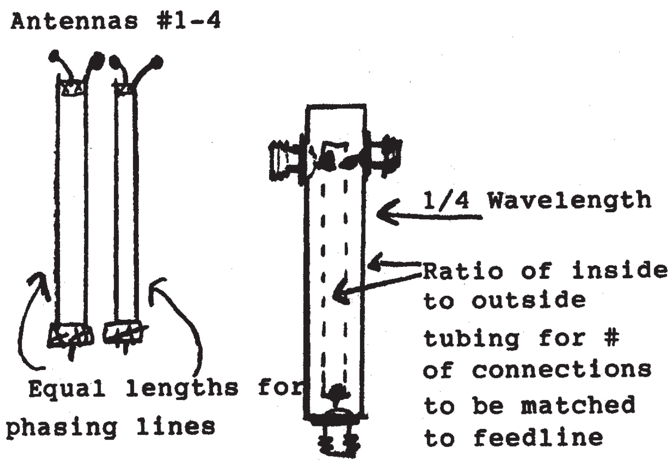


Figure 5

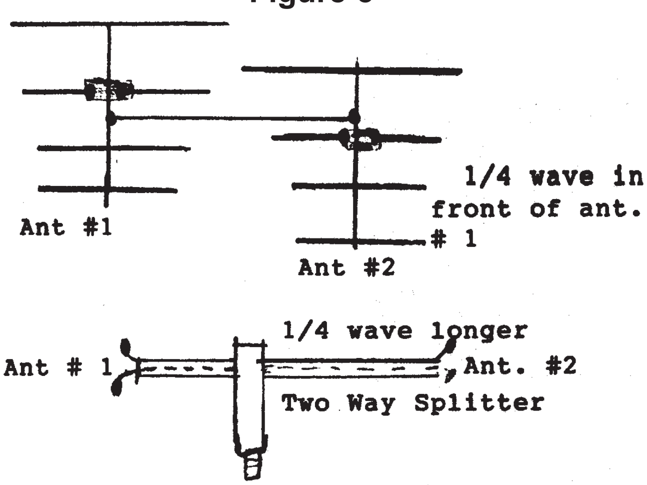


Figure 6

sliding one yagi slightly back and fourth in the boom to mast clamp.

THE CORNER REFLECTOR:

The reflector can be a large sheet or grid longer than 1/2wave wide. The gain and directivity can be increased by bending it into a 90 degree angle and spacing the dipole ½ wave in front of the bend in the reflector with about 4 to 10 dB gain (See figure # 7). Larger reflectors yield higher gain, some large reflectors elect to use 1 1/2 wave spacing from the bend to increase the gain by more fully illuminating the reflector.

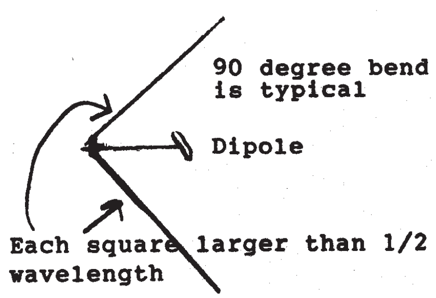


Figure 7

THE CURTAIN COLLINEAR ARRAY:

Dipoles can be phased together in a curtain collinear array to increase gain and directivity. The array is usually mounted ¼ wave in front of a reflector plate, grid or individual reflector elements in back of each dipole (see figure # 8). The dipole spacing side by side is ½ wave with another set of elements just

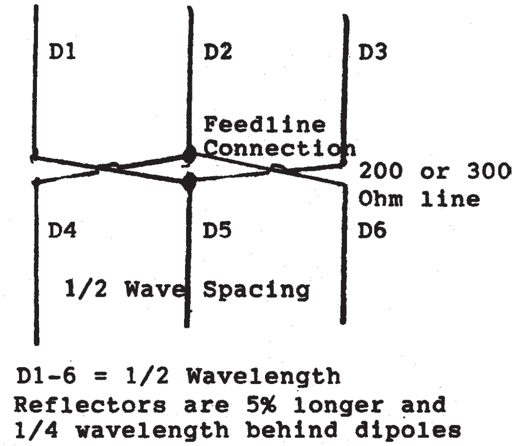


Figure 8

above the first set. This array is fed at the end of each dipole with a balanced transmission line harness with a 180 degree phase reversal between elements to allow for the signal's delay in the harness so all driven elements are in phase. Gain is 13 dB for 6 & 14 for 8 driven elements. The array is fed in the center with balanced transmission line or a 4:1 balun and coax. Usually a universal matching stub is used to obtain a precise match. I found that 6 driven elements were very close to 200 ohms so I did not need the matching stub. Curtain collinear arrays can be stacked and fed in phase to increase the gain and directivity. The larger the array the more critical is the need for proper spacing, aiming and phasing of each antenna in the array to maintain focus of the main lobe.

THE PARABOLIC DISH:

Parabolic (Dish) antennas use a reflector bent into a parabolic curve to achieve a massive amount of reflections in phase to a dipole/reflector (2 element) or horn feed (See figure # 9). A shroud can be added to the edges of the dish to improve the front to back and front to side pattern with insignificant gain change to the main lobe. Doubling the diameter of the parabolic reflector quadruples the gain (6 dB) and generates a much narrower front lobe. Dish antennas are most popular on the microwave bands because of large size and wind loading on VHF and lower UHF bands. ATVQ

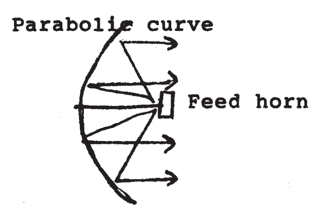


Figure 9

Airborne Amateur Television for a Regional Fire Agency

by: Ray Grimes, W6RYS Email: Ray.Grimes@motorola.com
Chief Radio Officer, County of Orange RACES
Orange County Sheriff's Communications
11278 Los Alamitos Blvd. #304
Los Alamitoes, CA 90720

Background and Overview

Amateur Television is one of many facets of Amateur Radio. Amateur Television, or ATV, has been around for over 40 years but has only recently been recognized as an important tool for public safety communications support. Though commercially available portable video microwave link systems for public safety may perhaps offer higher quality video and include more features, cost is prohibitive for many agencies, particularly where more than one portable TV system is required. A larger barrier is that broadband commercial or public safety video dedicated downlink frequencies are virtually unavailable in major cities, particularly for use from aircraft.

ATV may be transmitted over UHF at 430 MHz, 900 MHz, or 1.2 GHz directly (simplex) or through relay (repeater) stations. TV transmission outdoors ground range of 5 to 10 miles is achievable using simplex, with outdoors ground range of 50 miles or more possible using repeater stations. In some special applications, ATV can be relayed for hundreds of miles through a chain of relay stations. Airborne simplex video can be received up to 20 miles at a ground station, and up to 50 miles through a repeater station.

ATV plays an important role in the annual Pasadena Tournament of Roses Parade, providing video surveillance from rooftop camera locations to the field command posts. ATV was implemented by the Los Angeles County Disaster Communications Service (LADCS) during the 1984 L.A. Olympics, providing

rooftop camera surveillance of key street locations. LADCS has also tested ATV in County Fire helicopters. At one time, the Los Angeles County Sheriff's Department had ATV transmitters permanently installed in several of their helicopters. Some local police agencies use ATV in their helicopters, outfitted and operated by RACES members. In other parts of the country, ATV remote-controlled cameras are part of StormWarn or TornadoWarn networks, providing valuable "real time" information on the progress and direction of deadly weather systems. The Civil Air Patrol has used ATV from its aircraft, and ATV has even been operated from model airplanes and helicopters, and hot air balloons.

Orange County RACES has been using ATV for over 6 years. OCRACES ATV was implemented in Brea Mall Mutual Aid Fire/Rescue Exercises, providing "live" TV coverage of simulated disaster rescue operations for the TV monitor-equipped Orange County mobile command post located in the mall parking lot. OCRACES supported the City of Westminster in their Earthquake Disaster Exercise. OCRACES setup a two-way video link from the City of Westminster EOC (Emergency Operations Center) to the Orange County EOC. This allowed participating agencies to view the City of Westminster EOC operations, and the Westminster personnel were able to see the Orange County EOC in a simulated activation state.

Requirements

ATV is an FCC licensed transmission mode that operates on Amateur Radio frequencies. An Amateur Technician Class license or higher is required to operate the ATV transmitter. ATV receiving stations do not require licenses. FCC Rules 47 CFR 97.401 through 97.407, allow ATV transmissions for routine RACES drills and for actual emergencies under RACES and Civil Defense provisions. It is important to note that while Amateurs are permitted to support "emergency" communications, the daily business of a police or fire department may include emergencies, but the nature of their business is still routine. The FCC Rules provide for emergency communications support where true disasters exist.

ATV operators are required by FCC Rules to identify their stations at least every 10 minutes. This can be accomplished using an ATV transmitter voice subcarrier, or by use of a character generator that superimposes the call sign on the transmitted picture, or more simply, a call sign card may be held in view of the camera. The camera operator must remember to identify the station regularly. Orange County RACES has gone a step further with the use of an optional call sign video identifier board which automatically activates every 7 minutes, plus the addition of a GPS receiver interface which also superimposes real-time GPS coordinates of the viewed scene from the aircraft. This makes the entire identification process automatic, and provides a permanent position stamp on the video that may be referred to later.

Though licensed ham operators may send ATV transmissions to ATV receiving stations that do not require ham licenses, the licensed ham operator may not 'broadcast' one-way messages 'in the blind', but must transmit to another licensed ham operator. There is no prohibition as to one or more non-participating ATV receiving stations watching this 'live' video also. On occasion, an ATV station may capture crucial incident information on video tape that police or fire agencies may later confiscate as evidence. Expect that possibility at all times. The media may also approach an ATV operator, offering to purchase sensitive video documentation. That can produce two problems, in that the information may be considered 'restricted and sensitive' by a police or fire agency, and the amateur operator may find himself being challenged by the FCC if 'Amateur Radio for profit' is suggested.

As there are only two ATV UHF frequencies in Southern California for all to share, use of a VHF ATV coordination voice channel is imperative. In a widespread emergency, many agencies will all be competing for the two ATV frequencies. Air operations intensify the potential problems, where large area ATV coverage translates into long-range interference for neighboring agencies.

Equipment

ATV transmitting equipment includes a video transmitter, a camera, and an antenna system. UHF ATV transmitters are available in the 5 watt to 100 watt output power range. Higher power transmitters provide greatly improved ATV coverage, though at a price of significantly increased current consumption and increased interference to others. The ATV transmitting system may be powered from AC, exterior battery sources such as from a vehicle, a boat, an aircraft, or from self-contained rechargeable batteries. OCRACES ATV transmitting equipment has evolved into portable "grab and run" units that include all necessary ATV transmitting equipment in convenient, self-contained, self-powered packages. This is particularly handy for field operations or aircraft temporary installation.

ATV receiving equipment consists of a consumer type TV set operated on TV Ch. 03 or Ch. 08, depending on the ATV band in use; an ATV downconverter that converts the ATV frequencies to a common TV channel; and an ATV antenna. A fixed frequency, crystal controlled ATV receiving converter is preferred, so that the process of tuning for the received signal is eliminated, helping to simplify equipment operation.

Tape Recording

The ATV receiving station may also include a VCR to capture "live" video. Some RACES members have had good success with commercially available combination portable TV/VCR units. These units allow TV reception and video recording in one box. Another distinct advantage of these portable TV/VCR units is that they can be operated from AC or 12vdc power. The built-in VCR operates reliably over a wide range of operating voltages with little or no variation in recording or playback tape speed. Attempts to use a consumer grade VCR from a DC inverter may result in a recorded tape that can't be played back on AC power on the same machine, or on any other VCR, as the AC line frequency determines the critical speed of most recorder tape drive motors.

Antennas

ATV transmitting antenna requirements vary with the application. Similar to the transmitting equipment, the receiving station may be able to use a flexible whip antenna for short-range reception, or a TV antenna type yagi antenna for long range.

An aircraft ATV transmitter installation is most effective when connected to an exterior antenna. A small UHF portable antenna can at minimum, be duct-taped to a helicopter skid. A counterpoise such as a pie pan ground plane may be needed to assure proper antenna impedance matching. An antenna mismatch may produce transmitted picture 'ghosting' or color shifts. A quarter wave ground plane antenna would have to be mounted inverted to optimize a downward radiating pattern.

The use of an exterior transmitting antenna helps assure that the transmitter energy is not coupled into aircraft navigation or flight systems, while providing maximum ATV system performance. A permanent antenna may be installed on either a fixed wing aircraft or helicopter. The antenna should be installed on

the underside of the aircraft to minimize shadowing losses through the aircraft itself, remaining away from other antennas, struts, and wheels where possible. An antenna hole drilled through the skin of an aircraft would require a doubler plate for strength that would be installed by an A&P airplane mechanic. An antenna hole may also be drilled though an airframe inspection cover plate, as the mating inspection hole already has a doubler plate, still requiring an A&P airplane mechanic to perform the work and sign-off the installation.

Another reason helicopter antennas are mounted on the aircraft underside is to prevent rotor blade modulation as the overhead blades rotate through the antenna path, producing a unique warbling form of AM modulation interference of the ATV signal.

A few aviation manufacturers offer FAA approved omnidirectional blade type aircraft antennas that cover the VHF or UHF ham bands. These antennas must be installed by a licensed FAA repair station. Other non-approved antennas may also be installed on an aircraft, requiring the submission of an FAA 337 form application and completing an aircraft weight and balance revision, with the antenna installed by a licensed aircraft A&P mechanic. A 'temporary' antenna and ATV installation is the least complicated, with no FAA required installation forms needed. A battery powered, or 12vdc cigar lighter plug powered ATV transmitter installation can be readily used, and is considered as 'baggage'. A word of caution: some aircraft electrical systems are 24vdc negative ground. You may need a DC to DC inverter to operate 12vdc equipment. Make sure the equipment is shut off (or removed from accessory power sockets) during aircraft engine start-up and shutdown. Severe transient voltages may damage your equipment.

Radio transmission to and from an aircraft presents some unique challenges in that a vertical antenna characteristically produces a donut shaped pattern in the horizontal plane. The vertical axis presents a dead zone known as the cone of silence. For close proximity work, this effect is not a great problem, though at high altitude or for long distance communication and interference prevention, antenna pattern control is critical. A simple quarter wave omnidirectional whip works well from an aircraft at VHF or UHF. Gain antennas further compress the signal in the horizontal plane, making aircraft position and angle of back hyper-critical. The media often uses remote controlled steerable aircraft and ground station antennas that can be optimized for the best signal. Use of a helix or bi-polarized ground station antenna may also help to minimize cross-polarization effects as the aircraft moves about. Directional antennas aboard an aircraft are bulky and difficult to operate. Unless these are professionally engineered and mounted, they are more trouble than their worth. Regardless of the antenna and power configuration in use for an aircraft, the pilot is the final authority as to how the equipment will be carried, used, and attached.

SSTV

Slow-scan television has been around for decades but has only recently enjoyed new interest and purpose among the Amateur Radio community. This is largely due to the introduction of the Kenwood VC-H1 Video Communicator (c). Our public safety 'customers' have told us in the past that they only wanted real-time, high quality video. That of course, requires a sizable investment of money and personnel to deliver near broadcast quality live video. After a few demonstrations of SSTV, not only did we establish an interest and acceptance of SSTV, but several fire agencies purchased VH-H1's for their licensed Amateur firefighters to use in disaster operations. One fire captain asked the price of a VC-H1 system with a decent CCD camera? Upon receiving the answer, he laughed, commenting that he could purchase a lot of VC-H1's and portable transceivers for the cost of one fire truck tire. Acceptance of still-frame, slow scan pictures by public safety has been amazing to us, though we shouldn't be too surprised, being able to deliver almost 35mm film quality snapshots of disaster scenes in minutes of a call-out, with transmissions of up to 75 miles through a voice repeater, using only a handheld low-cost portable transceiver. The simplicity of SSTV and the minimum amount of equipment to do the job helps to sell SSTV to most anyone.

OCRACES made SSTV operational tests from my aircraft in early February, 2001. The equipment was a Kenwood VC-H1 and a 5 watt UHF portable transceiver, using the quarter-wave antenna permanently mounted underneath my 6 place Piper Saratoga aircraft. A Sony camcorder was substituted for the built-in VC-H1 camera. One of our county RACES voice repeaters on Santiago Peak was used for SSTV relay. Our first efforts consisted of orbiting around the EOC and the alternate EOC and sending pictures back to the ground. That worked flawlessly. We flew west to an area 45 miles from the repeater site, near Malibu. On January 31, 2001 Alaska Airlines Flight 261 crashed into the ocean off of Malibu, California. We thought it important and informative to see if we could provide useful coverage from a distant disaster scene. From the area near the Flight 261 crash scene, we were able to send P-5 quality slow scan pictures to our EOC and to several RACES ground stations from an altitude of 3,500 ft.

We flew just outside the temporary restricted area around Malibu, California where the investigation was in progress for the Alaska Airlines Flight 261 crash. As we weren't an official part of the recovery or investigation efforts, we stayed clear of the restricted area. During the Northridge Earthquake of 1994, we were able to secure permission to fly through several temporary flight restricted areas, on official business. It quickly became obvious that we needed to remain in orbit at or above 2,000 ft. AGL over the scene with our fixed wing aircraft. Though Air Traffic Control (ATC) would have granted permission for lower flight, we considered low altitude operation unsafe for us, as there was a swarm of public safety, military, and media helicopters over the incident. The pilot (also a licensed radio amateur), was committed to flying the aircraft and observing traffic, with the passenger/observer/radio operator/camera operator doing his job independently, maintaining regular communication and coordination with the pilot.

When the camera operator needed a special bank angle or orbit, he would give the pilot an advanced briefing of the action needed. The pilot would have to clear the area of air traffic and advise ATC of the pending activity prior to moving into position.

The Malibu area test from almost 50 miles away was so completely successful that we decided to fly to Catalina Airport for lunch, where SSTV testing continued. With the plane parked on the airport ramp, an excellent picture was transmitted to our RACES locations on the mainland through the repeater, and was also received by San Bernardino County RACES, around 100 miles away from our location. In essence, we never ran out of SSTV range, thanks to the narrow band SSTV mode that effectively allows a few watts of power to send quality photos up to 100 miles from an aircraft.

We in OCRACES remove the built-in VC-H1 CCD camera and substitute a high quality camcorder. The improvements in picture quality and resolution are amazing, adding low light imaging and tape recording capabilities. The quality of SSTV even passes the test of being e-mailed or projected on a large screen in our Emergency Operations Center (EOC). Before you get too excited about the Kenwood VC-H1, we understand that this wonderful product has been discontinued, though they can still be found in some ham radio stores and at ham radio swap meets.

TV Cameras vary in size, cost, quality, and features. Some ATV stations use surplus VCR compatible Vidicon tube cameras that plug directly into the ATV transmitting equipment. These workhorses provide clear, crisp pictures and typically feature 12X to 18X zoom lenses. Unfortunately, they are usually large and heavy and battery consuming, making them undesirable for portable operations. Recent developments in CCD (Charge Coupled Device) TV cameras have made high-quality color cameras available at low cost, exceeding the performance and reliability of Vidicon tube cameras. Compact CCD cameras are available in both black & white, and color models. A good camcorder fills this need while also providing recording and screen title capabilities. Some CCD camcorders also feature infrared (IR) night mode that offers a powerful new capability for low-cost Amateur Radio airborne video nighttime operations. In the IR mode, the camera operator has to work at keeping aircraft interior and ground lighting from overloading the camera, washing out the desired scene.

OCRACES operates a self-contained portable camera/transmitter package that includes a color CCD camera. The CCD camera uses a simple, fixed wide-angle lens. Both the Vidicon and CCD cameras have excellent low-light sensitivities, approaching 1 to 3 Lux for color saturation. Vidicon camera exhibits a unique property which can be important in fire fighting applications. Much of the light spectrum visible to a Vidicon camera is in the infrared range. This allows a Vidicon camera to "see" into the core of a fire through moderate smoke.

Professional helicopter video installations typically make use of costly exterior pod-mounted, remote-controlled, gyro-stabilized, high-magnification video cameras. The camera hardware and installation alone can cost in the six figure range. Gyro stabilization is important, particularly at high magnifications, to overcome the vibration and motion of the aircraft. Some success has been achieved for ATV applications with small solid-state portable digital cameras that include electronic anti-jitter circuitry. Police surveillance helicopters frequently use WESCAM(c) systems that allow excellent low light, high altitude (7,000 ft. AGL) surveillance. Since it is generally outside the scope of fire surveillance helicopter crews to read license plates from high altitudes, such cameras may be overkill.

In all portable aircraft camera operations, the operator must maintain an unobstructed view of the subject matter. Plexiglass windows cause reflections and distortions which degrade picture quality. An open door or a vent port serves best as a viewing area. Open aircraft doors are workable, though camera operator comfort and safety are more difficult to maintain.

Limitations and Special Considerations

While ATV appears to be the affordable alternative to commercial TV systems, there are some considerations, compromises and limitations that must be clearly understood. First, the FCC requires a licensed Amateur Radio operator be available to control the ATV transmitter at all times. This somehow has to fit into Fire Operations practices. A firefighter or other payload may have to be displaced to accommodate the ATV operator and his equipment. There is also the likelihood that the Fire helicopter may be given assignments that would not provide the opportunity to view and transmit the desired fire scene. When an emergency arises, the helicopter must be dispatched promptly. The ATV operator must be summoned to the airport with the first response team. The aircraft must be suited for the ATV system, including considerations such as maximum gross weight with crew and equipment, particularly on hot days and for high altitude locations.

While the transmitter can be powered off of an internal ATV transmitter battery, the ATV antenna must be readily available for immediate use. Though an exterior portable whip antenna could be duct-taped to a helicopter skid, this takes time and the installation effort might interfere with other aircraft preparations. As with anything affixed to the aircraft, the pilot must determine a safe and non-interfering location for all equipment.

Potential Radio and Aircraft Systems Interference

Fast scan television implements a standardized transmission format known as NTSC (National Television Standards Committee) that transmits video and voice subcarrier on approximately a 4.5 MHz wide segment of the band. As with all transmitters, there is potential for radio interference to other services, though these problems can be minimized or eliminated through good engineering practices. Of particular interest with regard to aircraft systems interference are on-board video transmitters and separate ham radio voice transmitters. Aircraft voice communications occurs between 116 MHz to 136 MHz, with navigation operating between 108 MHz and 116 MHz. The Marker Beacon operates at 75 MHz. Transponders operate between 1030 MHz and 1090 MHz, with DME located between 980 MHz and 1220 MHz. Emergency Locator Transmitters operate simultaneously at 121.5 MHz, 243.0 Hz, and 406.025 MHz. GPS receivers using the L1 mode operate at 1575.46 MHz. There are harmonics from ham transmitters that may fall on several of these bands, though actual interference may only occur on a few selected frequencies. The broad nature of the ATV video signal could produce interference to several aircraft frequencies simultaneously. Special attention should be given to aircraft operations with 430 MHz transmitter 3rd harmonics and 1.2 GHz amateur radio transmitters, particularly with respect to DME interference. Aside from classic harmonic and sideband noise interference to aircraft receivers, there is potential for RF interference to aircraft operating systems such as the autopilot. It is the ultimate responsibility of the air crew to make ground and air operational tests using all radio and flight systems to assure that on-board ham radio equipment does not affect their performance or poses a risk to flight operations.

Monitoring and Frequency Sharing

ATV operates on a few shared Amateur Radio frequencies. Whether operating through a repeater or using simplex for video transmissions, it is important to monitor and announce your intentions on the designated ATV voice coordination frequencies prior to transmitting. This is common courtesy during routine operations, and completely necessary during a wide area disaster, as interference to other operators must be minimized, particularly when operating from an aircraft.

Who is the Audience?

ATV reception sites must be carefully considered. High quality ATV transmissions can be sent directly to an on-scene mobile command post from a nearby helicopter or other good vantage point. One city's police helicopters orbit at or below 500 ft. over an incident and transmit ATV directly to a nearby mobile command post. The low orbit assures excellent picture quality and minimizes interference to other agencies on these shared frequencies. The "live" video is tape recorded in the mobile command post and may be transported by emergency vehicle to headquarters if necessary. In the case for our Regional Fire Agency, "live" video transmission to Fire Headquarters is desired, requiring that a permanent, dedicated ATV receiving station capable of UHF and 1.2 GHz reception be installed. It is recommended that RF filters be installed on the ATV transmitting and receiving equipment to prevent mutual interference with other nearby services.

ATV transmission is via Amateur Radio frequencies. These frequencies may be received by anyone with ATV equipment. While it is unlikely that the public at large would be able to intercept these TV transmissions, it is important to remember that this is an unsecure medium.

Criticism of ATV video usually includes a statement that "the picture doesn't look as good as NBC". Our reply is "that for the same investment, we can do it!" Color balance is also sometimes criticized. Good indoors color balance requires all of the controlled lighting a TV studio normally implements. Our portable ATV transmitter includes a CCD color camera and a high-intensity floodlight. Incandescent lights can give off a greenish hue, with mercury lights rendering a reddish or orange hue. This is of greatest concern in law enforcement where correct color rendition is mandatory for court evidence. In industrial camera systems, the high temperature furnace flame of a smelter plant must be monitored to assure correct combustion and temperature. In racing cars, alcohol fires are mostly invisible to the casual observer. The TV camera can see the infrared energy and heat waves. In fire scene observation, color is helpful, but correct color balance may not be achievable due to smoke filtering and sunlight effects.

Borrowing from Friends

There are several ATV repeaters that are all privately owned and funded, comprising the ATV Network. There is also a microwave interlink which ties these systems together, allowing long-distance video relays. A distinct limitation with these excellent systems is that they are privately constructed, maintained, and funded, with no assurances that they will be available in a major disaster emergency for public safety usage. The owners/operators have been very cooperative in allowing our RACES activities, but nevertheless, these are shared, private systems. Simplex UHF is then a good alternative for overall emergency operations.

Unique Benefits

Airborne ATV offers a unique and useful birds-eye view of a situation. ATV tests after the Laguna Firestorm proved that from a 1000 ft. orbit in a private aircraft, it was completely possible to identify street locations and promptly report situations via radio. Tape recorded video can later be reviewed for training and documentation purposes, and sometimes becomes key evidence where a crime may have occurred.

Back to Reality

Now that we have convinced the Regional Fire Agency that ATV and SSTV can offer outstanding and unique supplemental video communications services for major disasters, we now need to throw some water on this enthusiasm by restating the FCC limitations imposed on Amateur Radio video transmissions. As previously stated, ATV and SSTV transmissions are defined and regulated by the FCC. These modes must not be used for routine fire or police business that does not fall within the definition of true disaster communications. Having said that, ATV and SSTV can provide an important visual communications supplement for disaster site assessment and tactical planning. In keeping with Homeland Security planning and the President's Volunteer Services initiative, Amateur Radio can do the job, providing high quality video and photo transmissions, with the skilled technical staff to do the job, and all for free!

The A.T.N.A. Friday and Saturday Night ATV Dinner Meetings

A.T.N.A. is announcing their Dayton weekend activities regarding Friday and Saturday night ATV sessions. This year we will be back at "The Stockyards Inn", for the Friday night and Saturday night sessions. This will enable ATVers and guests to enjoy a moderately priced meal and also allow more time for technical presentations. The Stockyards Inn will provide separate checks as we order from the menu. There will be door prize drawings throughout the evening. Friday night will be a well structured event while Saturday night will be an informal gathering of ATVers.

Starting at 6PM both nights

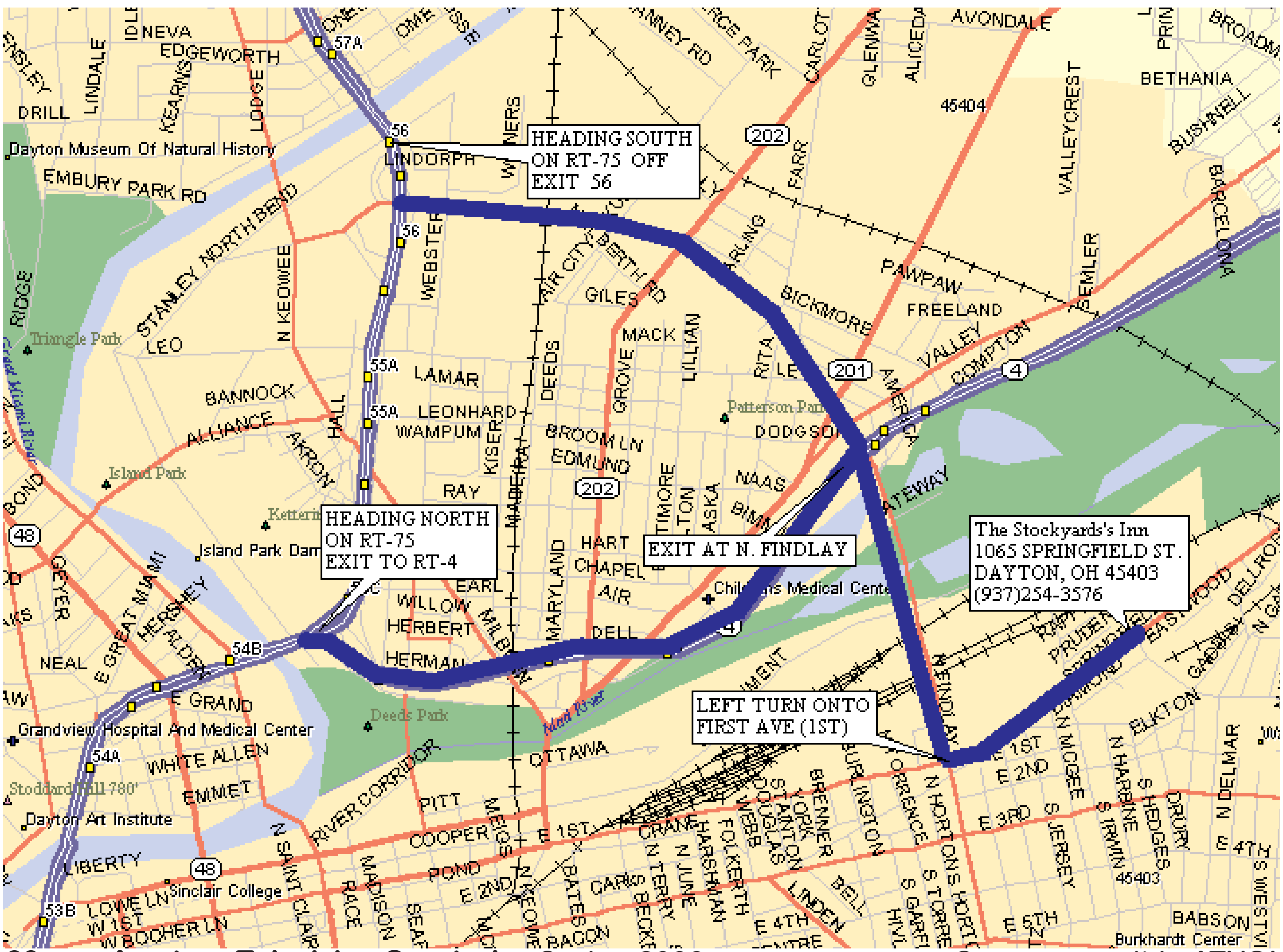
DIRECTIONS

From I-75 North, Exit 56, Stanley Avenue East, at RT-4 the road changes name to N. Findlay Street, at First Street turn left and the road will then merge into Springfield Street. Look for "The Stockyards Inn" on your left . The trip from I-75 is 3.4 miles and should take about 8 minutes.

From I-75 South, Exit onto SR-4 and get off at N. Findlay Street South. At First Street turn left and the road will then merge into Springfield Street. Look for "The Stockyards Inn" on your left. The trip from I-75 is 4.0 miles and should take about 6 minutes.

Please note: Each person will be responsible for their own dinner expenses.

For updates please see the A.T.N.A. Web Page: **www.qsl.net/atna**



The A.T.N.A. Program for Dayton 2003

Friday 16 May 2003

Stockyards Inn
1065 Springfield St.
Dayton, OH 45403
Phone 937-254-3576

1745 -1900	Dinner from menu with separate check. PLEASE dine with ATNA.
1900 - 1905	Program review by MC, Ron Cohen, K3ZKO
1905 - 1915	A video of the “Critter Cam”, by John, W3SST.
1915 - 1920	First Prize Drawing by Art Towslee, WA8RMC
1920 - 1950	Linked ATV Repeaters via Amateur TV Network by Mike Collis, WA6SVT (Video report followed by Tech talk with Q and A.
1950 - 2020	Giles, G1MFG compares and contrasts amateur television activities between Europe and the USA.
2020 - 2030	Break with refreshments curtesy of ATNA.
2030 - 2035	Second Prize drawing by Art Towslee, WA8RMC
2035 - 2120	“High-Speed Digital ATV”, presented by the ARRL HSMM Working group.
2120 - 2155	Upcoming Balloon flights by Bill brown, WB8ELK.
2155 - 2200	Wrap up Announcements / Good Night to all

Saturday 17 May 2003

Stockyards Inn
1065 Springfield St.
Dayton, Ohio 45403
Phone 937-254-3576

1800 - 2200 Informal dining with the ATVers and their friends.

ATVQ

ATV Forums - Saturday - May 17 52nd Dayton Hamvention, 2003

12:15 - 2:30 Amateur Television (session #3) ....Room 1

Moderator: **Bill Parker, W8DMR**

Speakers:

Mike Collis, WA6SVT - “What is ATV? And what can you do with ATV? “

Video showing ATV operation, both simplex and repeater, latest California mountain topping & more.

Giles Read, G1MFG - “A Comparison and Contrast of ATV Activities Between Europe and the USA”

UHF and Microwave ATV, as presently operated from across the pond, 1.2 & 2.4 GHz FM ATV operation.

Announcements from:

DARA ATV Repeater Status

ATNA Activities, K3ZKO

ATVQ, Editor WB9MMM

ATCO, Editor WA8RMC

See you there!

Bill Parker, W8DMR
w8dmr@copper.net

ATVQ

Amateur Television Contest

Contest period 00:00z 06/01/03 to 00:00z 09/01/03

Contest goal: To raise activity and promote *long haul* contacts on ATV.

Participants must hold at least a Technician class license and be within the boundaries of North America, Alaska or Hawaii.

In case of multiple Ham occupants, they may share equipment during the contest so long as the intent is not merely to manufacture points. All occupants who enter must submit their own log.

Schedules: The use of schedules is allowed, and can be made by any means available. The use of 144.340 mhz national ATV calling frequency is also allowed and encouraged.

REPEATER CONTACTS DO NOT COUNT, Distance calculations will be between both stations in the QSO with no relay allowed.

Exchange: Callsign with at least P-1 video on any amateur band 70cm and above.

MOBILE or **PORTABLE** stations must exchange their location at the time of contact as determined by portable GPS or other verifiable means.

VIEWER: Station does not have to exchange any video but must be a licensed amateur and confirm at least a P-1 reception report to the transmitting station via 2 meters or another amateur band.

CLASSES:

There will be 4 classes for participants:

HOME: Primary location of residence with Fixed Antenna structure. Minimum distance for repeat contacts (75 Miles)

PORTABLE: Station can be set up just for the contest and may not operate from any other location during the contest period. Minimum distance for repeat contacts (50 Miles)

MOBILE: Station can operate stopped or while moving but all antennas must be affixed to the mobile unit and capable of transmit while in motion. Minimum distance for repeat contacts (25 Miles)

VIEWER: Station must be able to receive video at P-1 signal level and relay report to the transmitting station. Minimum distance for repeat contacts with this class is determined by the transmitting stations type or class.

Scoring System: Each valid contact will be awarded points for the mileage between the two stations on an ever-increasing difficulty per frequency basis as follows:

70cm = 2 points per mile

33cm = 4 points per mile

23cm = 6 points per mile

13cm and above gets 10 points per mile!

A station can be worked for points only once unless they are a minimum distance apart as specified by the class of entry. (See CLASSES) and then they may be worked once in a calendar month through the contest period.

The distance between stations will be calculated by the Maidenhead Grid and sub grid identifier coordinates listed on QRZ.com and rounded down to the nearest mile. Every effort should be made by entrants to verify or update their information before the contest starts. If you do not have Internet to look up a stations coordinates please ask the other station, if they do not know then leave the mileage column blank and it will be determined by the verifier. No changes can be made to coordinates once the contest starts unless you move.

Distance will be calculated with the (Bearing and Distance) DOS program by W9IP that is used by the ARRL for distance records.

LOG's: All logs must be in a standard format as specified below:

STATION WORKED RPT UTC DATE FREQUENCY DISTANCE CLASS

Your log information should also include your Name, Address, your Maidenhead Grid and sub grid identifier coordinates, and a list of equipment used.

Logs can be submitted by email or regular mail and must be received by September 15th to be eligible for contest Awards. Send the logs to:

ATVQ Contest
5931 Alma Dr.
Rockford, IL 61108

or to: ATVQ@hampubs.com

AWARDS:

All Scores will be published in ATVQ and certificates will be awarded for the top three scores in each class. The highest overall score of the contest (The one who covers the most miles on ATV) will receive the OVERALL WINNER PLAQUE

Thanks to Bob Delaney, KA9UVY, for putting this contest idea together!

Free Ham Rig Manuals

Try this link for all your - HAM RADIO MANUALS - needs. It ncludes operating manuals and many service manuals for both new rigs and vintage. Nearly ALL Ham rigs ever produced are covered

1. http://www.ab7sl.com/index.html?row1col2=links.html

For great tech tips for - CUSHCRAFT R5/R7/R7000 ANTENNAS - Includes downloadable "black box" internal image and schematics as well as R5/R7 trap technical drawing and R5/R7/R7000 troubleshooting steps.

2. http://www.ab7sl.com/index.html?row1col2=r7.html

Also available at www.ab7sl.com

1. DX Page w/ 100's of "live" DX cluster links
2. W9INN Antennas Page w/ data and illustrations
3. FREE downloadable IOTA List
4. Equipment photos and Station Description
5. Lots of Software Downloads too....

If You Move

Please send us your NEW ADDRESS! We pay 70 cents for each returned ATVQ. And we are usually nice and send another copy to your new address which costs us $1.29. Please help us from having to do this. Thanks!

Digital Dimensions In ATV

Brett Williams - WA6SXU Email: brettwi@attbi.com
ATN DLP manager
5844 Coldbrook Ave.
Lakewood, CA 90713

The FCC has decreed that as early as 2006 United States television transmissions will begin a switch to digital signal rather than analog. This presented a fascinating challenge for the Amateur Television Network "ATN", and we have been working on a solution for two years. Though we are not required to use the same standards as commercial television in our transmissions, ATN will be able to implement conversion of our network to digital television, thus we will remain on the leading edge of technology.

The Amateur Television Network is a collection of chapters spaced widely around Southern California, Arizona, New Mexico, Nevada and Indiana. Our goal is to tie each ATN chapter together through linking, thereby enabling each member's transmission to be seen through all chapter hubs.

Previously, linking amateur television repeaters has been slow, arduous, expensive and difficult to maintain. Over the past twenty years buying or leasing transmitter space on mountaintops and installing bidirectional microwave links between repeaters has enabled ATN to fill in coverage across the Southern California and Southern Nevada area. But our expansion has run up against an insurmountable barrier – the distance between states is simply too far to link in any scale of economy available to amateurs. Thus, two years ago ATN began an experimental program called the Digital Linking Project, which investigated linking repeater sites together via automatically controlled, internet connected gateways similar to what is currently being done with voice repeaters and Echolink1-type software.

Our initial feasibility study revealed several concerns; most significantly that bandwidth of uncompressed video and audio is huge, thousands of times larger than voice alone. Compression software that works well for audio shows signs of delay and breaking up as packets arrive out of sequence and are put back together into analog audio. Would the same process with video be impossible to recreate in any meaningful time frame? Only a few years ago, video conferencing software was in its infancy. Postage stamp sized video windows with a few frames per second of motion was amazing at the time, allowing an individual to see and hear the person with which you were communicating over dial up lines at 28 Kbps or 53 Kbps speed. Steady improvements in compression algorithms improved frame rate, but bandwidth continued to be limited at such speeds. Although methods of overscanning allowed video to appear full screen, the limited motion and resolution was noticeably jerky and extremely distracting. Such low bandwidth video is interesting to watch as a curiosity, but it is not what we are accustomed to seeing from a video camera.

Meanwhile, ATN started evaluating various free or shareware software such as iVista, EarthCam, and Microsoft Netmeeting. Each has its limitations, and although they allow viewers to see what is happening on a repeater in the comfort of their home, these three programs are not up to the standards of linking repeater sites together.

Finally, commercial products were examined. Several professional products were reviewed, and their costs (in the thousands of dollars) prevented any serious consideration. Finally, a software program from Real Products2, the $199.95 Helix Producer Plus and the free Helix server, was selected due to cost, robustness, and flexibility for bandwidth. This particular program together with the availability of high speed internet drastically changed matters for the better.

Findings on Optimal Product Selection

Helix Producer Plus is a software-operated compression algorithm that allows the user to select audio and video quality depending on available bandwidth. The host computer must have a quality video capture card installed, and be able to output video from its video card. In addition, processor speed must be in the range of 600 MHz or faster for the computer to keep up with encoding in real time. The software incorporates a delay loop that allows compression to take place; the delay has a range of time between 4 to 10 seconds. Tests performed in linking

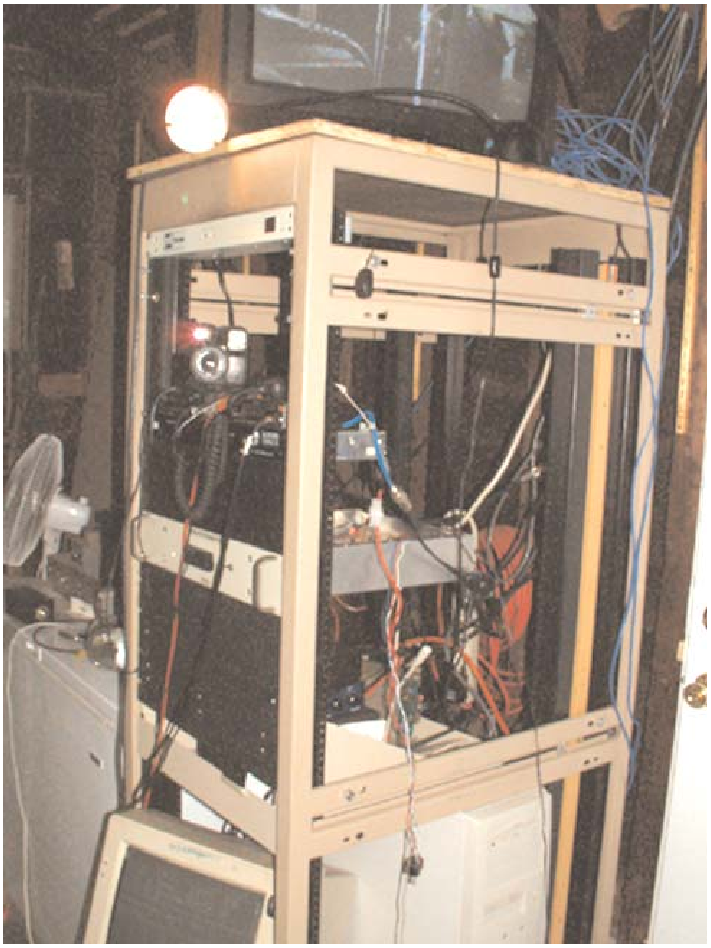


Photo of test bed system. This rack includes all necessary equipment to evaluate the digital linking system. From top to bottom, standard TV monitor, hi resolution camcorder for live video, 144 MHz and 1200 MHz linking command and control radios, 2.4 GHz FMTV exciter, 1200 MHz crystal controlled receiver, various A/V switching equipment and distribution amps, 600 MHz Pentium III PC and monitor with LAN cable for high speed internet.

New Mexico with Los Angeles showed a similar delay, however faster computers participating in linking would reduce any delay. Additionally, dedicated computers are a big plus in allowing the software to operate to the maximum that system resources allow. At times, an individual computer's available system resources can fall to less than 10% while encoding at 256 Kbps even with a dedicated computer; other tasks running in the background on the encoding computer can crash the system.

Video compression has many conditions which affect performance of the encoding computer. Noise is the biggest concern for a video compressor, noise being comprised of nearly infinite bandwidth. A time base corrector or at least a blue screen from a VCR is recommended to prevent the software from "seeing" noise in any form. A high frequency noise filter can be used to slightly soften the luminance portion of the filter to help reduce high frequency noise (snow). Additionally, maximizing the quality of the video to be linked is very important as, basically, the compression software has an easier job to encode a cleaner signal.

Most video cards available today have an S-VHS output in addition to a computer monitor connection. This provides very clean video that can be combined back to composite video with an inexpensive Radio Shack converter. Audio is available at the line out jacks on a standard sound card. Thus, base band video and audio are available at the computer to run into a linking transmitter. A dedicated LAN connection from DSL or cable modem should provide acceptable bandwidth for full screen 30 frame per second video to link from anywhere in the world to your repeater hub. Additional testing is taking place that will allow a "network control" operator to control the flow of signals to and from various hubs, and allow point to point linking or broadcasting of our club's nets and meetings to all chapters.

The ideal computer for acting as a linking machine would be a dedicated streaming server. Professional servers are costly, however, after the dot com crunch of the late 90's, many servers came on the surplus market, and some are acceptable for acting as the hub of an internet linked network described above. On the other hand, a dedicated 2 GHz PC can act as a good server. The exact equipment compliment can be varied, even combining two computers, one for a dedicated server (which can be slightly slower at 500 MHz) and one for the producer (encoder). Real Products distributes the free decoder via their web site on the net. Finally, a static IP address would help in being able to find the server, but a redirected URL may work as well. Ongoing tests are detailed on ATN's award win-

Product	Cost	Customer support?	Compression and product quality	ATN rating (5 best, 1 worst)
Microsoft Netmeeting	Free	Web site	Medium, fixed size, directory problems	3
EarthCam	$4.95/month	Web site	Medium, fixed size, no audio	2
Helix Producer Plus	$199.95/ free server	Phone, web, online tutorial	Variable compression and size depending on bandwidth, expandable to full screen	5
iVista	$49.99/$99.99	Web site, email	Medium, occasional server problems	2

ning web page 3 under the Digital Linking Project banner, including a blog of current efforts.

Digital transmissions

Analog television has been with us for nearly 70 years. HDTV will soon make analog television a memory, but for amateurs a quandary looms before us. Shall we stay with the existing analog format and be relegated to the throwaways of (hopefully) cheap analog TV sets in 2006, or keep pace with current technology? ATN has a plan for developing our own format of digital television, but without the overhead and commercial cost associated with HDTV. The second phase of ATN's digital conversion will introduce digital transmission formats which have several advantages over analog: higher signal to noise than FMTV and AMTV due to reciprocal noise figures, fading resistance, and "perfect" pictures when bit rates meet minimum standards. PCM or QPSK encoders coupled to amateur radio standard power amplifier stages allow simple digital transmission, with similar reception through a PCM or QPSK modem.

The problem with both 8-VSB (US DTV standard) and QAM-64 (CATV digital standard) modulation: although you can obtain higher data rates for the same bandwidth used, the requirement for extreme linearity in all amplifier stages following the modulator poses a specific problem. QPSK (DBS satellite standard) can permit four times the data rate compared to direct FM modulation of the data. QPSK can be transmitted using existing FM ATV transmitters and received with FM ATV receivers with the baseband data taken from the receiver and applied to a QPSK demodulator.

A receiver could be modified to use less bandwidth, conserving spectrum in the band on the order of 2 MHz occupied bandwidth, and at the same time improves the signal to noise ratio and improves DX operation.

ATN is now designing both a QPSK modulator and demodulator; we hope to perfect them and make boards available to interested parties. ATN intends to prepare an ATVQ article describing the modulator and demodulator when we have a working and tested version.

Endnotes
http://www.synergenics.com/el/
http://www.realnetworks.com
http://www.atn-tv.org

ATVQ

2.4 GHz 1 KW+ Mobile Station Of WA6SVT

This is Mike WA6SVT at Dave KA6DPS's QTH. We just took pictures of probably the first in ATV. Mobile 2.4 GHz ATV above one kilowatt.

The amplifier is a 100 watt MMDS-ITFS amplifier used on the 2.5-2.7 GHz band. The amplifier was modified for 2441.5 MHz and the amplifier re biased for class AB-1 from its original class A. This allows better output power and cooler operation. With one watt drive yields 120 watts out.

The antenna is a Comet GP-24 14 dBi omni vertical mounted on a tripod and mast 3 feet above the roof of the truck. E.R.P. is near 2 kilowatts, enough power to capture out many base stations using the ATV repeater on Santiago (test only).

Exciter is a Wavecom II modified for the 2.4 GHz band plan. The pictures received on the repeater were P-5 even when trees or buildings were blocking line of sight to the repeater 30 miles away.

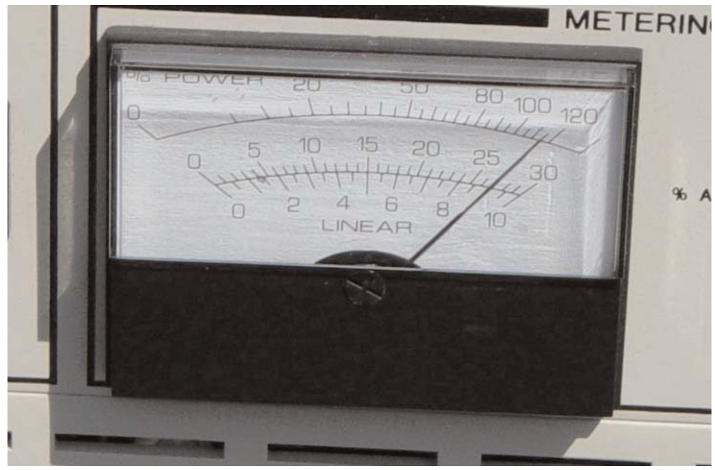
On another subject about 2.4 GHz. I am requesting the ATV

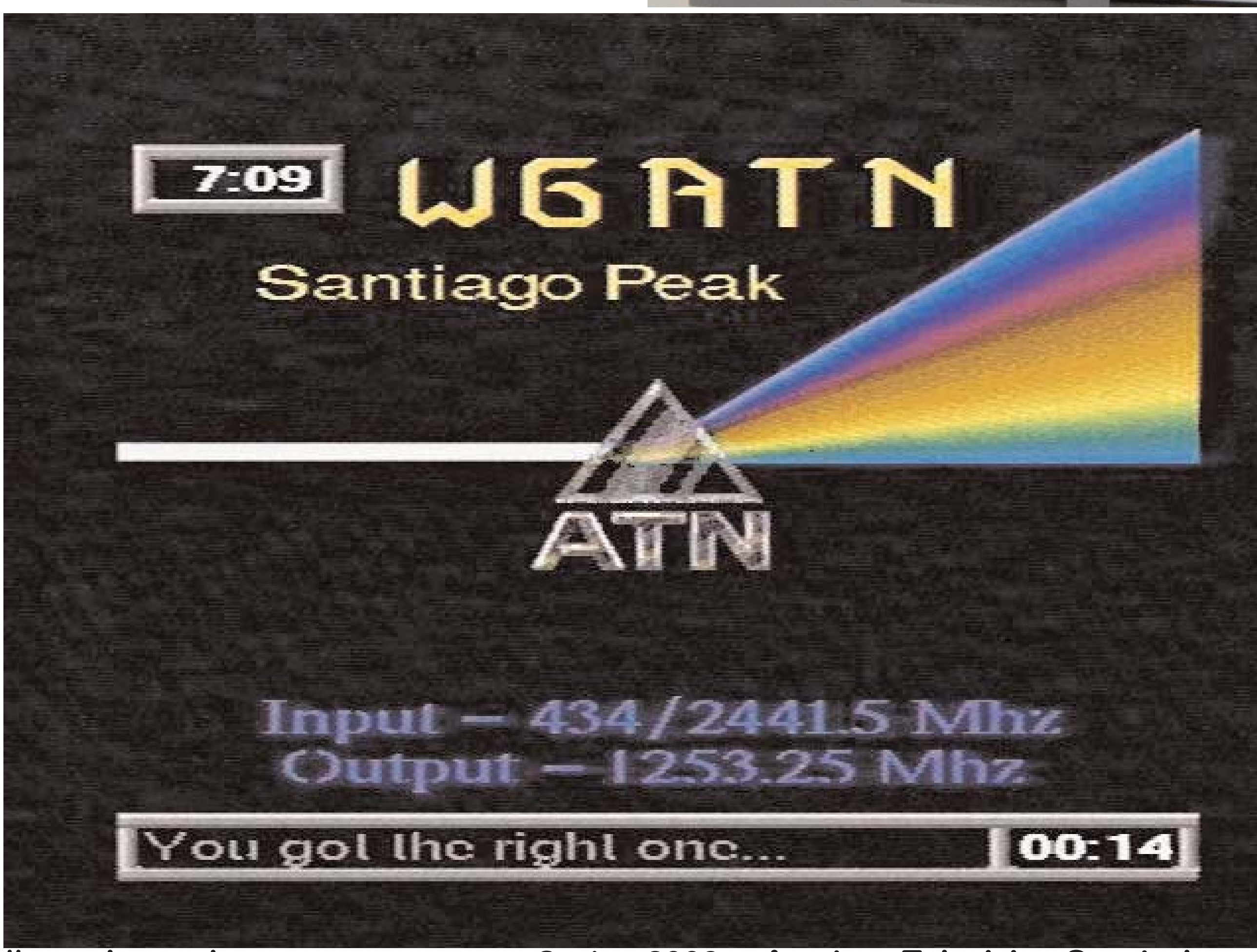
community to let ATVQ know if your group is actively using 2.4 GHz and what frequency is used. ATN is working with ATVQ and the ARRL to find out the extent of FM ATV or AM ATV on 2.4 GHz. The reason is due to a proposed Ham WiFi operation (see the latest issue of QST on page 28) on 2.4 GHz. The article proposes to use 2432 MHz with 22 MHz bandwidth, this would have a major impact to ATV operations. We would like to try and propose a new band plan to protect existing ATV and Oscar, point to point links and other non spread spectrum operation and try to find out if its possible to find a frequency to allow Ham WiFi that will not cause harmful QRM.

I will be at Dayton this year and will be available to discuss this issue. We may need to decide on a national ATV frequency on 2.4 GHz that best fits the band on an engineering bases.

Mike WA6SVT

ATVQ





Digital ATV On 70cm And Above

In case of you are not knowing this, here is good news for ATV pioneers:

The german DATV development team of AGAF, DARC and Bergische University Wuppertal has started final ordering of DATV sets with slightly higher costs, but lately interested parties without a commercial background can still put bids by fax to DC6MR, (+49231/486989) or online at **www.datv-agaf.de** with formular.html

Background Info
The professional production of at least one hundred units results in a comparatively low price. In addition it was the clear goal from the very beginning that no money should be earned but that the units should be sold by AGAF on a no profit, no loss basis, instead.

Many OM from Germany and several other countries have ordered already and have send the money in advance, others have announced they will order at short notice but partly have not shown any reaction yet.

To realize the low price the magic number of at least one hundred units is required. Furthermore it is not very likely that we can launch a second activity of this order of magnitude in the near future.

Therefore we ask to take a quick decision to order such that we can get the overview mid January. On **http://www.datv-agaf.de** you find the procedure how to order, in addition Heinz is ready to assist via **dc6mr@t-online.de**.

The two units can be seen as the basic equipment of a digital ATV station, for point to point transmission as well as for repeater operation. Due to the standardized I/O interfaces, the programmability of various digital modulation schemes and data rates by software, the possibility to transmit also from harddisk and record on harddisk these units are an investment that will maintain its value for a long time.

On delivery the exciter comes with pre-programmed 2 Mbit/s GMSK, 5 Mbit/s GMSK and 5 Mbit/s QPSK according to DVB-S.

The output frequency of the exciter is 434 MHz; since the 70 cm GMSK RX is still under development, an easy to build 70 cm / 23 cm converter was developed by means of which DATV can be transmitted on 23 cm in QPSK and received with a cheap digital satellite set-top box as demonstrated during Ham-Radio 2002 and with the long term test at DB0KO in Cologne (see **www.datv-agaf.de**, un-stuffed boards will be made available via AGAF).

In addition to the preparations for the production of the 100 plus x basic units work is carried out on the following units:

70 cm GMSK RX
Prototype of the UHF-front-end and of the dual bandwidth IF-part (2 MHz and 6 MHz) is working, experimental set-ups of the digital signal processing unit and the re-modulator providing a DVB-S signal on 1434 MHz allowing the MPEG decoding by means of a digital satellite set-top box are working. A complete prototype of the receiver is expected to be ready in late spring 2003.

70 cm / GHz-Transverter
23 cm transverter is to be developed first; a synthesizer covering the whole band with step widths of 1 MHz, 2 MHz or 8 MHz, a programmable preference frequency and LCD-display is working; work is started on the up and down-converter parts; transverters for higher GHz- bands to be developed later.

Program Multiplexer
It combines up to six MPEG data streams to one transport stream, especially for repeater operations allowing several DATV QSO's simultaneously. The output of the multiplexer is just connected to the MPEG input of the DATV exciter.

Software development
The software available today will be extended to more data rates, easier control of the harddisk and prepared such that it can be downloaded easily from the web.

An overview of possible combinations and applications of the DATV basic units can be found in the presentation DJ8DW gave during Ham-Radio 2002, also available as pdf file on the site **www.datv-agaf.de**.

The developments are carried out for a great deal by students of the Bergische University Wuppertal and voluntary OM. There is no company working for profit behind the activities. Therefore, and due to possible delays with the delivery of components, some delays of the projects cannot be excluded despite all efforts.

We do hope to have given some more information and inspiration for DATV.

Vy 73

Heinz, DC6MR / AGAF e.V.
Hans-Joerg, DL4EBK / DARC e.V.
Uwe, DJ8DW / Bergische Universitaet Wuppertal

conveyed by
Klaus Kramer, DL4KCK
AGAF e.V.
DL4KCK@t-online.de

ATVQ

Coming Events
GPSL 2003

Great Plains Super Launch 2003 - the 3rd annual convocation of ham radio high altitude balloon groups. This year's GPSL is sponsored by Edge of Space Sciences <www.eoss.org> and will be held in conjunction with the University of Colorado Space Grant College BalloonSat Workshop.

The GPSL Conference will be held on the campus of U. Colo from 10AM to 5PM on Friday, June 14, 2003. The conference program is just now coming together, but will include presentations on the TVNSP Explorer balloon payloads, the latest developments at ANSR and the newly-developed FAA position reporting feature based on I-gated APRS beacons. The specific conference room is TBD but will be posted on www.eoss.org in a few weeks. A dinner will be held afterwards at a nearby eatery.

Early Saturday AM, June 15, the GPSL crews will head east on I-70 to the town of Deer Trail CO, where they will prepare to launch at least three balloons carrying small experimental packages, or "BalloonSats", designed and built by the 50-odd CU Workshop attendees from NASA Space Grant Colleges from all over the US. Balloon teams from EOSS, TVNSP and ANSR will conduct the launch, tracking and recovery operations, using their own APRS and DF tracking beacons.

If the Saturday winds or weather are unsuitable, the launches will be postponed to Sunday 16 June.

All interested amateurs are warmly invited to attend this exciting event. Check www.eoss.org for the latest GPSL information.

73 de Mike W5VSI - manes@attglobal.net

ATVQ

Let's talk ATV (EchoLink)

Just a note to let everyone know that here in Southern Illinois we are now on EchoLink thanks to Flip N9AZZ. Our local ATV group can be reached on 144.340 simplex via N9AZZ-L 86900 on EchoLink.

We have had this new tool going for about a week and have had contact with the Minnesota ATV Group and verified that the ATV repeater K5DAK in Pine Bluff Arkansas in no longer functioning.

If your ATV group is available on EchoLink please let us know! I hope to use this new tool to coordinate DX contacts across country this spring and summer!

Bob Delaney - KA9UVY-TV ka9uvy@hotmail.com
Check out **http://members.tripod.com/silatvg for S. Il. ATV**

ATVQ

ATV Repeater
Greater Buffalo, NY

The K1CRA ATV Repeater is now up and running in the Greater Buffalo, NY area!

Input is currently on 439.25 with output on 923.25. These frequencies may change as we work the bugs out of the system and find more folks interested in ATV. But, with some folks in our group using tight filtering, these are the best frequencies for the time being.

The Buffalo group is also looking to DX on ATV! Since ATV usually requires a schedule to catch DX the gang here in Buffalo encourages all to contact us to arrange schedules. We generally operate on 439.25 simplex at 10 a.m., 3 p.m. and 10 p.m. but other times are fine with planning.

Go ATV! We don't abuse it, so why should we lose it!

73!

Craig - K1CRA
www.k1cra.com

ATVQ

A Simple Video ID'er

Gene This is such a simple Idea that many of us may have overlooked it. I thought it might be something to share with other ATV operators. At any rate I thought you might find it worth print.

73, Bob - KA9UVY-TV
ka9uvy@hotmail.com

Editor: Using your computer with video out gives lots of possibilities to be creative.

ATVQ

Waco Amateur Television Society (WATS), Inc., Now Part Of Heart O'Texas Amateur Radio Club (HOTARC)

FYI, the Waco Amateur Television Society (WATS), Inc., has dissolved and has become part of Heart O'Texas Amateur Radio Club (HOTARC). All assets were donated to HOTARC, including the 70 cm ATV repeater and the Skycam which sits atop the Waco Hilton on Lake Brazos. Input of the repeater is on 439.25 MHz, (LSB), with output on 421.25 MHz. The new ID chips for both repeater and Skycam were generously donated by Bill Brown, WB8ELK, of ELKTRONICS, who did a great job.

HOTARC and WATS have had a good working relationship since the beginning of WATS about twelve (12) years ago. However, we found it could be better if we combined. Surprisingly, interest in ATV has already increased since our combining on the first of this year. HOTARC meets on the third Thursday of each month in the Automotive Technology building on the campus of Texas State Technical College (TSTC). TSTC is located on the former James Connally AF Base at Waco, TX.

Horace, W5TAH
W5TAH@aol.com

ATVQ

More Texas

Good report, Horace! To add to that, let me say that Waco area ATV has been rejuvenated by a local SSTV group. Here's how. Every night, around 9pm, anywhere from 3 to 12 hams in a 50+ mile radius are sharing SSTV pictures over two meters. (it's a great way to have fun with your digital camera!) Yes, you read right: EVERY NIGHT! Seven nights a week! I'm amazed, too, but it has been going on for several months now, so it's not just a fad.

Early on, one of the ATVers decided to point his camera to the PC screen and show fellow ATVers what the received images looked like, and it really caught on. Soon, the SSTVers were eager to get an ATV receive station. The group has had several "antenna parties": constructing $10 homemade ATV receive antennas (yagi) that, using a cable-ready TV, can receive the 421.25MHz ATV repeater output within a 40-50 mile radius. The ATV station (now there are several of them) now serves as Net Control (NC) for the nightly SSTV Roundtable, with most of the SSTV group able to have a "duplex" conversation with NC via 2m and ATV. The ATV aspect has evolved, too. It now transmits a running slideshow of the recently received SSTV images, with occasional fade-ins to the face of the NC. So the ATV repeater is now "radio-active" over two hours every night, and the SSTV group is planning several new uses for ATV in the coming months.

For more info, contact David Bush KC5UOZ mailto:kc5uoz@bigfoot.com or Leon Cheney K5ZZM mailto:lcheney@earthlink.net.

Believe it: SSTV can add energy to "fast scan" ATV!

John, AC5CV
chamber@cord.org
Waco, TX * EM11jn
http://www.qsl.net/ac5cv

ATVQ

January Meeting New Zealand ATV Group

Henry ZL1AAN had a report on the Musick Point anniversary public event. It is going to be printed in the 29er Magazine of the North Shore Branch. Co-incidentally Henry is the editor.

I had a pile of assembled PCBs, enough to make three 23cm FM ATV TX when I get things tried, tested & boxed up, on display at the meeting. It has been a slow road with a busy work year last year & other shack projects on the go.

The latest South East Queensland ATV magazine was available to look at, as was the recent ATVQ magazine from the USA.

Opportunity was taken to purchase a few things from the AK VHF Group inc trading table.

Various modules, that our members have been working on, were rounded up for possible inclusion in the new low power Channel 39 ATV repeater for Whangarei. Plans have been made for myself & Wayne ZL1UJK to spend 5 Days visiting Whangarei during the last week of March.

Kevin ZL1OVY received (I delivered) a vital part (LM2941 IC) for his 23cm FM TV TX.

A certain amount of looking at the APRS mode took place on the clubrooms PC. Now if someone can interface the video out of a PC to ATV, another great source of a video signal would made.

On the way home I called in to Quentin ZL1QF & was given more amplifier modules - ex ZL1BQ old configuration & some that are "dead-uns" needing repairs. I hope I've enough bits now to get a couple of watts up the coax from a site in Whangarei.

Michael Sheffield - ZL1ABS
mjsheffield@xtra.co.nz
176 Albany Highway, Albany, Auckland,
New Zealand

ATVQ

ATVQ TO PAY FOR ARTICLES!

Payment for Technical Articles

ATVQ will pay for certain articles that it publishes. I will outline the policy here, but it will be subject to change as needed to make sure that ATVQ continues to be an ongoing publication. ATVQ will pay $25.00 for technical articles that are published and are a minimum of 2 pages. While this is not a great amount, I hope it will encourage more technical type articles to be written. Exceptions will be articles that are written by a manufacturer/seller of equipment that is being written about. While I do not want to discourage this type of article, the article itself is an advertisement of the product. Articles from clubs will be encouraged, and I would expect they would like to share their information with the ATVQ readership. Information gathered from the Internet will not be paid for and is mostly small filler items.

Ideas

Do you have an idea for an article that you've said to yourself that you wanted to write, but never did. Feel free to check with us to see if it is of interest, or write and send it in. No guarantees that it will get published, but if you don't try, you will never know. I'll be looking to see what you can do!

ATVQ

CONTRIBUTORS GUIDE

Preferred method of receiving articles is from **Microsoft Word**, however **Wordperfect** is OK too. Next preference would be **ASKII text**, followed by **typewritten** or **hand written** (clearly). Diagrams or pictures (B&W or Color) can be sent in hard copy, or if you scan them in, save to PCX or JPG formats (actually I can read about anything). If you send a computer disk, make sure it is PC (not MAC) format.

When sending in articles in Microsoft Word, please SAVE with FASTSAVE OFF and save in Word 6 format. Also, articles written in any word processor, consider what will happen when it is re-formatted to fit the style that I might put it in. An example would be setting up tables or adding figures into the article. They can be very hard to strip out. If possible, put the tables, figures, each in a file by itself. This will help me to be able to import into the magazine format.

Articles can be sent to:
ATVQ, 5931 Alma Dr., Rockford, IL 61108

or to our email address: **atvq@hampubs.com**
Also note our web page address: **http://www.hampubs.com**

ATVQ

BADGERLAND AMATEUR TELEVISION SOCIETY - FALL MEETING

KA9QFJ made a motion to keep annual dues at $20. Motion was seconded by N9UDO, and passed.

Election of officers. KB9VMC made a motion to re-elect the current slate of officers. N9UDO seconded, motion passed. Officers for 2003 continue to be: President Jim Paul N9LKY, Vice President Bill Hommel KA9QFJ, Secretary Tom Weeden WJ9H, Treasurer Steve Schulze N9UDO.

Technical committee report: WJ9H reported on WMTV's Heliax line section replacement. WMTV's 2 GHz receiver had signals from the fixed downtown camera to be within 0.1 dB of levels prior to the line damage. The signal from the 434.0 MHz ATV transmitter is much better.

Old business: Progress on slow-scan project. Jim N9LKY combined parts from two computers, sound card, and NTSC graphics card to construct an SSTV machine. Software is MMSSTV. A receiver and antenna are needed, also a frequency. Brad KB9VMC will sweep his existing receive multi-coupler at his site to determine if a 2 meter frequency can be shared on the existing antenna. The video output of the SSTV receiver will feed one of the inputs to the BATS transmitter on 421.25 MHz.

Tom Weeden WJ9H- tcweeden@tds.net

ATVQ

Balloon V1.0 from page 18

The balloon itself is from Kaymont
http://www.kaymont.com/pages/home.html

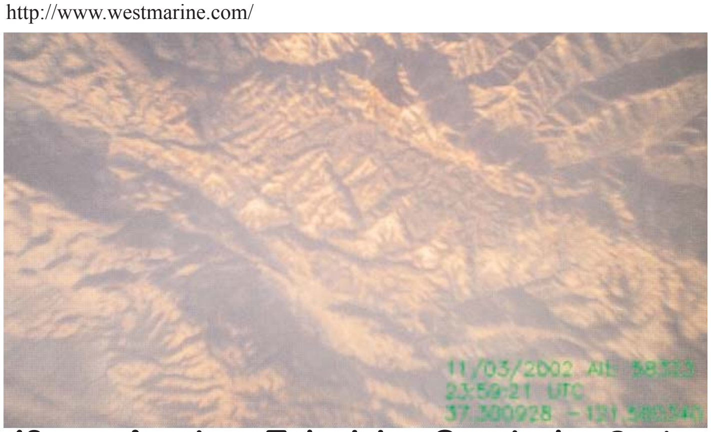
I used a 1500 gram sounding balloon
http://www.kaymont.com/pages/sounding_frmst.html

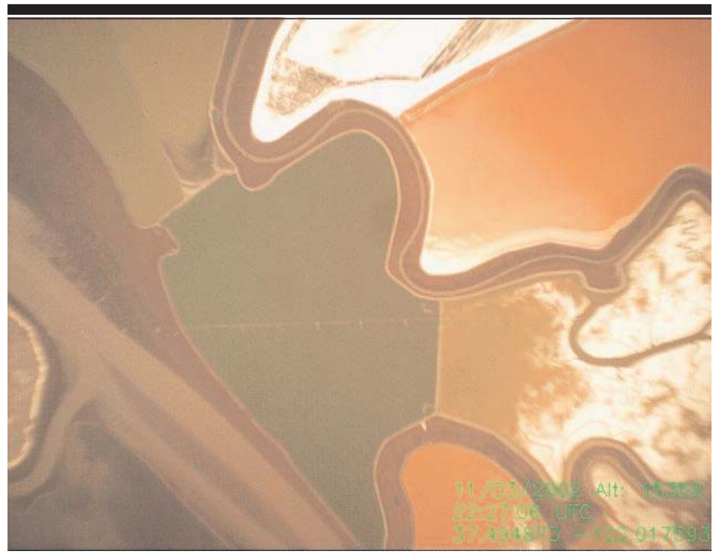
Rocketman Enterprises
http://www.the-rocketman.com/

R7C standard chute
http://www.the-rocketman.com/chutes.html

The radar reflector
http://www.westmarine.com/webapp/wcs/stores/servlet/ProductDisplay?storeId=10001&langId=-1&catalogId=10001&productId=1661

West Marine
http://www.westmarine.com/





Perl for the flight computer (flight.pl)
http://shark.dls.net/~jmeehan/balloon/flight.txt

Microsoft's Terraserver
http://terraserver.microsoft.com/

Here's a screen capture of the APRSPoint/MapPoint display
http://shark.dls.net/~jmeehan/balloon/flight-path.gif

several graphs from the telemetry data
http://shark.dls.net/~jmeehan/balloon/aprs.htm
DLS Internet — for hosting this site

ATVQ

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12V ADAPTER/CHARGER (Optional). CP-18A/E allows for 12V operation while charging.

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