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Amateur Television Quarterly

Sue Miller, W9YL, SK

Central Illinois/St. Louis Area ATV Operator Of The Year Floyd Hofman, W9EX (right)

Mr. "IVCA", Lew Tepfer, W6FVV, SK

Inside:
Digital DX - It Can Be Done
Basic Elements Of MPEG Video
Antenna Mounting ATV Downconverters

D0 - No Picture/Sound

Digital "P" Codes

D1

D2

D3

D4

D5

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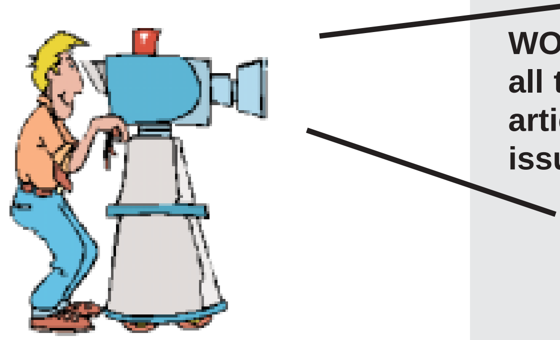
Amateur Television Quarterly

TABLE OF CONTENTS



WOW! Look at all the great articles in this issue!

A Trip In November

Well, we have reached the 'real' millennium and are in 2001. When I was a little, the years over 2000 seemed like just science fiction. Never thought I would be looking back and seeing all the technology changing at a rate that it has. That and the stock market, but that's another story.

Shari & I have had a couple of nice trips, one, at least that I would like to mention. We were invited to the ATV banquet in Litchfiled, IL on November 5th (story on page 36). Now to back up a bit.

On November 4th, there was to be a balloon launch in Michigan, and at the altitude that it was to get to, we might be able to see ATV from Rockford, IL. I had invited all the local club over to the house to see what we could see. Well, the launch was cancelled at the last minute due to high winds aloft, and so was the meeting. We could not have everyone over to the house for the re-scheduled time as it was November 5th, the day we had to leave early for a 5 hour drive to Litchfield.

While disappointed that we would not be able to try for video, I decided to take the usual 2 meter/440 rig in the car with us. The first thing that we attempted almost as we drove out on the highway, was to tune in 143.600 MHz for the International Space Station. I had heard that the Russians were using that frequency, and I wanted to see if I could hear anything. I had printed out the times from Nova so we would know when to listen. Using the vertical through the glass antenna, the Russian voice came in just fine. Wow, I did not think it would be THAT good.

We also took our low band radio so we could keep track of the balloon launch as there was to be a net on 40 meters. As I tuned to the announced frequency, there was net control, just as promised. We checked in and listened as they kept us informed about liftoff and progress as the balloon rose into the air.

The intent was to cut the balloon down at 40,000 feet, again due to the high winds aloft. Net control announced as the balloon climbed through 20,000 feet, 30,000 feet, getting close to cut down, through 40,000 feet, any time now, 45,000, 50,000, you get the idea. The cut down did not work.

Inflation

As we approached Bloomington, IL, and it was announced that the balloon was over 80,000 feet, I looked at Shari and asked, "I wonder if we could hear the telemetry on 144.34 MHz?" I dialed in the frequency, and sure enough, there it was. We did not have a computer in the van with us, so all we could do was listen, but it was fun just to hear the telemetry from such a distance. At that time, I believe that balloon was a little North-West of Detroit, MI. Too bad we did not brig the ATV receiver and a small beam!

After that we listened to net control letting us know that the balloon had burst, and followed the decent until we stopped for lunch. It was fun and made the trip go a lot faster than it would have without it. Thanks to all the people involved in Michigan for the days entertainment!

Here are some pictures of the balloon launch.
Gene - WB9MMM

Liftoff

Recovery

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, it is a starting point and 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!

AUTHORS 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**

ATV Temperature Stability

I often get asked about antenna mounting our downconverters as an alternative to antenna mounted preamps for eliminating long length coax loss for optimum sensitivity. One of the major drawbacks of tunable over crystal controlled the is frequency stability over temperature and having to retune the frequency slightly between night and day times. In the process of writing an app note on this subject I decided to find out what the real numbers were for our tunable TVC-2G/TVC-4G 420-450 MHz downconverter as an example. I was surprised to find out that the frequency change was only 340 kHz higher in frequency going from 75 F to 5 F in my freezer. Most TV sets Automatic Frequency Control (AFC) will lock in and hold +/- 1 to 2 MHz - well within the 70cm downconverter frequency drift range.

But why then do they some times need to be readjusted?. It is probably because the tuning was left at one end of the AFC range and drifts just out side and also that there is a strong adjacent broadcast TV signal that is trying to capture also. The trick is to tune the ATV picture in and then rock the downconverter tuning back and forth in small increments to find the range, then leaving it in the set in the middle.

73, Tom O'Hara W6ORG - P. C. Electronics - TOMSMB@aol.com

Digital DX, It Can Be Done

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Crown Point, IN 46307

With the controversy surrounding 8VST-T modulation, and the generally gloomy outlook for its acceptance for indoor reception, vs having outside antennas, and the various questions of, is it going to work, here is a little excitement.

While my ATV friends may think I am absent from the airwaves, I in fact have just been very busy on the commercial side of TV. Recently I completed a study (600+ pages) comparing UHF reception in Chicago. The study involved 5 NTSC UHF stations and 1.25 DTV stations. That's one full data and one with partial data. Recently more stations in Chicago have joined the DTV world, and I will be conducting another study shortly that will document the DTV reception. I'm using my own personal "ENG" truck, mast and a slew of test gear that almost makes my ham shack look light.

Meanwhile, there are now some 60+ DTV stations operating full time in several markets. You can obtain a current list by visiting the NAB [www.NAB.ORG/dtv] site and going to the DTV station page. There they list by market the DTV operating stations and the list is updated as quickly as stations become operational.

You can receive NTSC/Digital TV fairly inexpensively. A WinDTV card for your computer (by Haupaggue Electronics) is available for $299 at most computer stores or by Internet. The NTSC is only about $49. I purchased 8 of the NTSC/DTV cards to pass around station staff to monitor our own Channel 45 DTV signal which is a half million watts from the top of the Sears Tower. I have one in my home computer, and it is hooked to my master house antenna system. The antenna is a typical mid range Wineguard UV combo on the roof top, about 25 feet above ground. A rotor lets me move it to view adjacent markets.

From my home south of Crown Point, IN, (about 45 airline miles from the Sears Tower) I can usually watch South Bend P4. about 50% of the time, Milwaukee from the Lake inversion effect, and frequent glimpses of Indianapolis, Lafayette, Ft Wayne, Madison, and more distant locations. Needless to say, these coincide with the 440 MHz ATV band openings. The VHF stations in these markets are also similarly viewable under the same atmospheric conditions.

The obvious question is, "Are the DX DTV stations also able to be received?" The answer is yes, and to some extent, more easily than the NTSC stations!

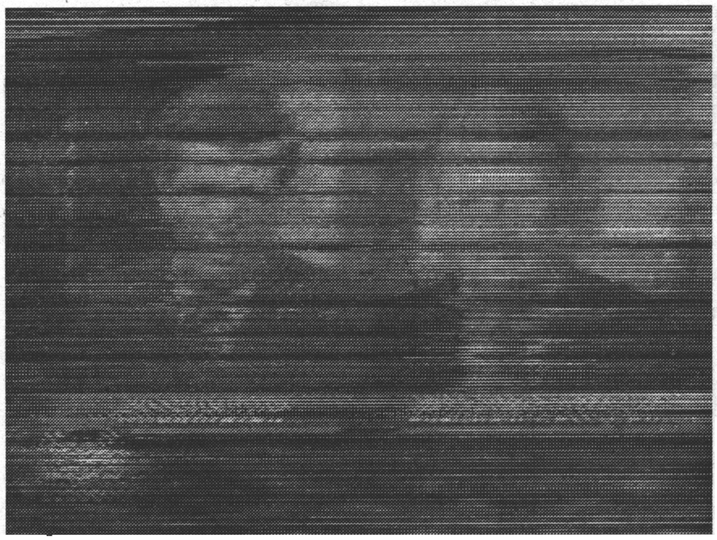
Sunday morning 10-28-00, between shopping, making meals and training dogs, I managed to squeeze in a few minutes of regular TV and noticed a band opening. Milwaukee and

DTV 8 FROM MILWAUKEE

Indianapolis were fairly strong, but South Bend a bit iffy. In Milwaukee there is a rather low powered DTV-8 that carries NTSC 10 WMTV. It is best known in broadcasting for interference to Muskegon, MI viewers of WOOD TV 8 located in Grand Rapids. The shot being about 65 miles directly across the lake between Milwaukee and Muskegon. The Channel 8 Milwaukee station has decreased its power and changed to a directional antenna to reduce the problem, but as we hams know, when the band is up, power is meaningless with 10 watt 300 mile contacts on ATV possible.

NTSC 10 FROM MILWAUKEE

Sure enough, channel 10 from Milwaukee was visible. Channel 6 was there but had two other CO-channel signals beating with it. A scan of the DTV mode found channel DTV8. At first,



NTSC 6 FROM MILWAUKEE - 9:15 AM 10/28/00

NTSC 6 FROM MILWAUKEE - 11:40 AM 10/29/00

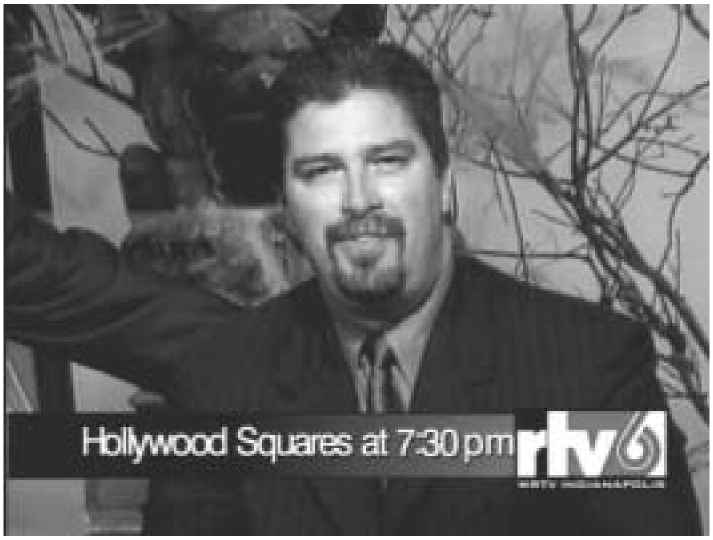
much like rain fade DBS, the signal was blocks, intermittent and audio bits here and there, but as the band improved, the signal got better until there was full reception. I snatched a few frames in the WinDTV 2000 program, and E-mailed them off in hopes of a reception confirmation. The scan also picked up a DTV 25 station. I did not know where that was, and so a search was made by rotating the antenna while watching the DTV 25 channel on the computer. When I got to the Indianapolis direction, it popped in and came in just fine. Full reception. So I captured a few frames of DTV 25 which is the parallel of WRTV channel 6 Indianapolis. I could also get 13 NTSC from Indianapolis just fine. DTV pictures are either "perfect" or nothing, albeit, there is a 1 dB range of signal level where the error rate may produce partial pictures, blocks, or broken sound. DXing the usual NTSC signals often is difficult because of the co-channel interference. This is clearly seen in the channel 6 NTSC pictures. The closest channel 25 NTSC signal to me is Peoria, IL, about 100 miles, the DTV 25 signal is about 150 miles away. There was no trace of the Peoria signal, but the Indianapolis signal was certainly P5, or perhaps we should say D5! The NTSC 13 pictures is a good P4+, some co-channel signal can be seen from a local (6 miles) LPTV channel 13 that runs video juke box. Although not visible in this pix, there is also a 13 in Grand Rapids, that when the band is open, gets competition from the local LPTV 13. If I turn the antenna today, I can see it also. While the Indianapolis channel 25 DTV signal was easily received, there was only P1 to P2 signals from one Indianapolis NTSC UHF stations, and the others were not visible at all. So in this one instance, UHF DTV was perfect while UHF NTSC was basically not watchable from 150 or so miles.

DTV 6 FROM INDIANAPOLIS 10/28/00

DTV 25 FROM INDIANAPOLIS 10/29/00

DTV 6 FROM INDIANAPOLIS 10/28/00

NTSC 13 FROM INDIANAPOLIS 10/29/00



DTV 6 FROM INDIANAPOLIS 10/28/00

The Milwaukee low power DTV 8 signal was also visible, but the more powerful NTSC VHF channels in Milwaukee was a full P5 perfect reception, except for some co-channel interference. So even low power VHF DTV can make it, albeit not as well as full power VHF NTSC.

I did not receive any of the DTV signals from South Bend, and the NTSC signals were at best P3 (16, 22, 28), quite a bit less than “normal.”

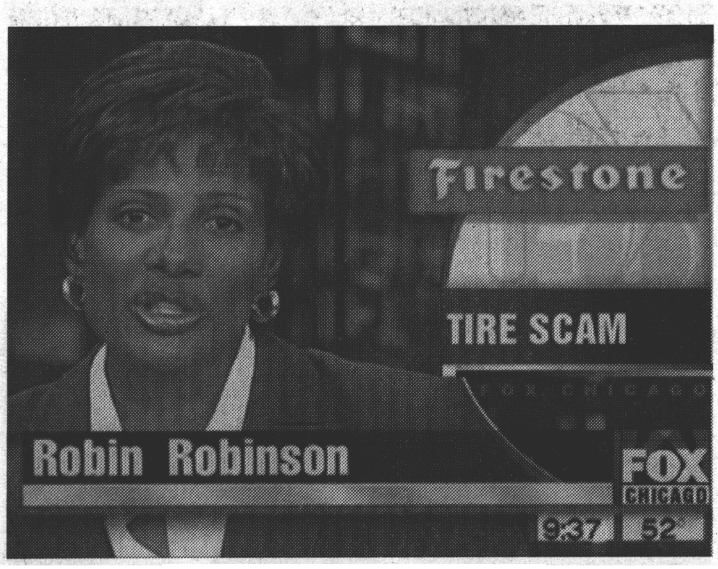
Also included is the ID shot from my own Channel 44N/45D station that has a half million watts from the Sears building 24/7. Its the most powerful DTV station in Chicago. For those watching DTV, Chicago has D31 WFLD fox at 200 kW ERP, D43 WCPX (with 6 multiplex channels of programming) at 100 kW ERP, D45 WSNS with 467 kW ERP. All are at the same antenna height (but not the same antennas) from the top of the Sears building. Soon NBC 29 and ABC 52 will be operating (they have been testing on air for the past week) and WGN DTV 19 is supposed to be on in December.

The WinDTV board is quick in locking in to the DTV signals. The board itself doesn't have a lot of buffer memory, and will, on perfectly good signals, occasionally drop frames, or block defect the picture. But for the money, its perfectly fine in these early days of DTV.

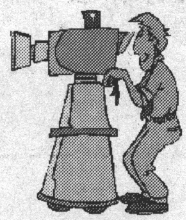
The WinDTV board receives all VHF and UHF channels, in NTSC M, **NTSC** N or ATSC 8VSB-T mode. It also has two inputs, one for an antenna and one for cable. It can scan both and selects the demodulation mode automatically between analog and DTV. The board also has lots of **nifty** features to capture video input from an external source, i.e., your baseband video and audio from an ATV receiver, TV set, camera, VTR, etc., and has a good tuner. I have not yet tried to see if using the cable input for cable channels **56-60** will net ATV signals, but it would be a natural thing to try. The capture mode lets you snatch off air frames, and there is also a movie mode, however, you need lots of disk space to store the PEG picture files!

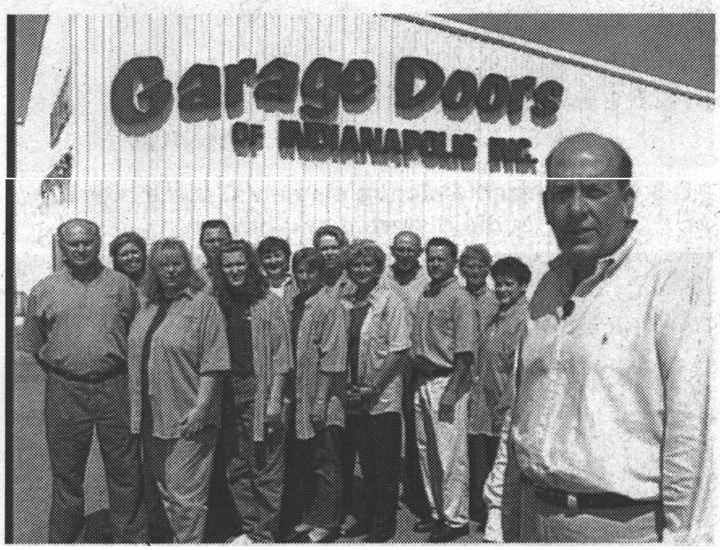
So here are the pictures, and happy DXing the new DTV world.

ATVQ

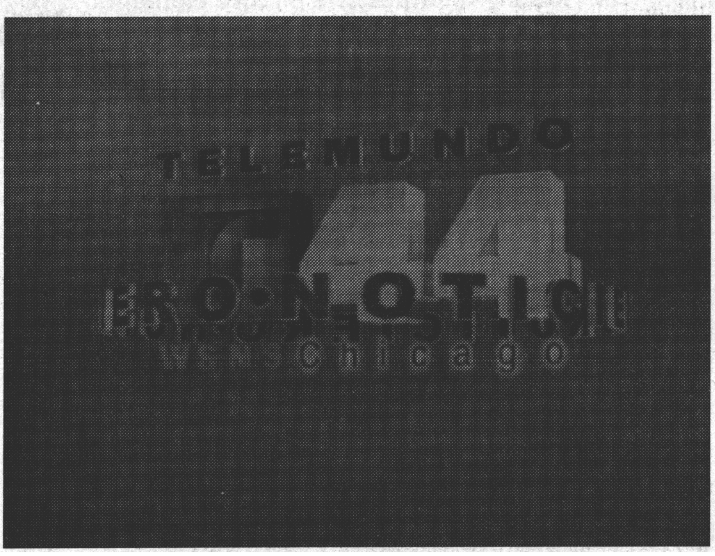


DTV 31 WFLD CHICAGO FOX





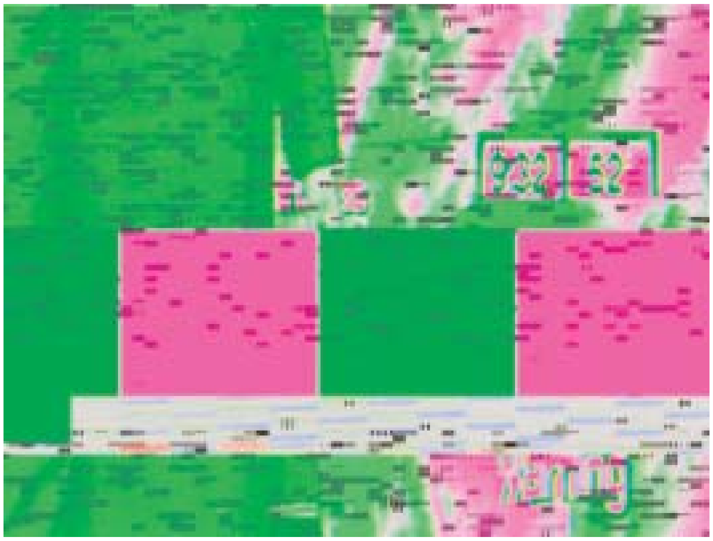
DTV 6 FROM INDIANAPOLIS 10/28/00



NTSC 44/DTV 45 WSNS CHICAGO

DTV RATING

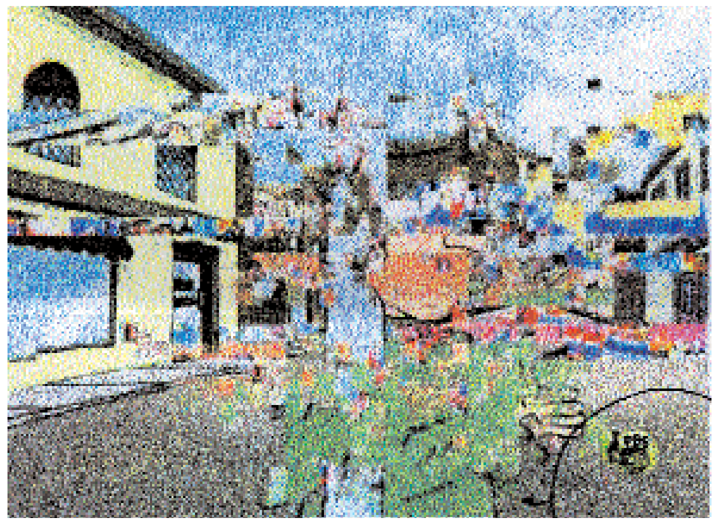
D0 - No picture and no sound
(of course - no picture shown!)



D 1- Only a few bits, no sound, large blocks

D 2 - Bits of several frames, no easily recognizable picture elements, no audio but crackles

D 3 - Recognizable picture elements, some breakup, audio distorted and broken



D4 - Mostly recognizable picture elements, some portions of previous frames, ID bug visible (lower right corner), audio mostly present. (This picture had to be scanned)

D 5 - Perfect picture and sound

1296 MHz stuff 4 sale:

Bensat sat receiver new in box. make offer

Parabolic 24 cm ATV transmitter and ATV receiver (FM video mode) frequency agile. Each comes with gain whip antenna, one Comet SB123 and one Diamond DPNR123. Would make a nice link or station. Never used. Run on 12 V DC. Make offer

Array of 4 long boom yagi's on H frame with power divider and heliax harness. Most loops need to be unmushed from sitting around and falling over in the yard. About 26 dbd gain total. Worked for EME with 300 watts! Pick up only! (dig out of 36" of snow as of today)

2 tube amp. 2C39 type, air or water cooled your choice since new water jackets are included no extra charge. Includes: machines cavity amp, input, output N connectors and assemblies all mounted on aluminum panel. power supply parts include filament-bias transformer, HV transformer and HV diode array on PCB and cooling fan. Includes 2 new tubes. Add your box and power switch and make a noise on 1296 MHz. Make offer.

No reasonable offer refused, all or part. Will have more stuff dug out shortly.

Henry AA9XW - 5317 W 133rd Ave - Crown Point, IN 46307
A9XW@cs.com

The Basic Elements Of MPEG Video Compression

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Introduction

With the introduction over the last few years of cable, satellite, and terrestrially broadcast digital television transmissions, interest from the amateur television community is growing as to how this all works, and even how to possibly get involved from a hobbyist perspective. There is considerable complexity inherent to these systems, with much specialist knowledge necessary in some fairly diverse areas, such as video and audio processing, bitstream multiplexing, error detection and correction, etc. This paper is intended to provide an introduction to one particular area, namely the techniques of MPEG video compression that are relevant to digital television, from low-resolution services up through high-performance HDTV applications.

MPEG video compression is used in many current and emerging products. It is at the heart of digital television set-top boxes, DSS, HDTV decoders, DVD players, video conferencing, Internet video, and other applications. These applications benefit from video compression in the fact that they may require less storage space for archived video information, less bandwidth for the transmission of the video information from one point to another, or a combination of both. Besides the fact that it works well in a wide variety of applications, a large part of its popularity is that it is defined in three finalized international standards (MPEG-1, -2, and -4), with a fourth standard (MPEG-7) currently in the definition process.

It is the purpose of this paper to introduce the reader to the basics of MPEG-1 and MPEG-2 video compression, from both an encoding and a decoding perspective. The workings of the basic building blocks such as the discrete cosine transform and motion estimation are covered, but detailed explanations of the MPEG syntax are not. MPEG-2 is a superset of MPEG-1, but in general this paper treats the common ground of the two standards, as the differences tend to be understood better by the more advanced reader.

Example Video Compression Calculation

One of the formats defined for HDTV broadcasting within the United States is 1920 pixels horizontally by 1080 lines vertically, at 30 frames per second. If these numbers were all multiplied together, along with 8 bits for each of the three primary colors, the total data rate required would be approximately 1.5 Gb/sec. Because of the 6 MHz. channel bandwidth allocated, each channel will only support a data rate of 19.2 Mb/sec, which is further reduced to 18 Mb/sec by the fact that the channel must also support audio, transport, and ancillary data information. As can be seen, this restriction in data rate means that the original signal must be compressed by a figure of approximately 83:1. This number seems all the more impressive when it is realized that the intent is to deliver high-quality video to the end user, with as few visible artifacts as possible. This paper will show some of the basic techniques that make this video compression possible.

MPEG Video Basics

The acronym MPEG stands for Moving Picture Expert Group, which worked to generate the specifications under ISO, the International Organization for Standardization and IEC, the International Electrotechnical Commission. What is commonly referred to as “MPEG video” actually consists at the present time of three standards, MPEG-11 and MPEG-22, and MPEG-4. The MPEG-1 & -2 standards are similar in basic concepts. They both are based on motion compensated block-based transform coding techniques, while MPEG-4 deviates from these more traditional approaches in its use of software image construct descriptors, for target bit-rates in the very low range, < 64Kb/sec. Because MPEG-1 & -2 are standards targeted at applications that amateur and professional television broadcasters are most interested in, this paper concentrates on compression techniques relating only to these two standards. Note that there is no reference to MPEG-3. This is because it was originally anticipated that this standard would refer to HDTV applications, but it was found that minor extensions to the MPEG-2 standard would suffice for this higher bit-rate, higher resolution application, so work on a separate MPEG-3 standard was abandoned.

MPEG-1 was finalized in 1991, and was originally optimized to work at video resolutions of 352x240 pixels at 30 frames/sec (NTSC based) or 352x288 pixels at 25 frames/sec (PAL based), commonly referred to as Source Input Format (SIF) video. It is often mistakenly thought that the MPEG-1 resolution is limited to the above sizes, but it in fact may go as high as 4095x4095 at 60 frames/sec. The bit-rate is optimized for applications of around 1.5 Mb/sec, but again can be used at higher rates if required. MPEG-1 is defined for progressive frames only, and has no direct provision for interlaced video applications, such as in broadcast television applications.

MPEG-2 was finalized in 1994, and addressed issues directly related to digital television broadcasting, such as the efficient coding of field-interlaced video and scalability. Also, the target bit-rate was raised to between 4 and 9 Mb/sec, resulting in potentially very high quality video. MPEG-2 consists of profiles and levels. The profile defines the bitstream scalability and the colorspace resolution, while the level defines the image resolution and the maximum bit-rate per profile. Probably the most common descriptor in use currently is Main Profile, Main Level (MP@ML) that refers to 720x480 resolution video at 30 frames/sec, at bit-rates up to 15 Mb/sec for NTSC video. Another example is the HDTV resolution of 1920x1080 pixels at 30 frame/sec, at a bit-rate of up to 80 Mb/sec. This is an example of the Main Profile, High Level (MP@HL) descriptor. A complete table of the various legal combinations can be found in reference 2.

MPEG Video Layers

MPEG video is broken up into a hierarchy of layers to help with error handling, random search and editing, and synchronization, for example with an audio bitstream. From the top level, the first layer is known as the video sequence layer, and is any self-contained bitstream, for example a coded movie or advertisement. The second layer down is the group of pictures, which is composed of 1 or more groups of intra (I) frames and/or non-intra (P and/or B) pictures that will be defined later. Of course the third layer down is the picture layer itself, and the next layer beneath it is called the slice layer. Each slice is a contiguous sequence of raster ordered macroblocks, most often on a row basis in typical video applications, but not limited to this by the specification. Each slice consists of macroblocks, which are 16x16 arrays of luminance pixels, or picture data elements, with 2 8x8 arrays of associated chrominance pixels. The macroblocks can be further divided into distinct 8x8 blocks, for further processing such as transform coding. Each of these layers has its own unique 32 bit start code defined in the syntax to consist of 23 zero bits followed by a one, then followed by 8 bits for the actual start code. These start codes may have as many zero bits as desired preceding them.

Intra Frame Coding Techniques

The term intra coding refers to the fact that the various lossless and lossy compression techniques are performed relative to information that is contained only within the current frame, and not relative to any other frame in the video sequence. In other words, no temporal processing is performed outside of the current picture or frame. This mode will be described first because it is simpler, and because non-intra coding techniques are extensions to these basics. Figure 1 shows a block diagram of a basic MPEG video encoder for intra frames only. It turns out that this block diagram is very similar to that of a JPEG still image video

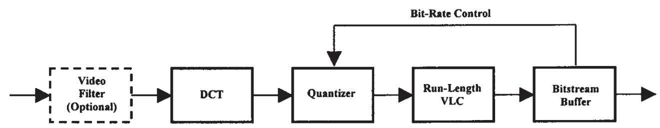

Figure 1: Intra Frame Encoder

encoder, with only slight implementation detail differences. The potential ramifications of this similarity will be discussed later in this paper. The basic processing blocks shown are the video filter, discrete cosine transform, DCT coefficient quantizer, and run-length amplitude/variable length coder. These blocks are described individually in the sections below.

Video Filter

In the example HDTV data rate calculation shown previously, the pixels were represented as 8-bit values for each of the primary colors - red, green, and blue. It turns out that while this may be good for high performance computer generated graphics, it is wasteful in most video compression applications. Research into the Human Visual System (HVS) has shown that the eye is most sensitive to changes in luminance, and less sensitive to variations in chrominance. Since absolute compression is the name of the game, it makes sense that MPEG should operate on a color space that can effectively take advantage of the eye's different sensitivity to luminance and chrominance information. As such, MPEG uses the YCbCr color space to represent the data values instead of RGB, where Y is the luminance signal, Cb is the blue color difference signal, and Cr is the red color difference signal.
A macroblock can be represented in several different manners

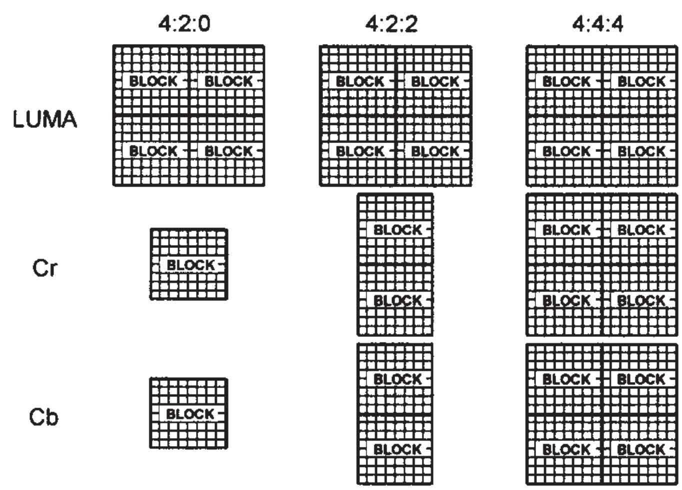

Figure 2: Video Formats

when referring to the YCbCr color space. Figure 2 shows 3 formats known as 4:4:4, 4:2:2, and 4:2:0 video. 4:4:4 is full bandwidth YCbCr video, and each macroblock consists of 4 Y blocks, 4 Cb blocks, and 4 Cr blocks. Being full bandwidth, this format contains as much information as the data would if it were in the RGB color space. 4:2:2 contains half as much chrominance information as 4:4:4, and 4:2:0 contains one quarter of the chrominance information. Although MPEG-2 has provisions to handle the higher chrominance formats for professional applications, most consumer level products will use the normal 4:2:0 mode so that is the one concentrated on in this paper.

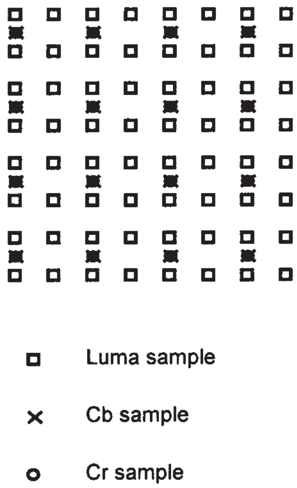

Figure 3: Pixel Format

Because of the efficient manner of luminance and chrominance representation, the 4:2:0 representation allows an immediate data reduction from 12 blocks/macroblock to 6 blocks/macroblock, or 2:1 compared to full bandwidth representations such as 4:4:4 or RGB. To generate this format without generating color aliases or artifacts requires that the chrominance signals be filtered. The pixel co-siting is as given in Figure 3, but this does not specify the actual filtering technique to be utilized. This is up to the system designer, as one of several parameters that may be optimized on a cost vs. performance basis. More details on video filtering may be found in this reference3.

Discrete Cosine Transform

In general, neighboring pixels within an image tend to be highly correlated. As such, it is desired to use an invertible transform to concentrate randomness into fewer, decorrelated parameters. The Discrete Cosine Transform (DCT) has been shown to be near optimal for a large class of images in energy concentration and decorrelating. The DCT decomposes the signal into underlying spatial frequencies, which then allow further processing techniques to reduce the precision of the DCT coefficients consistent with the Human Visual System (HVS) model.

The DCT/IDCT transform operations are described with Equations 1 & 2 respectively4:

$$F(\mu, \nu) = \frac{1}{4} C(\mu)C(\nu) \sum_{x=0}^{7} \sum_{y=0}^{7} f(x, y) \cos\left[\frac{(2x+1)\mu\pi}{16}\right] \cos\left[\frac{(2y+1)\nu\pi}{16}\right]$$

$$C(\mu) = \frac{1}{\sqrt{2}} \; for \; \mu = 0$$

$$C(\mu) = 1 \; for \; \mu = 1,2,\ldots,7$$

Equation 1: Forward Discrete Cosine Transform

$$f(x, y) = \frac{1}{4} \sum_{\mu=0}^{7} \sum_{\nu=0}^{7} C(\mu)C(\nu)F(\mu, \nu) \cos\left[\frac{(2x+1)\mu\pi}{16}\right] \cos\left[\frac{(2x+1)\nu\pi}{16}\right]$$

Equation 2: Inverse Discrete Cosine Transform

In Fourier analysis, a signal is decomposed into weighted sums of orthogonal sines and cosines that when added together reproduce the original signal. The 2-dimensional DCT operation for an 8x8 pixel block generates an 8x8 block of coefficients that represent a “weighting” value for each of the 64 orthogonal basis patterns that are added together to produce the original image. Figure 4 shows a grayscale plot of these DCT basis patterns, and Figure 5 shows how the vertical and horizontal frequencies are mapped into the 8x8 block pattern.

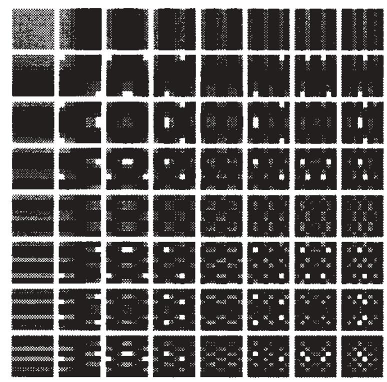

Figure 4: DCT Basis Patterns

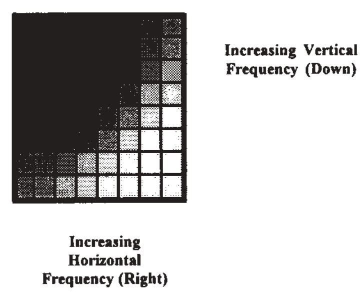

Figure 5: DCT Frequency Mapping

Note again that the above equations are based on data blocks of an 8x8 size. It is certainly possible to compute the DCT for other block sizes, for example 4x4 or 16x16 pixels, but the 8x8 size has become the standard as it represents an ideal compromise between adequate data decorrelation and reasonable computability. Even so, these formidable-looking equations would each normally require 1024 multiplies and 896 additions if solved directly, but fortunately, as with the case of the Fast Fourier Transform, various fast algorithms exist that make the calculations considerably faster.

Besides decorrelation of signal data, the other important property of the DCT is its efficient energy compaction. This can be shown qualitatively by looking at a simple 1-dimensional example. Figure 6 shows an n-point increasing ramp function, where n in this case equals 4. If the Discrete Fourier Transform (DFT) of this signal were to be taken, then the implied periodicity of the signal is shown as in the top portion of the figure. Quite obviously, an adequate representation of this signal with sines and cosines will require substantial high frequency components. The bottom portion of the figure shows how the DCT operation overcomes this problem, by using reflective symmetry before being periodically repeated. In this manner, the sharp time domain discontinuities are eliminated, allowing the energy to be concentrated more towards the lower end of the frequency spectrum. This example also illustrates an interesting fact, that the DCT of the n-point signal may be calculated by performing a 2n-point DFT5.

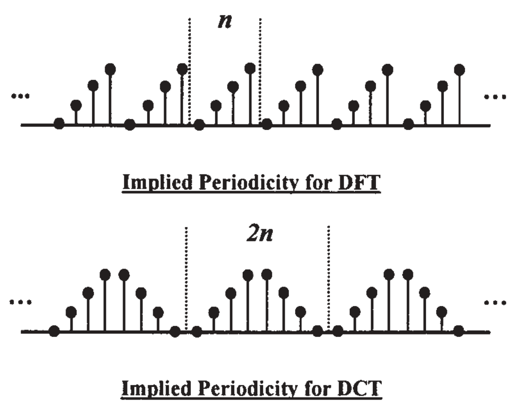

Figure 6: DCT Symmetry

To further demonstrate the effective energy concentration property of the DCT operation, a series of figures are given showing a deletion of a number of DCT coefficients. Due to space limitations, as well as the fact that these pictures would not have reproduced well on magazine paper, the figures referenced in the next two paragraphs may be viewed by going to the following Internet web pages: Figures 7-10 are located at:
http://members.aol.com/symbandgrl/figure7.htm
and Figures 11-14 are located at:
http://members.aol.com/symbandgrl/figure11.htm.
Figure 7 shows an 8-bit monochrome image, where an 8x8 DCT operation has been performed on all the blocks of the image, all of the coefficients are retained, then an 8x8 IDCT is performed to reconstruct the image. Figure 8 is the same image with only the 10 DCT coefficients in the upper left-hand corner retained. The remaining 54 higher frequency DCT coefficients have all been set to zero. When the IDCT operation is applied and the image reconstructed, it is shown that the image still retains a fairly high degree of quality compared to the original image that was reconstructed using all 64 DCT coefficients. Figure 9 eliminates another diagonal row of DCT coefficients such that only 6 are kept and used in the IDCT operation. Again, some degradation is apparent, but overall the picture quality is still fair. Figure 10 continues by eliminating another row, resulting in only 3 coefficients saved. At this point, fairly significant blockiness is observed, especially around sharp edges within the image. Figure 11 illustrates the extreme case where only the DC coefficient (extreme upper left-hand corner) is kept. Although dramatic blockiness is apparent, the image is still surprisingly recognizable when it is realized that only 1 out of the original 64 coefficients have been maintained.

Figures 12-14 show the above process in a slightly different light. These three figures clearly show the amount of energy that is missing when the higher frequency coefficients are deleted. It is also apparent that this energy is concentrated in areas of the image that are associated with edges, or high spatial frequencies. Because of this, it is desired that the total number and the degree of DCT coefficient deletion be controlled on a macroblock basis. This control is accomplished with a process called quantization.

DCT Coefficient Quantization

As was shown previously in Figure 5, the lower frequency DCT coefficients toward the upper left-hand corner of the coefficient matrix correspond to smoother spatial contours, while the DC coefficient corresponds to a solid luminance or color value for the entire block. Also, the higher frequency DCT coefficients toward the lower right-hand corner of the coefficient matrix correspond to finer spatial patterns, or even noise within the image. Since it is well known that the HVS is less sensitive to errors in high frequency coefficients than it is for lower frequencies, it is desired that the higher frequencies be more coarsely quantized in their representation.

The process of DCT coefficient quantization is described as follows. Each 12-bit coefficient is divided by a corresponding quantization matrix value that is supplied from an intra quantization matrix. The default matrix is given in Figure 15, and if the encoder decides it is warranted, it may substitute a new quantization matrix at a picture level and download it to the decoder via the bitstream. Each value in this matrix is pre-scaled by multiplying by a single value, known as the quantizer scale

8	16	19	22	26	27	29	34
16	16	22	24	27	29	34	37
19	22	26	27	29	34	34	38
22	22	26	27	29	34	37	40
22	26	27	29	32	35	40	48
26	27	29	32	35	40	48	58
26	27	29	34	38	46	56	69
27	29	35	38	46	56	69	83

Figure 15:Default Intra Quant Matrix

code. This value may range in value from 1-112, and is modifiable on a macroblock basis, making it useful as a fine-tuning parameter for the bit-rate control, since it would not be economical to send an entirely new matrix on a macroblock basis. The goal of this operation is to force as many of the DCT coefficients to zero, or near zero, as possible within the boundaries of the prescribed bit-rate and video quality parameters.

8	4	2	1	0	0	0	0
4	2	1	0	0	0	0	0
2	1	0	0	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Figure 16: Example Coefficients

Run-Length Amplitude/Variable Length Coding

An example of a typical quantized DCT coefficient matrix is given in Figure 16. As desired, most of the energy is concentrated within the lower frequency portion of the matrix, and most of the higher frequency coefficients have been quantized to zero. Considerable savings can be had by representing the fairly large number of zero coefficients in a more effective manner, and that is the purpose of run-length amplitude coding of the quantized coefficients. But before that process is performed, more efficiency can be gained by reordering the DCT coefficients.

Since most of the non-zero DCT coefficients will typically be concentrated in the upper left-hand corner of the matrix, it is apparent that a zigzag scanning pattern will tend to maximize the probability of achieving long runs of consecutive zero coefficients. This zigzag scanning pattern is shown in the upper portion of Figure 17. Note for the sake of completeness that a second, alternate scanning pattern defined in MPEG-2 is shown in the lower portion of the figure. This scanning pattern may be chosen by the encoder on a frame basis, and has been shown to be effective on interlaced video images. This paper will concentrate only on the use of the standard zigzag pattern, however.

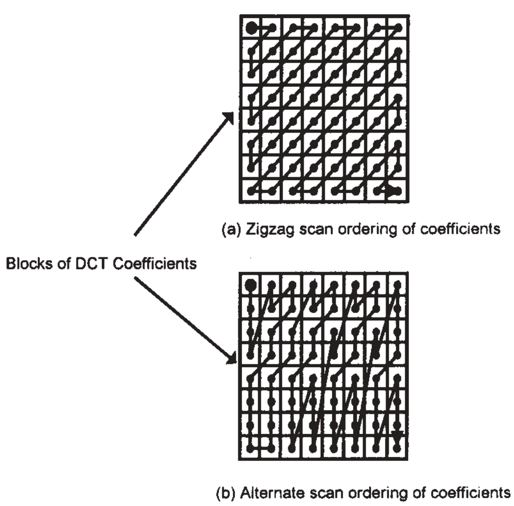

Figure 17: DCT Coefficient Scanning

Again, the block of quantized DCT coefficients as presented in Figure 16 is referenced. Scanning of the example coefficients in a zigzag pattern results in a sequence of numbers as follows: 8, 4, 4, 2, 2, 2, 1, 1, 1, 1, (12 zeroes), 1, (41 zeroes). This sequence is then represented as a run-length (representing the number of consecutive zeroes) and an amplitude (coefficient value following a run of zeroes). These values are then looked up in a fixed table of variable length codes6, where the most probable occurrence is given a relatively short code, and the least probable occurrence is given a relatively long code. In this example, this becomes:

ZERO RUN-LENGTH	AMPLITUDE	MPEG CODE VALUE
N/A	8 (DC Value)	110 1000
0	4	0000 1100
0	4	0000 1100
0	2	0100 0
0	2	0100 0
0	2	0100 0
0	1	110
0	1	110
0	1	110
0	1	110
12	1	0010 0010 0
EOB	EOB	10

Note that the first run of 12 zeroes has been very efficiently represented with only 9 bits, and the last run of 43 zeroes has been entirely eliminated, represented only with a 2-bit End Of Block (EOB) indicator. It can be seen from the table that the quantized DCT coefficients are now represented by a sequence of 61 binary bits. Considering that the original 8x8 block of 8-bit pixels required 512 bits for full representation, this is a compression of approximately 8.4:1 at this point.

Certain coefficient values that are not particularly likely to occur are coded with escape sequences to prevent the code tables from becoming too long. As an example, consider what would happen if the last isolated coefficient value of 1 was instead a value of 3. There is no code value for a run-length of 12 followed by an amplitude of 3, so it is instead coded with the escape sequence 0000 01, a 6-bit representation of the run-length (12 = 001100), and finally a 12-bit representation of the amplitude (3 = 000000000011). All of the other values in the table remain the same as before. In this case, the total number of bits will grow to 76, and the compression is lowered to approximately 6.7:1.

Video Buffer and Rate Control

Most of the applications that were mentioned in the introduction use a fixed bit-rate for the transmission of the compressed information. For the case of HDTV broadcasts, this fixed rate will be 18 Mb/sec for the video signal. Unfortunately, the individual video images to be coded may contain drastically varying amounts of information, resulting in wildly varying coding efficiencies from picture to picture. This may also occur within a given picture, as portions of the picture may be very smooth, yet other areas may contain large amounts of high frequency information. Because of these variations, it is necessary to buffer the encoded bitstream before it is transmitted. Due to the fact that the buffer must necessarily by limited in size (physical limitations and delay constraints), a feedback system must be used as a rate control mechanism to prevent underflow or overflow within the buffer. The buffer and rate controller are necessary for intra frame only coding/decoding systems, but become even more important for non-intra coded systems as the coding efficiency changes relative to the type of frame coding utilized, and there can be drastic differences in the total number of bits that ultimately are used to represent the original I, P, and B frames.

By looking at Figure 1, it can be seen that the only block available for the rate control mechanism to reasonably modify is the DCT coefficient quantizer. Because the quantizer matrix may be changed on a picture basis and the quantizer scale may be changed on a macroblock basis, these parameters are commonly used by encoder rate control algorithms to provide dynamic control over the relative buffer fullness. In this manner, a constant bit-rate may be provided by the output of the encoder buffer, yet underflow or overflow may be prevented without severe quality penalties such as the repeating or dropping of entire video frames. It should be noted that although rate control algorithms are necessary in fixed bit-rate applications, neither the MPEG-1 nor the MPEG-2 standard define particular implementations. Since these algorithms have direct bearing on the ultimate video presentation quality, most of them are encoder vendor proprietary, and the subject of current research. A list of some of the more well-known general algorithms may be found in this reference 3.

Non-Intra Frame Coding Techniques

The previously discussed intra frame coding techniques were limited to processing the video signal on a spatial basis, relative only to information within the current video frame. Considerably more compression efficiency can be obtained however, if the inherent temporal, or time-based redundancies, are exploited as well. Anyone who has ever taken a reel of the old-style super-8 movie film and held it up to a light can certainly remember seeing that most consecutive frames within a sequence are very similar to the frames both before and after the frame of interest. Temporal processing to exploit this redundan-

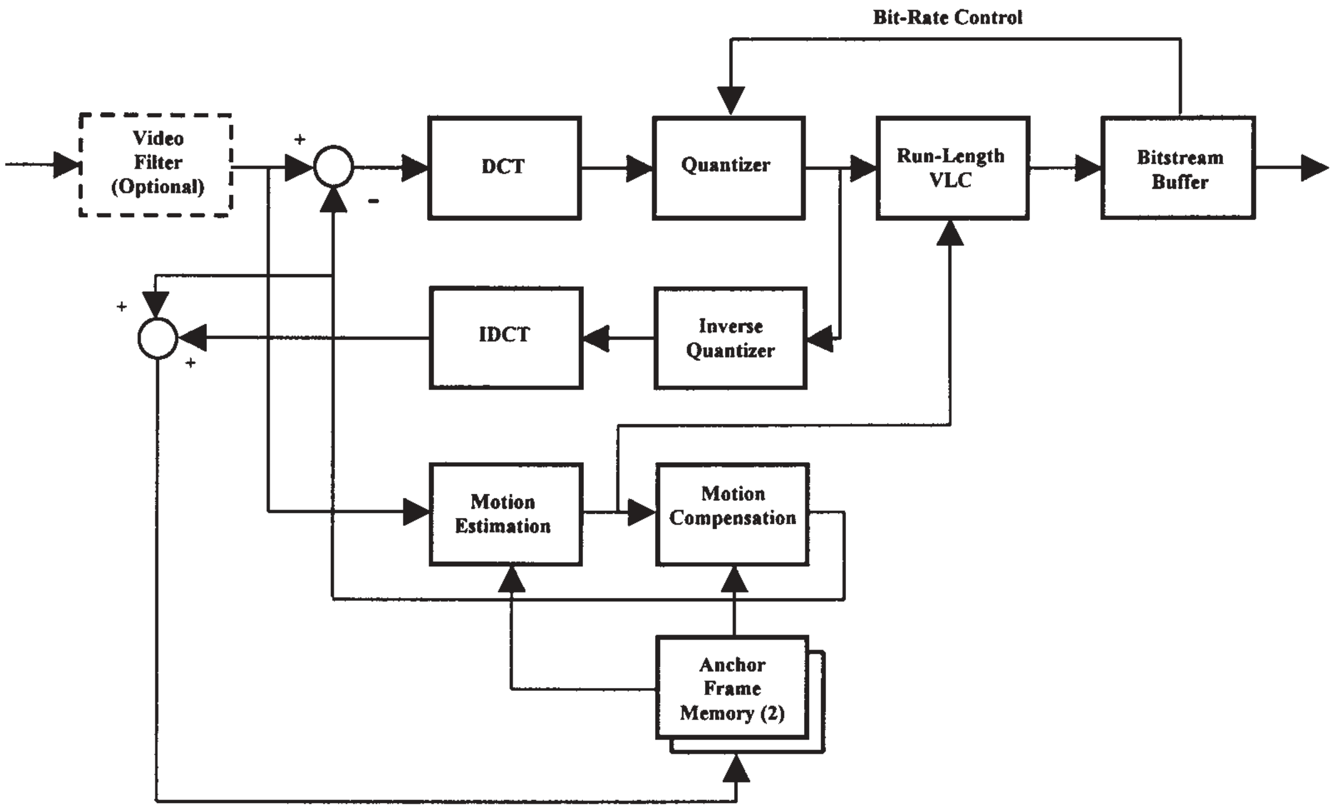

Figure 18: Non-Intra Frame Encoder

cy uses a technique known as motion compensation. A block diagram of the basic encoder with extensions for non-intra frame coding techniques is given in Figure 18. Of course, this encoder can also support intra frame coding as a subset.

P Frames

Starting with an intra, or I frame, the encoder can forward predict a future frame. This is commonly referred to as a P frame, and it may also be predicted from other P frames, although only in a forward time manner. As an example, consider a group of pictures that lasts for 6 frames. In this case, the frame ordering is given as I,P,P,P,P,P,I,P,P,P,P,...
Each P frame in this sequence is predicted from the frame immediately preceding it, whether it is an I frame or a P frame. As a reminder, I frames are coded spatially with no reference to any other frame in the sequence.

B Frames

The encoder also has the option of using forward/backward interpolated prediction. These frames are commonly referred to as bi-directional interpolated prediction frames, or B frames for short. As an example of the usage of I, P, and B frames, consider a group of pictures that lasts for 6 frames, and is given as I,B,P,B,P,B,I,B,P,B,P,B,... As in the previous I & P only example, I frames are coded spatially only and the P frames are forward predicted based on previous I and P frames. The B frames however, are coded based on a forward prediction from a previous I or P frame, as well as a backward prediction from a succeeding I or P frame. As such, the example sequence is processed by the encoder such that the first B frame is predicted from the first I frame and first P frame, the second B frame is predicted from the second and third P frames, and the third B frame is predicted from the third P frame and the first I frame of the next group of pictures. From this example, it can be seen that backward prediction requires that the future frames that are to be used for backward prediction be encoded and transmitted first, out of order. This process is summarized in Figure 19. There is no defined limit to the number of consecutive B frames that may be used in a group of pictures, and of course the optimal number is application dependent. Most broadcast quality applications however, have tended to use 2 consecutive B frames (I,B,B,P,B,B,P,...) as the ideal trade-off between compression efficiency and video quality.

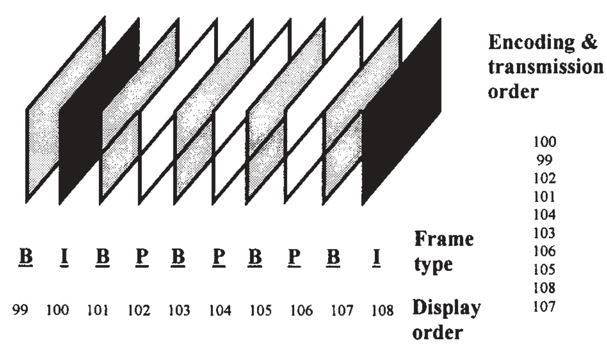

Figure 19: Frame Ordering

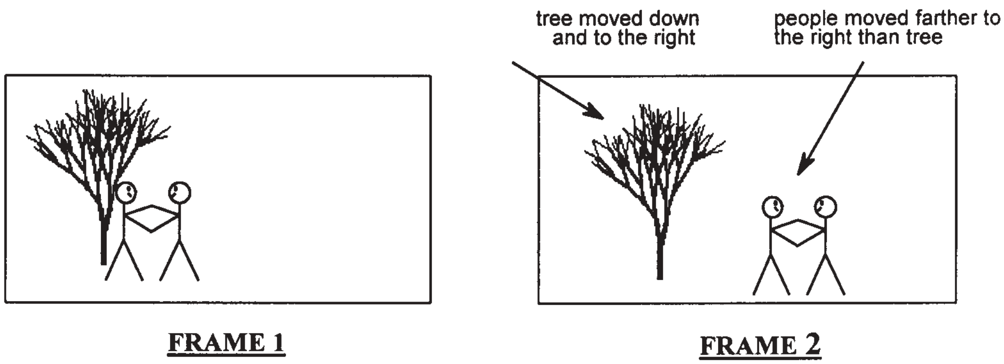

Figure 20

The main advantage of the usage of B frames is coding efficiency. In most cases, B frames will result in less bits being coded overall. Quality can also be improved in the case of moving objects that reveal hidden areas within a video sequence. Backward prediction in this case allows the encoder to make more intelligent decisions on how to encode the video within these areas. Also, since B frames are not used to predict future frames, errors generated will not be propagated further within the sequence.

One disadvantage is that the frame reconstruction memory buffers within the encoder and decoder must be doubled in size to accommodate the 2 anchor frames. This is almost never an issue for the relatively expensive encoder, and in these days of inexpensive DRAM it has become much less of an issue for the decoder as well. Another disadvantage is that there will necessarily be a delay throughout the system as the frames are delivered out of order as was shown in Figure 19. Most one-way systems can tolerate these delays, as they are more objectionable in applications such as video conferencing systems.

Motion Estimation

The temporal prediction technique used in MPEG video is known as motion estimation. The basic premise of motion estimation is that in most cases, consecutive video frames will be similar except for changes induced by objects moving within the frames. In the trivial case of zero motion between frames (and no other differences caused by noise, etc.), it is easy for the encoder to efficiently predict the current frame as a duplicate of the prediction frame. When this is done, the only information necessary to transmit to the decoder becomes the syntactic overhead necessary to reconstruct the picture from the original reference frame. When there is motion in the images, the situation is not as simple.

Figure 20 shows an example of a frame with 2 stick figures and a tree. The second half of this figure is an example of a possible next frame, where panning has resulted in the tree moving down and to the right, and the figures have moved farther to the right because of their own movement outside of the panning. The problem for motion estimation to solve is how to adequately represent the changes, or differences, between these two video frames.

The way that motion estimation goes about solving this problem is that a comprehensive 2-dimensional spatial search is performed for each luminance macroblock. Motion estimation is not applied directly to chrominance in MPEG video, as it is assumed that the color motion can be adequately represented

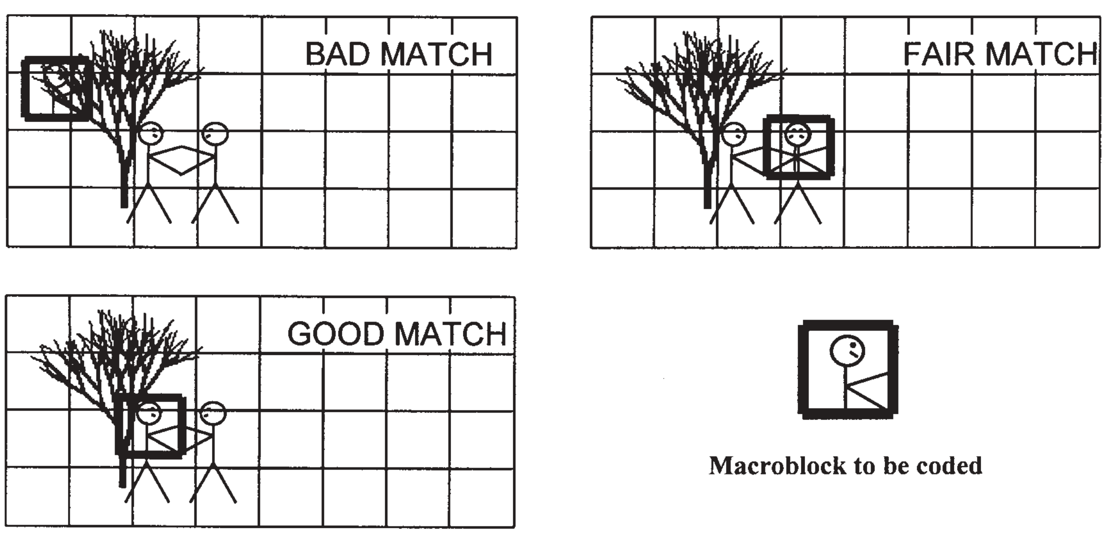

Figure 21

ADVERTISING RATES AND DEADLINES

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SPRING	April 1	April 15	May 1
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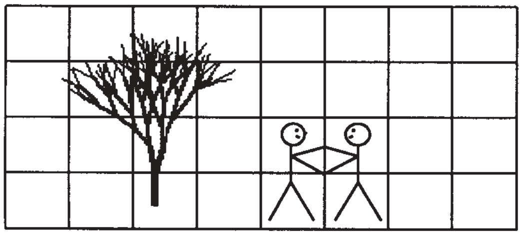
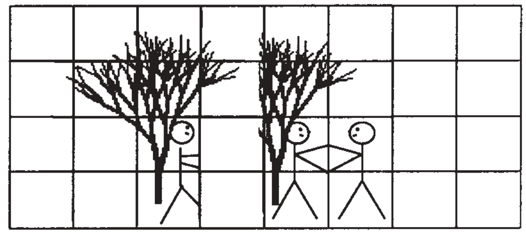
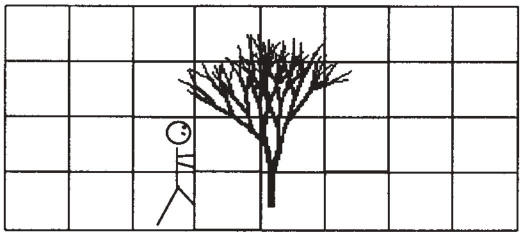


Desired Picture



Minus Predicted Picture



Residual Error Picture
(Coded & Transmitted)

Figure 22

with the same motion information as the luminance. It should be noted at this point that MPEG does not define how this search should be performed. This is a detail that the system designer can choose to implement in one of many possible ways. This is similar to the bit-rate control algorithms discussed previously, in the respect that complexity vs. quality issues need to be addressed relative to the individual application. It is well known that a full, exhaustive search over a wide 2-dimensional area yields the best matching results in most cases, but this performance comes at an extreme computational cost to the encoder. As motion estimation usually is the most computationally expensive portion of the video encoder, some lower cost encoders might choose to limit the pixel search range, or use other techniques such as telescopic searches, usually at some cost to the video quality.

Figure 21 shows an example of a particular macroblock from Frame 2 of Figure 20, relative to various macroblocks of Frame 1. As can be seen, the top frame has a bad match with the macroblock to be coded. The middle frame has a fair match, as there is some commonality between the 2 macroblocks. The bottom frame has the best match, with only a slight error between the 2 macroblocks. Because a relatively good match has been found, the encoder assigns motion vectors to the macroblock, which indicate how far horizontally and vertically the macroblock must be moved so that a match is made. As such, each forward and backward predicted macroblock may contain 2 motion vectors, so true bidirectionally predicted macroblocks will utilize 4 motion vectors.

Figure 22 shows how a potential predicted Frame 2 can be generated from Frame 1 by using motion estimation. In this figure, the predicted frame is subtracted from the desired frame, leaving a (hopefully) less complicated residual error frame that can then be encoded much more efficiently than before motion estimation. It can be seen that the more accurate the motion is estimated and matched, the more likely it will be that the residual error will approach zero, and the coding efficiency will be highest. Further coding efficiency is accomplished by taking advantage of the fact that motion vectors tend to be highly correlated between macroblocks. Because of this, the horizontal component is compared to the previously valid horizontal motion vector and only the difference is coded. This same difference is calculated for the vertical component before coding. These difference codes are then described with a variable length code for maximum compression efficiency.

Of course not every macroblock search will result in an acceptable match. If the encoder decides that no acceptable match exists (again, the “acceptable” criterion is not MPEG defined, and is up to the system designer) then it has the option of coding that particular macroblock as an intra macroblock, even though it may be in a P or B frame. In this manner, high quality video is maintained at a slight cost to coding efficiency.

Coding of Residual Errors

After a predicted frame is subtracted from its reference and the residual error frame is generated, this information is spatially coded as in I frames, by coding 8x8 blocks with the DCT, DCT coefficient quantization, run-length/amplitude coding, and bitstream buffering with rate control feedback. This process is basically the same with some minor differences, the main ones being in the DCT coefficient quantization. The default quantization matrix for non-intra frames is a flat matrix with a constant value of 16 for each of the 64 locations. This is very different from that of the default intra quantization matrix (Figure 15) which is tailored for more quantization in direct proportion to higher spatial frequency content. As in the intra case, the encoder may choose to override this default, and utilize another matrix of choice during the encoding process, and download it via the encoded bitstream to the decoder on a picture basis. Also, the non-intra quantization step function contains a dead-zone around zero that is not present in the intra version. This helps eliminate any lone DCT coefficient quantization values that might reduce the run-length amplitude efficiency. Finally, the motion vectors for the residual block information are calculated as differential values and are coded with a variable length code according to their statistical likelihood of occurrence.

Intra Frame Decoding

To decode a bitstream generated from the encoder of Figure 1, it is necessary to reverse the order of the encoder processing. In this manner, an I frame decoder consists of an input bitstream buffer, a Variable Length Decoder (VLD), an inverse quantizer, an Inverse Discrete Cosine Transform (IDCT), and an output interface to the required environment (computer hard drive, video frame buffer, etc.). This decoder is shown in Figure 23.

Figure 23: Intra Frame Decoder

The input bitstream buffer consists of memory that operates in the inverse fashion of the buffer in the encoder. For fixed bit-rate applications, the constant rate bitstream is buffered in the memory and read out at a variable rate depending on the coding efficiency of the macroblocks and frames to be decoded.

The VLD is probably the most computationally expensive portion of the decoder because it must operate on a bit-wise basis (VLD decoders need to look at every bit, because the boundaries between variable length codes are random and non-aligned) with table look-ups performed at speeds up to the input bit-rate. This is generally the only function in the receiver that is more complex to implement than its corresponding function within the encoder, because of the extensive high-speed bit-wise processing necessary.

The inverse quantizer block multiplies the decoded coefficients by the corresponding values of the quantization matrix and the quantization scale factor. Clipping of the resulting coefficients is performed to the region -2048 to +2047, then an IDCT mismatch control is applied to prevent long term error propagation within the sequence.

The IDCT operation is given in Equation 2, and is seen to be similar to the DCT operation of Equation 1. As such, these two operations are very similar in implementation between encoder and decoder.

Non-Intra Decoding

It was shown previously that the non-intra frame encoder built upon the basic building blocks of the intra frame encoder, with the addition of motion estimation and its associated support structures. This is also true of the non-intra frame decoder, as it contains the same core structure as the intra frame decoder with the addition of motion compensation support. Again, support for intra frame decoding is inherent in the structure, so I, P, and B frame decoding is possible. The decoder is shown in Figure 24.

Implementation Issues

It is all very fine to have standards that define video compression techniques, but general acceptance will never come if those standards cannot be reasonably implemented. Of course the expression "reasonably implemented" will be highly application dependent. Take for example the case of a typical digital television set-top box. These devices are extremely cost sensitive, with target prices of approximately 200-300 dollars for a self-contained unit including chassis and power supply. As such, the typical design consists of a custom VLSI chip dedicated to video compression, and supported by external DRAM and a very low-price microprocessor. Cost is further reduced in systems such as these by incorporating the audio decoder and the transport demultiplexer into the same VLSI device as the video decoder, with some chips even incorporating internal microprocessor cores as well. Devices were available a few years ago that performed these functions while interfacing with standard DRAM via a 64-bit data bus (CCIR-601 resolution video decoding), but most manufacturers have further reduced cost and increased performance by lowering the data bus interface to 32 bits and using faster SDRAM (Synchronous DRAM) chips for external storage. Also, it was pointed out previously that the basic techniques used in MPEG video are similar to those used in the JPEG still image compression standard. Because of this, it is fairly easy to design a multi-purpose decoder device to incorporate extra functionality such as JPEG, or even H.261 video conferencing support if the end application warrants the inclusions. High-end applications such as HDTV decoding chipsets (an emerging cost sensitive consumer area) are now being supported by various manufacturers such as ATI. Information on ATI's offering may be found by visiting:
http://www.ati.com/na/pages/showcase/set-top/
and scrolling down to the RAGE HDTV chip description.

Another possible need for MPEG video decoding, but somewhat

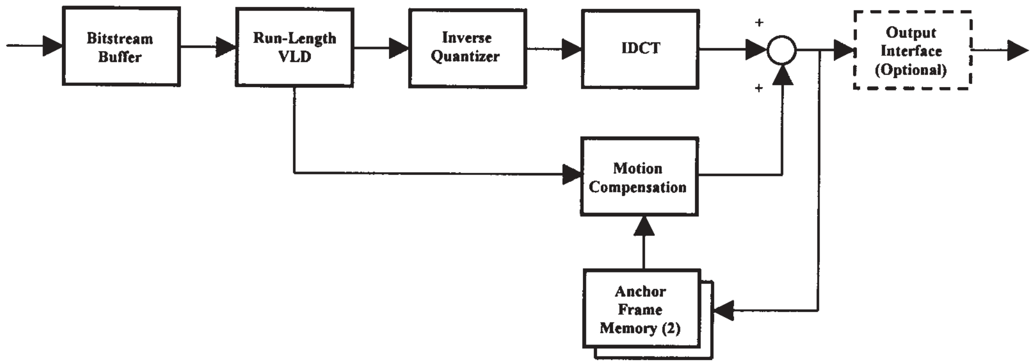


Figure 24: Non-Intra Frame Decoder

orthogonal to the above, is with web browsing in the PC environment. In this application, the user may desire to decode the video bitstream without having to purchase a separate card containing extra hardware. Here it is common to utilize a software decoder running entirely on the host CPU. There are presently many suppliers of PC software to decode and display MPEG video, and their performance is dependent on the source bitstream, video resolution, and CPU speed.

New PC and workstation applications have recently emerged that severely tax the CPU, and that cannot be successfully implemented by merely using higher clock speed CPU chips. In these cases, CPU designers have taken a careful look at what "multimedia" applications such as MPEG video require, and have started to include instructions and architectural features within the CPU to facilitate these demanding requirements. An in-depth overview of video compression's influence on CPU design is available in this reference7, and it includes details of Intel's MMX, Sun's Visual Instruction Set, and Hewlett-Packard's MAX-2 subword parallelism architectures, and how they have been used to improve the performance of applications using MPEG video. Even with extensive improvements to the processor, both in operating frequency and instruction set performance, extremely demanding multimedia applications can still severely tax the overall system performance. Applications requiring state-of-the-art graphics and HDTV-resolution video decoding can be greatly enhanced by a combination of a modern high-performance CPU and external graphics/video accelerator chip such as the ATI Radeon. This part has been architected to off-load certain computationally expensive portions of the MPEG algorithm, such as the IDCT and motion compensation calculations, while freeing the CPU to work on things it is better suited for.

Since MPEG encoding is roughly an order-of-magnitude more demanding computationally than the decoding process, considerably more processing power is required. If the application can tolerate non-realtime processing, then bitstreams for video applications up to and including HDTV resolutions can be generated using software encoders and then stored digitally. PC boards for generating realtime MPEG-1 bitstreams are available for under $1000, while MPEG-2 capable systems are available for under $2000, but realtime HDTV encoders are currently in another league, namely for a limited number of professional applications.

Summary

This tutorial paper is just an introduction to some of the various components of MPEG-1 and MPEG-2 video compression. Textbooks have been written about individual techniques such as the discrete cosine transform, and this and other components are the subjects of current academic and industry research. The reader is encouraged to search out more in-depth information on these topics, MPEG syntax, applications, etc., which can be found in the references listed below.

References

1 "Coding of Moving Pictures and Associated Audio for Digital Storage Media at up to about 1.5 Mbit/s," ISO/IEC 11172-2: Video (November 1991).

2 "Generic Coding of Moving Pictures and Associated Audio Information: Video," ISO/IEC 13818-2 : Draft International Standard (November 1994).

3 Barry G. Haskell, Atul Puri, Arun N. Netravali, "Digital Video: An Introduction to MPEG-2", Chapman and Hall, 1997.

4 K.R. Rao, P. Yip, "Discrete Cosine Transform - Algorithms, Advantages, Applications", Academic Press, Inc., 1990.

5 Majid Rabbani, Paul W. Jones, "Digital Image Compression Techniques", SPIE Optical Engineering Press, 1991.

6 Joan L. Mitchell, William B. Pennebaker, Chad E. Fogg, Didier J. LeGall, "MPEG Video Compression Standard", Chapman and Hall, 1997.

7 IEEE Micro Magazine - Media Processing, IEEE Computer Society, Volume 16 Number 4, August 1996.

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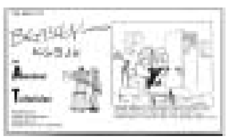

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SPEED TRAPS GONE MAD

A report has revealed that two traffic patrol officers from North Berwick were involved in an unusual incident whilst checking for speeding motorists on the A1 road between Oldhamstocks and Granthouse.

Last May, they were using a hand held radar device to trap unwary motorists on the Edinburgh to London trunk road. One of the unnamed officers used the device to check the speed of an approaching vehicle, and was surprised to find that his target registered a speed in excess of 300 mph. The £5,000 machine then seized up and could not be reset by the bemused PCs.

The radar had in fact latched on to a NATO Tornado aircraft over the North Sea, which was taking part in a simulated low flying exercise over the Borders and Southern Scotland.

Following a complaint by Sir William Sutherland, Chief Constable of the Lothian and Borders Police Force to the RAF liaison office, it was revealed that the officers had a lucky escape. The tactical computer on board the aircraft not only detected and jammed the "hostile" radar equipment but also automatically armed a Sidewinder Air to Ground Missile in readiness to neutralise the perceived threat. Luckily the Dutch pilot was alerted to the missile status and was able to override the automatic protection system before the missile launched.

The police have so far declined to comment although it is understood that officers will be advised to point their radar guns inland in the future.

Item published in the
Berwickshire Gazette – 11th November 1998

Using VHF/UHF TV Antennas On ATV

by Clint Turner - KA7OEI - email: turner@ussc.com
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West Jordan, UT 84084

Does “HAM” stand for “Haven’t Any Money”?

Many amateur radio operators (myself included) are cheapskates. After all, this is a hobby, and rather than spending money on things like coax, antennas, clothes and food, we’d rather spend our money on the new rig, or on that ‘neato’ junque that we just saw at the swapmeet (or on Ebay...) I’m not speaking for all of us, mind you, but I’m sure you know someone that fits the description.

In the same spirit, we’ll often try to make do with something that we have on hand when, in our heart, we really know that it won’t work to well. We are often willing to spend a lot of time **trying** to make it work when, if we were paying ourselves minimum wage, we could have bought the real thing.

On ATV, the question is often asked: **“Can’t I use my existing rooftop TV antenna for 70cm ATV and get a good picture?”** The intent here is save money by trying using the antenna/coax that you probably already have connected to your TV.

The answer is: **“Yes, you can’t.”**

Well, probably.

Since I was curious about this too, so I did some measurements using the following antennas. A “nickname” of each antenna is in quotes just after each letter to aid in deciphering the charts below:

A - “RSANT” Radio Shack VHF/UHF combination, Model VU-75XR. “18” elements (according to the catalog) which translates to 3 VHF “dipoles” (each “dipole” is counted as 2 elements since it is a log-periodic antenna) and on UHF it has 4 directors, 1 driven element, and 6 “reflector” elements on the “vee” portion. The 300-75 ohm balun was mounted on the antenna.
B - “UVANT” A **large** VHF/UHF combination, unknown manufacture (about 15 years old.) 11 VHF “dipoles”, on UHF it has 6 directors, 1 driven element, and 6 “reflector” elements on the “vee” portion. The 300-75 ohm balun was mounted on the antenna.
C - “TVYAGI” 10 element yagi cut for to channel 14, made by Blonder-Tongue.
D - “HTANT” 2meter/440 HT dual-bander rubber duck antenna. (1/4 wave on 2 meters, 5/8 wave on 70cm, made by Premier.) The antenna was held horizontally and rotated until a consistent peak was found. (The antenna was broadside to the transmitter for the peak.)
E - “8LYAGI” 8 element 70cm yagi, homebrew broadband. Antenna gain minus feedline loss is approximately 10dbi.
F - “RABBIT” Rabbit Ear antenna with 18” length of twinlead and balun. Various combinations of antenna rotation, minimal, partial, and full telescoping of the elements was tried. Interestingly, the signals were within 2 db of the best value no matter how the elements were telescoped or collapsed when the antenna was oriented for best signal (i.e. broadside to the transmitter site.)

Measurement conditions:

- All measurements were made with a Sadelco MiniMax 800 signal strength meter. This meter is rated for an accuracy of +- 0.25 db over a 5-862 MHz operating frequency range and lab measurements tend to corroborate this.
- All measurements were made on the same site and with a clear view of the transmitter site (which was 15 miles distant and over 4700 feet higher in elevation.)
- For antennas **A**, **B**, and **C** a short (18”) length of RG-6 was used to connect the antenna to the signal meter.
- Antenna **D** was connected directly to the signal meter via an F to BNC adapter.
- For antenna **E**, approx. 15 feet of 9913-type coaxial cable was used to connect the antenna to the signal meter.
- The balun on antenna **F** was connected directly to the signal meter.
- Even though antennas **D** and **E** are ostensibly 50 ohms, no attempt was made to compensate. It should be noted that the loss of a balun to convert 75 ohms to 50 ohms would likely incur as much loss as the mismatch itself! (The mismatch between 50 and 75 ohms only represents a VSWR of 1.5:1 anyway...)
- The signal level readings represent those of the visual carrier only.

Sadelco MiniMax 800 TV signal strength meter

Signal Sources:

- The ATV signal source was the WB7FID repeater on 426.25 MHz.
- The Channel 14 and Channel 30 signal sources were from KJZZ-TV and KUWB respectively.
- **All three** signal sources originate from the top of the Oquirrh Mountains, about 15 miles west of the receive site. These sites are within 3 degrees of each other in terms of bearing.
- All signals are horizontally polarized.

Results:

- These results are in dbmV. This is “db with respect to 1 millivolt of RF at 75 ohms.” This may be an unfamiliar number to many, but we are more interested in **performance differences** between antennas than the absolute signal strengths. To provide a more familiar reference, signal strengths in microvolts are given in parenthesis, along with the **actual observed** picture quality.
- For a discussion of the “P” ratings and about how much signal it takes to get a particular quality signal, go the the “P’s and Q’s of Video Signals” page: **http//www.ussc.com/~uarc/utah_atv/psandqs.html**

Signal strength readings for the WB7FID ATV Repeater (426.25) visual carrier on each antenna:

- **A** - RSANT: -23 dbmV (approx. 71 microvolts, a P2 [“noisy”] picture)
- **B** - UVANT: -15 dbmV (approx. 178 microvolts, a P3 picture)
- **C** - TVYAGI: -20 dbmV (approx. 100 microvolts, a “noisy” P3 picture)
- **D** - HTANT: -19 dbmV (approx. 112 microvolts, a “noisy” P3 picture)
- **E** - 8LYAGI: -10 dbmV (approx. 316 microvolts, a P4 picture)
- **F** - RABBIT: -17 dbmV (approx. 141 microvolts, a P3 picture)

Signal strength readings for KJZZ-TV channel 14 visual carrier (471.25 MHz) visual carrier on each antenna:

- **A** - RSANT: +15 dbmV (approx. 5.6 millivolts)
- **B** - UVANT: +25 dbmV (approx. 17.8 millivolts)
- **C** - TVYAGI: +27 dbmV (approx. 22.4 millivolts)
- **D** - HTANT: (No reading taken)
- **E** - 8LYAGI: (No reading taken)
- **F** - RABBIT: +11 dbmV (approx. 3.5 millivolts)

Signal strength readings for KUWB channel 30 visual carrier (567.25 MHz) visual carrier on each antenna:

- **A** - RSANT: +18 dbmV (approx. 7.9 millivolts)
- **B** - UVANT: +19 dbmV (approx. 8.9 millivolts)
- **C** - TVYAGI: -2 dbmV (approx. 794 microvolts)
- **D** - HTANT: (No reading taken)
- **E** - 8LYAGI: (No reading taken)
- **F** - RABBIT: (No reading taken)

Conclusions:

“If you use a VHF/UHF TV antenna for watching ATV, don’t expect great results.”

Clearly, the amateur-band antennas worked better than the non-ham antennas. I didn’t expect the VHF/UHF TV-type antennas to work quite as badly as they did. As you can see, you would be better off with either a rubber duck or a pair of rabbit-ear antennas (**on your roof!**) than antenna **A** (the Radio Shack VU-75XR.) Antenna **B** (the large 15 year old VHF/UHF antenna) performed quite a bit better for ATV than did **A**, but even it doesn’t even perform as well as a 3 element yagi might!

It is interesting to compare the performance of antenna **C** (the 10 element yagi for channel 14) against the other antennas. It can be reasonably assumed that this antenna is working about as well as a standard 10 element yagi might (which would imply a gain of about 14 dbi. By extrapolation, antenna **A** would have a gain of 2dbi and antenna **B** would have a gain of 12dbi.

By comparison, if we assume that antenna **E** (the 8 element 70cm yagi) has a gain of 10 dbi (this figure includes feedline loss) then we see that, at 426.25 MHz, **A** has a gain of 1 dbi (1db worse than a dipole!) and antenna **B** has a gain of about 9dbi - about the same gain as a 3 element yagi.

While these numbers may seem pretty poor, these readings jibe with experience: Most VHF/UHF TV antennas tend to drop in gain as frequency goes down. This would make sense because, to get better “low end” gain, the elements (and the antenna itself) need to be longer - and this would make it more expensive. Looking at the signal strengths of channel 14 and channel 30 on antennas **A** and **B** reveals that these two antennas perform more or less identically. Visual comparison of the two antennas shows that they are similarly constructed - but with one critical difference: The UHF elements on the **B** antenna are slightly longer and are constructed in a way that makes them intrinsically more broadbanded.

“How much power would the ATV repeater have to run to make a typical VHF/UHF TV antenna work well?”

At present, antenna **A** yields a signal of 71 microvolts **at the antenna.** Measured at the end of about 60 feet of RG-6 coaxial cable **and** going through one splitter, we end up with a signal strength of -29 dbmV (about 35 microvolts.) This results in a noisy (P2) picture.

Presently, the WB7FID ATV repeater runs about 60 watts or so output into the filter/combiner/isolator network. If we wanted to improve the P2 that we are currently receiving to, say, a “good P3” (a perfectly watchable picture, but with some noise) we would have to increase the signal strength from the current -29 dbmV (35 microvolts) to about -15 dbmV (approximately 178 microvolts) - a difference of 14db. This means that the transmit power would have to be raised from 60 watts to 1500 watts - **that's full legal power**! Conversely, if we were to move closer to the repeater's transmit antenna, we'd have to be closer than one-forth the distance we started with in order to get that 14 db improvement! (In our case, we'd have to move from 15 miles to 3 miles which would put us on the slopes of the mountains...)

As you might suspect, we have neither the budget or the physical space required to accommodate such a power level.

On the other hand, if someone were to put up a relatively small 70cm yagi (say, a 5 element yagi - which would be about 2 feet long) you'd end up with a gain of about 11 dbi or so. At the antenna you'd get a signal strength of approximately -11 dbmV (about 280 microvolts) at the location above. With this much signal from the antenna, we could lose 4 db in our coax (nearly 100 feet of good quality RG-6 coax) and **still** have as much signal as we'd get if we were to "up" the repeater's power to 1500 watts and using our rooftop VHF/UHF antenna.

Concluding conclusions:

If you **do** want to watch ATV, you probably **won't** get a decent signal from your rooftop antenna unless you live **very close** to the repeater and you do not have excessive feedline loss caused by splitters. If you have a TV signal amplifier (especially an inline antenna-mounted type) then you may get some pretty reasonable signals if you are in the Salt Lake valley. Don't forget that if you have line-of-sight to Farnsworth Peak, even a fairly modest (10 element) 70cm yagi will work pretty well anywhere in the Provo to Ogden area.

While the WB7FID repeater will be improved as time goes on, chances are that we will not be increasing the power so much that there will be a "night and day" difference. The best "bang for the buck" can be had by a small-to-modest investment, by the person who wishes to look at the ATV repeater, in antenna and feedline. From Ogden to Provo the signals are strong enough that a relatively small beam (a homebrew antenna, for example) fed with a reasonably short run of coax will result in very good pictures - and even these can be improved upon with only a bit more effort!

For further information about signal strength in various areas along the Wasatch Front, go to the Receiving the WB7FID ATV Repeater At Your QTH page.

ATVQ

Sue Miller, W9YL, SK

Sue Miller, W9YL, wife of Don Miller, W9NTP, passed away on November 10, 2000 from a heart attack. Everyone in the ATV/SSTV Amateur Radio Community will feel the loss. Sue worked with Don to provide outstanding service to all of us.

Don sent me the above QSL card. He says "Sue has always been supportive to my experiments o SSTV. The picture on the QSL card was the first picture sent around the world via Australia by relay. This happened back in the sixties."

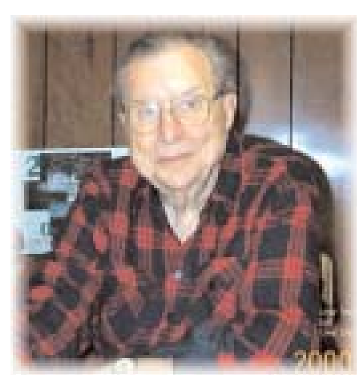
He went on to say, "She had been a ham since 1947. We were married in 1946 and she took the tests from Class B license through the Extra class. Her picture was in several magazines when the Russians sent up Sputnik. I built a spiral antenna that had to be turned with a pipe wrench. She was pictured turning the antenna with the wrench. She was named the 'armstrong rotator'."

All of us at ATVQ send our sincere sympathy. We will miss seeing her smiling face at hamfests. God be with you.

ATVQ

Lew Tepfer, W6FVV, SK

Mister IVCA, Lew Tepfer, W6FVV, died December 22, 2000 as a result of an automobile accident. Memorial services were held at Lake Shastina Community Church, Lake Shastina, CA on December 28th. I first met Lew at the Dayton Hamvention in, I believe, 1993, when I introduced SSTV with the Sound Blaster. Lew always had words of encouragement and was one of the most friendly people that I knew.

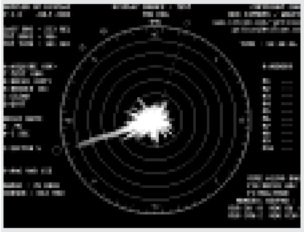


Lew "Mister IVCA" will be missed by his wife Lila and the SSTV ham community throughout the world.

God Bless.

ATVQ

An Electronic Compass With A PIC Serial RS232 Interface



by Robert Simmons WB6EYV - email: pelican2@silcom.com
1445 harbor View Dr. 138
Santa Barbara, CA 93103

Introduction

This article describes an electronic compass with a serial RS232 interface, achieved with a PIC 16F84 microcomputer. The compass is an OEM "module" manufactured by Precision Navigation, (model V2X) and available from Jameco Electronics for US$50. Display software for the resulting RS232 message is available (free) on the web, at the author's homepage.... it runs on an IBM PC, and allows the user to select the serial COM port employed. Source code for the PIC chip is provided here, as well as a schematic diagram and an explanation of how to modify the code to achieve any desired RS232 message format.

Background

This compass is actually part of a larger project, which includes a Doppler - type VHF direction finder (Doppler "DF") intended for mobile operation... The compass was added to the original DF design to provide automatic updates of any changes in vehicle heading, so the display software could "adjust" to these changes, without any manual input of vehicle heading from the equipment operator.

The PIC code described here generates an RS232 message which "disguises" the compass heading as an "Agrello - format" DF message, which is fairly popular in the DF community. This PIC program was originally written to test / demonstrate (to myself) that I understood enough about the compass module to operate it, and extract meaningful information from it...

At the time, I already had a display program that could display Agrello DF messages, so the PIC program described here allowed me to test and develop the PIC software for the compass. The display program generates a "radar screen" display, in which compass information is "painted" as radial lines. A "bug" located on the outside edge of the azimuth scale indicates the last reported DF bearing. (in this case, the last reported compass heading)

Later, I "merged" the resulting PIC compass code into the PIC DF measurement code (described on the website) so that the resulting RS232 message contained both DF information (relative bearing) and compass information. (magnetic heading) I created a new version of the display software to employ both items of data, resulting in a "radar screen" display in which the compass automatically drives the azimuth scale, (and everything displayed on it) and automatically corrects for any changes of vehicle heading.

This article contains the "compass only" version of the PIC source code, and provides a website link to download the display software that I used to test it. The display software is written in MSDOS QuickBasic 4.0, and has been compiled into 85K of IBM code with an "exe" file extension, which downloads in about 2 minutes. The QuickBasic source code is available on request from the author, for free.

The Compass

The compass is an OEM "module" manufactured by Precision Navigation of Santa Rosa, California. They manufacture a variety of inexpensive electronic compass devices, mostly for after - market sales in the automotive community. This particular compass has been around for quite some time, and has been the subject of articles in various hobby magazines, particularly in amateur robotic applications.

Their website address is :

http://www.precisionnavigation.com/vector2/xmain2.html

A detailed description of the compass is available at this web address :

http://www.precisionnavigation.com/techpage2.html

The compass can be purchased for US$50 from Jameco Electronics, p/n 126703. Their website address is :

http://www.jamco.com

The PIC 16F84 chip is manufactured by Microchip Corporation, Tempe, Arizona. This particular chip is (according to Microchip's information) their most popular model of microcomputer, and many, many articles have employed it in a wide variety of applications. Microchip PIC devices have spawned a whole subculture of computer hobbyists, who find the PIC devices easy to program and use in a wide variety of applications, all over the world.

The company provides very detailed and specific information about all their devices, on the web.

Their home page web address is :

http://microchip.com

A very detailed and complete data sheet (124 pages long) for the PIC 16F84 is available on the company website as a downloadable ".pdf" file, at this address :

http://microchip.com/download/lit/pline/picmicro/families/16f8x/datasheet/30430c.pdf

A CDROM copy of the entire Microchip website can be requested (for free) at this address :

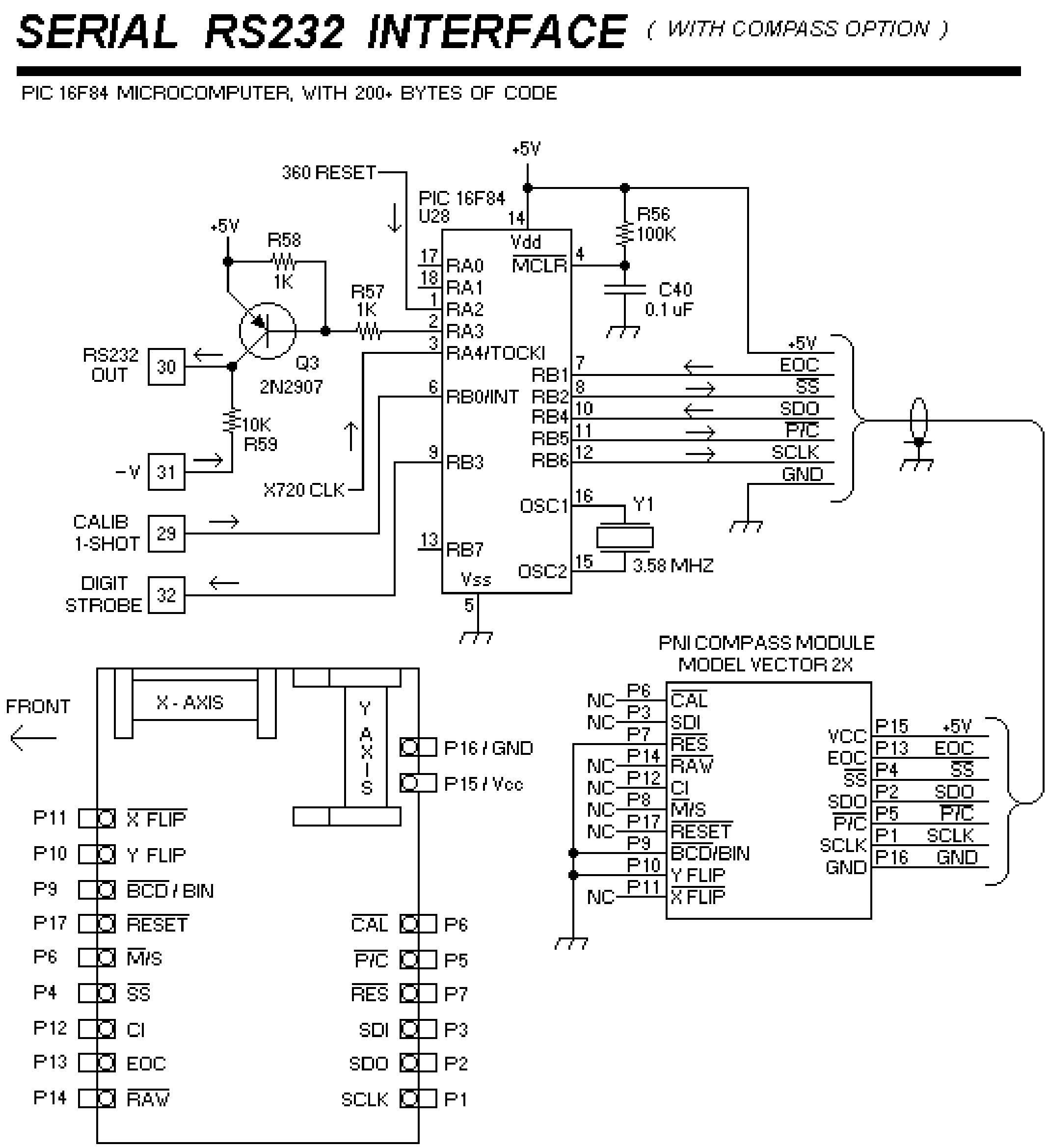
http://microchip.com/10/lit/request/index.htm

This CDROM includes all the data sheets for all the devices that Microchip manufactures, and it is very worthwhile to have, since it eliminates the long time delays associated with web downloads. It is (as far as I can tell) a verbatim copy of the website.

The Schematic

Here is the schematic diagram of the compass / RS232 interface. Negative supply voltage for the RS232 link is "robbed" from the TXD line of the host computer, which is (otherwise) ignored.... this eliminates the need for an "onboard" negative supply.

The circuit is simple enough to be constructed with point - to - point wiring or wire wrap methods, on 0.1 x 0.1 inch perf board.



In this software, the parameter Y is fixed at a value of 7.

The message is transmitted at 1200 baud, with 7 data bits, no parity, (bit 8 = 0) and two stop bits.

The code that determines exactly what characters are transmitted is located in the routine called ASCOUT, and this routine can be modified by the reader (if desired) to generate different message contents.

The code that determines the “bitwise” format of each ASCII character is contained in the routine called SEROUT, and this code can be modified by the reader to change the parity bit and / or the number of stop bits, etc.

The actual baud rate is determined by a software timing loop, using the value of a quantity called BAUD, located in the symbol table at the bottom of the code... the value of this variable is used in a software decrement loop, to determine the amount of time for each individual bit of transmitted data... larger numbers yield slower baud rates, and vice versa.

Be aware that the baud rate does not follow an exact “inverse law” curve for this value... cutting the value in half will not exactly double the baud rate, due to timing “overhead” caused by additional (necessary) instructions in the decrement loop... it will probably be necessary to “fine tune” this value experimentally, or with o-scope observations of the output data, if it is changed.

The present value of this quantity is close to the maximum value that can be expressed with a single byte of data, so baud rates slower than 1200 baud will require significant changes in the delay routine, to accommodate multiple byte time delay values. Another method can be used to avoid this... the baud rate is sensitive to the microcomputer’s crystal operating frequency, and the present design employs a 3.58 MHz “color burst” crystal... using a crystal with a lower frequency will allow slower baud

The Source Code

This section contains a listing of the PIC source code. The RS232 message complies with the spec for Agrello DF messages :

%XXX/Y(cr)

Where % = ASCII percent sign
XXX = ASCII DF bearing :
BRG X100 degrees
BRG X10 degreees
BRG X1 degrees
/ = ASCII fraction bar sign
Y = ASCII DF signal quality, ranging from 0 to 7
(cr) = ASCII carriage return

rates without altering the decrement routine, but (of course) the value of BAUD will have to be adjusted.

Changing the crystal frequency should have no other effects on the operation of the compass... the PIC chip spends most of its time "waiting" for the compass to calculate heading information, and (therefore) only produces 5 to 10 compass messages per second.

The source code listing may be retrieved from:

http://www.silcom.com/~pelican2/COMPASS1.asm

The Display Program

The display program is written in Microsoft QuickBasic 4.0, which is obsolete and no longer supported by Microsoft. Still, it is a very popular and simple language, and versions of it can generally be found on the internet for amounts ranging from $10 to $50... Get the books if possible, they contain many examples that are worth having. If you have Windows 95, there is a very old copy of it (ver 1.1, I believe) on the backup CDROM provided with the OpSys... it is located in the CDROM directory called OLDMSDOS.

You do not need the QuickBasic software to run the display program, but you will need it if you want to modify it... the display program available on my website is already compiled into an MSDOS program with an ".exe" file extension, so it starts up and runs like any other ".exe" file. If you want to modify the program, you will need to contact me via e-mail to obtain a (free) copy of the source code for it.

The display program has a "simulation" mode that allows it to be operated without any external input data, so the user can become familiar with its features and operation... after the user selects the baud rate and COM port, the program automatically " boots up" in the simulation mode. External data can be selected by turning off the SIMULATION function, by hitting keystroke "T". (for test)

The display program (filename : Doppler31.exe) can be downloaded from my website at this web address :

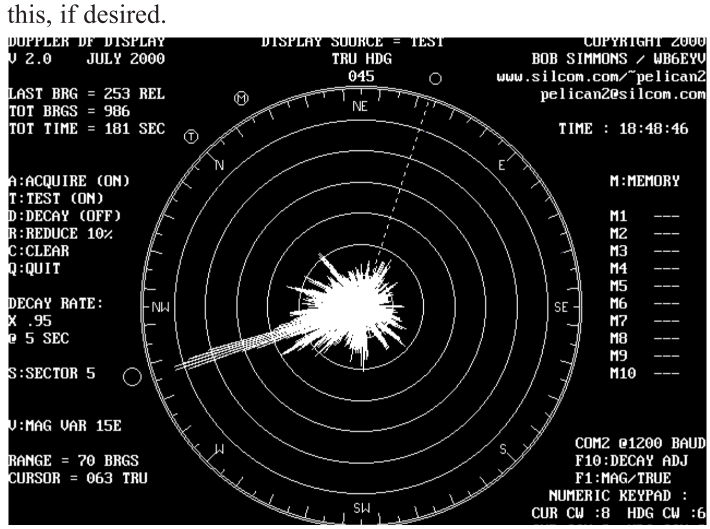
http://www.silcom.com/~pelican2/DOPLER31.exe

Here is a screen shot of the display program... Bear in mind that this program was originally written to display Doppler DF bearings, NOT compass information, so there are many features available here that are meaningless for a compass display....

The radial lines represent historical DF "vectors" and the length of each vector is proportional to the number of DF reports on that particular heading. (in this case, the number of "compass reports" on a particular heading) A large empty circle on the outside of the azimuth scale represent the most recent DF report or (in this case) the most recent "compass heading" report. More information about the display program is available on the website.

If you want to use another display program, you can also use the Windows HYPERTERMINAL utility program, which is included in the Windows OpSys. It is located in the STARTUP menu section called ACCESSORIES... this is a utility program that allows the computer to be used as a "dumb terminal" for interface with other external devices... To use it, you must "create" a "new" connection by giving it a name and selecting an icon for it. Once this is done, it must be configured for the right baud rate, number of data bits, etc, and the port must be selected to the appropriate serial RS232 COM port... when operating, it will display a text printout of the exact message text being received at the COM port... this is the utility program I used to originally get the PIC RS232 serial port running properly.

If you use this program, be aware that the PIC transmitted message contains no line feed characters, so the displayed message will "overwrite" itself on the same line, without advancing to the next line after each message... There is an option in the HYPERTERMINAL program that will automatically append line feeds to carriage returns, which can be invoked to achieve this, if desired.



P. C. Electronics 2522 Paxson Lane Arcadia CA 91007-8537 USA

Tel: **1-626-447-4565** m-th 8am-5:30pm pst (UTC - 8) Tom (W6ORG) & Mary Ann (WB6YSS) O'Hara
24 hr FAX order line 1-626-447-0489 Email: tomsmb@aol.com
Web site: http://www.hamtv.com

Antenna Mounting ATV Downconverters

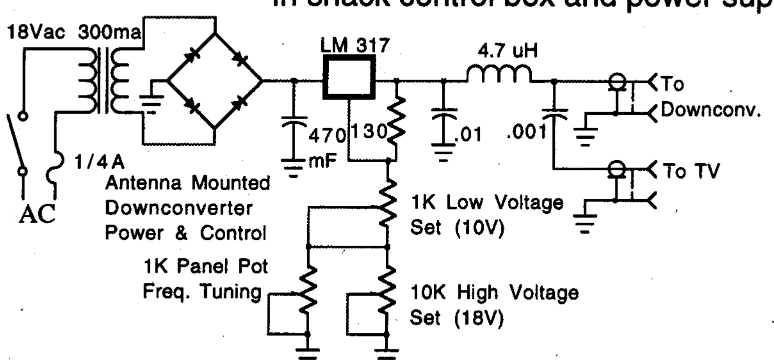
For optimum sensitivity, the first preamp stage in a receiving system should be placed directly at the antenna to avoid the coax loss. The first stage should be the lowest noise device in the system and can either be part of the downconverter or a stand alone preamp. There are some pluses and minuses to antenna mounting downconverters vs just a preamp vs low loss coax..

The Pluses: It is more important to minimize coax loss with FM ATV systems than AM ATV since the picture to noise ratio changes more rapidly. With AM the picture to noise ratio is dB for dB with 6 dB being one P unit or half the distance for the same picture to noise level. An acceptable rule of thumb has been 3 dB or less coax loss or greater than 100 ft of Belden 9913 or LMR-400 on the 70cm band for instance, before considering expending time and money on an improvement. With FM it depends on the modulation index and how good the limiter is - given the 4 MHz deviation standard we use on the 902 through 2400 MHz bands and poor limiting found in today's IC PLL or quadrature detectors it is about 2-3 dB for each dB of coax loss. The higher bands have much more coax loss so having the first stage as close to the antenna as possible is much more significant. Many may try ATV by first getting a down converter and antenna to receive the local repeater output. If everything practical has been done with antenna gain and positioning and the picture still has some snow in it, then eliminating the feed line loss is the next step. If the repeater is crossband, and you don't have to transmit on the repeater output band, then just adding an antenna mounted preamp might be the best way to go. If you don't mind a little solder slinging, then you can repackage the downconverter board in a weather proof box for antenna mounting and build a DC coupler/ control box. The coax to the shack can be hundreds of feet of RG6 which has little loss at ch3 and which the converter gain has overcome. To transmit on the same band, you must add the complexity of T/R switching.

The Minuses: Primarily it is cost, complexity and reliability. As mentioned, if you want to transmit on the same band, you need to build in a RF T/R relay system. RF coax relays for UHF and above are not cheap and you need to sequence the DC and RF so that you don't transmit into an open coax for too long and that there is enough isolation between the two relay ports such that the transmitter does not blow the preamp. Max RF at the preamp should not exceed a few milliwatt's.

Effective weather proofing is important so that moisture does not get in and ruin the circuit. The box generally needs to be constructed to have seams and connectors only on the side pointing to the ground. Temperature is also significant especially in areas with weather extremes. Most ham gear is not designed or even tested to see how it does below freezing - a proportional resistive heater is some times used in this case. With tunable downconverters the LO frequency will probably drift and require slight frequency dial adjustment every 10 degrees of outside temperature change or so - this may or may not be a source of annoyance. The TVC-2G only drifted 340 kHz from 75 down to 5 degrees F which is in the range of most TV AFC's if tuned in the center. Higher bands will shift more.

In shack control box and power supply



The downconverter board from the TVC-4G, 9G or 12G can be removed and the control box built using the old chassis box and many of its parts - it uses a CAB234 box.

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

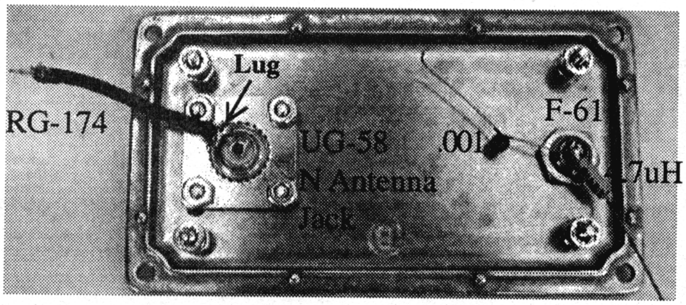
PC ELECTRONICS

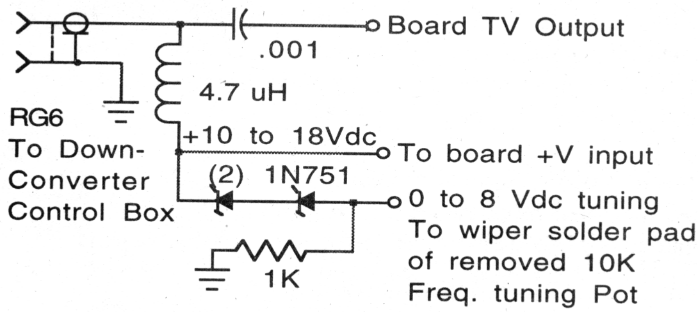
Antenna Mounting ATV Downconverters, Continued

Repackaging:

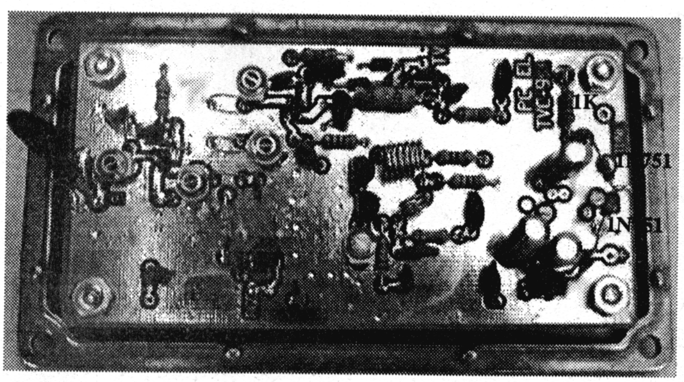
Shown below is a TVC-9 902-928 MHz tunable downconverter built into an Eagle 4591 die cast aluminum box. All holes are in the cover so no moisture can get in when mounted facing the ground. The board is first placed and centered on the inside of the top cover. This way the 4 1/8" dia mounting screw holes can be marked and then drilled accurately. Then drill a 1/8" pilot hole directly between the two board mounting holes at one end for the F-61 jack. On the other end drill the pilot hole in-between but about a 1/2" in from the line between the two board mounting holes. Finish drilling the F jack to 3/8" and on the other end the UG-58 N jack to 5/8". Place the UG-58 jack in the hole and mark and then drill the 1/8" diameter holes for the four 4-40x5/16", lock washer and nut.

Wrap one end of a .001 mF disc cap and a 4.7 uH inductor around the center pin terminal of the F-61 jack as close to the insulation as possible and then solder. The cap lead must be long enough to reach the TV output of the board and the inductor to the + voltage input. Cut off the excess terminal as close as possible to the wires. This is necessary to clear the bottom of the board. Mount the UG58 jack and use a solder lug under one of the outer mounting nuts and pointed toward the center pin terminal. Cut a piece of RG174 50 Ohm coax to about 2". Strip the outer insulation back 1/4 inch and fold back the braid. Strip the center conductor 1/8". Place one end through the solder lug hole and solder to the center terminal. Flair the braid around the solder lug and solder them together. Check for shorts.





On the downconverter board, remove the old tuning pot wires and the bandspread 10K trim pot. Twist and solder the two 1N751 Zener diode leads together then solder the cathode end of one to the extra hole on the + DC input trace and the other end to the wiper solder pad of the old tuning pot wire. At the extra solder pad next to the wiper solder pad add the 1K with the other end soldered to the ground plane.



Put in the four 4-40x5/8" board mounting screws and secure with a lock washer and nut. Then put a nut on each one and thread down about 1/4" from the end along with a lock washer. Place the board on the screws and put a nut on each down to where the screw top is flush with the nut, then tighten the respective nut on the bottom of the board. Check to make sure none of the connectors are touching the bottom of the board, then solder the cap, inductor and coax ends to their respective locations on the board. Check that there are no shorts on the F61 jack center to ground.

Preset the tunable downconverter control box by first turning the 1K frequency tuning pot to full CCW which is the lowest frequency and DC VCO voltage. Set the Low Voltage pot for 10Vdc out which will give zero volts to the varicap on the downconverter board. Then turn the frequency pot to full CW and set for the highest frequency which is 18Vdc. Connect the downconverter and reset the lowest frequency and highest frequency while receiving an ATV signal for the about 2 and 8 respectively on a 0-10 dial.

2000 FIFTEENTH ANNUAL ATV BANQUET LITCHFIELD, ILLINOIS 11-5-2000

Central Illinois/St. Louis Area ATV Club
Scott Millick K9SM - email: smillick@cillnet.com
907 Big Four Ave.
Hillsboro, Illinois 62049

With Halloween just past, the Central Illinois/St. Louis Area Amateur Television Club celebrated its fifteenth annual banquet. Chilly weather did not deter this dedicated group of ATV operators and their wives from another night of fellowship and meeting new members. The banquet was held at the Ariston Restaurant in Litchfield which is the central point for the club with members attending from the Champaign, Bloomington, Salem, Il., and St. Louis, Mo. areas. There were 34 members attending.

Activities began at 4 PM with Happy Hour and WB9QLY, Kathy Millick, registering the guests. As they arrived from the distant points members made and renewed acquaintances telling stories about their last years activities .

At 5 PM Scotty K9SM called the group to order. After a few announcements the clatter of dishes, glasses, and utensils and chit chat continued during the course of the main meal and dessert.

The tenth annual Central Illinois/St. Louis Area ATV Operator of the Year was presented to Floyd Hofmann, W9EX from Bloomington, Il. Floyd has been on ATV for several years is always around to help those who need it.

Gene Harlan, WB9MMM, and his wife Shari, N9SH, publishers of ATVQ Magazine, from Rockford, Illinois attended and Gene was the guest speaker. He provided some insights of ATV activities in other areas of the country that he had observed as well as a recent trip to Europe and their ATV activity. The story about the German TV production was particularly interesting. The group enjoyed his humor and information that he provided was appreciated by all.

The prize portion was next with the random draw for prizes and the famous heads and tails game for special restaurant certificates providing a lot of fun and laughter as well as exercise.

With all the prizes passed out farewells were said and everyone made their way home with the next banquet scheduled for November 2001. ATVQ

XYL of AA9MY, Lynn, AA9MY and K9KKL

W0DQY, K0PFX and KD9SG

K9KKL, K9QFR and K9IDQ
Note to K9KKL - Don't for get to write an article about amplifiers for ATVQ!

K9RRP with XYL, N9QIH, Pat

W9EX, KA9SZX, N9ABR and K9DAG

K9SM presenting ATV Operator Of The Year to W9EX, Floyd Hofman! Congratulations Floyd!

I would like to thank the Central Illinois/St. Louis Area ATV Club for inviting Shari, N9SH, and myself to join them for their fine get together. It was great meeting all the attendees and having the opportunity to chat, even if for only a short while!
Gene - WB9MMM

Beagle Software Releases ClockWatch for Windows Millennium Edition

MINNEAPOLIS, MN - January 2, 2001 – Beagle Software, America’s leading producer of time-synchronization software, has released it’s popular ClockWatch program for Windows ME (Millennium Edition). Beagle Software’s ClockWatch program, which synchronizes a customer’s PC clock to the Atomic Clock at the National Institute of Standards and Technology (NIST) in Boulder, Col., can be downloaded for a free 30-day trial at www.beaglesoft.com.

While the computer world seems to be safely beyond any Y2K problems, the start of the new millennium, which commenced on January 1, 2001, reminds the world how important time, and the keeping of accurate time, is in today’s fast-paced global environment.

PC Computing Magazine, recently discussing the poor accuracy of PC clocks, wrote, “The best solution [to this problem] is to install a time utility that adjusts your clock automatically using Internet servers calibrated to atomic time. Our favorite is Beagle Software’s ClockWatch.”

Besides its top selling ClockWatch software, Beagle Software also has an important presence in the business place with its DocuClock time/date stamper. DocuClock stamps the time and date on documents with an accuracy of within one second of the Atomic Clock, which is crucial to many business people, including securities traders who are regulated by OATS (Order Audit Trail System), requiring an accuracy of within three seconds of the Atomic Clock.

Beagle Software is located in Minneapolis, Minnesota. The company’s customer list includes top colleges and universities, financial institutions, utility companies, weather services, government agencies, media outlets, medical facilities and scientific laboratories.

For additional information on Beagle Software or the products that they offer, visit their Web site at: **http://www.beaglesoft.com** or call (612) 370-1091.

Kyle McNary

ATCO ATV Repeater on 1250 MHz DX

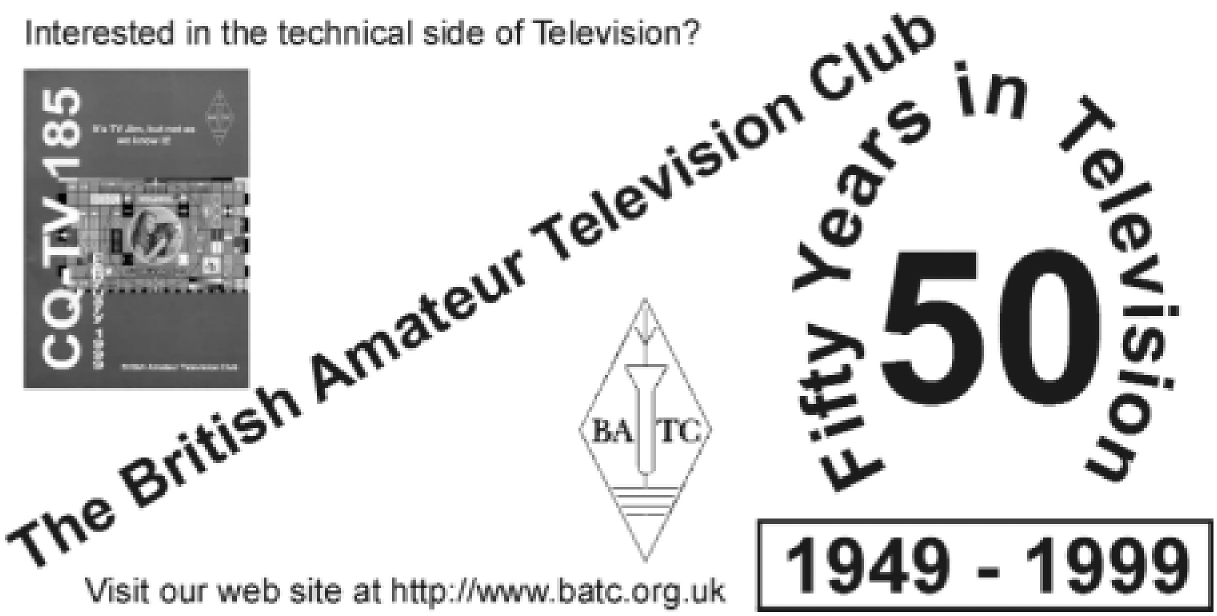
The ATCO 1.25 GHz FM ATV repeater was seen in Lynn, Indiana by KB9JGF, Bill. Thursday morning at 10:30 AM, January 11, 2000, Bill tuned his satellite C-band downconverter one channel higher (10 to 11). He normally monitors 1270 Mhz.

Much to his amazement, the W8RUT/R repeater was locked, in color, and a P-4 signal. Using his 439.25 MHz ATV transmitter, every time he keyed-up and then stood by, he observed the 1.25 GHz FM ATV repeater from Columbus, Ohio. The city of Lynn, Ind. is located 120 miles from Columbus, Ohio.

KB9JGF’s antenna for 23 cm is horizontally polarized; the W8RUT/R atv repeater has a vertically polarized omni antenna for 23 cm.

Reported by W8DMR

Bill Parker w8dmr@copper.net



Video ID'er Using PIC16F84 and BOB-II Video Text Display Module

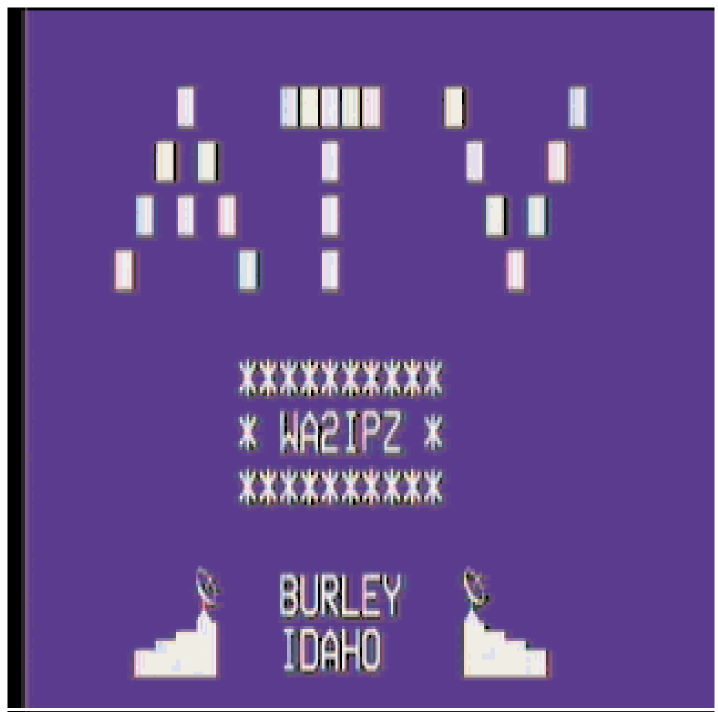
By Charles L. Stackhouse WA2IPZ - email : cstack@safelink.net
65 Vista Lane
Burley, Idaho 83318

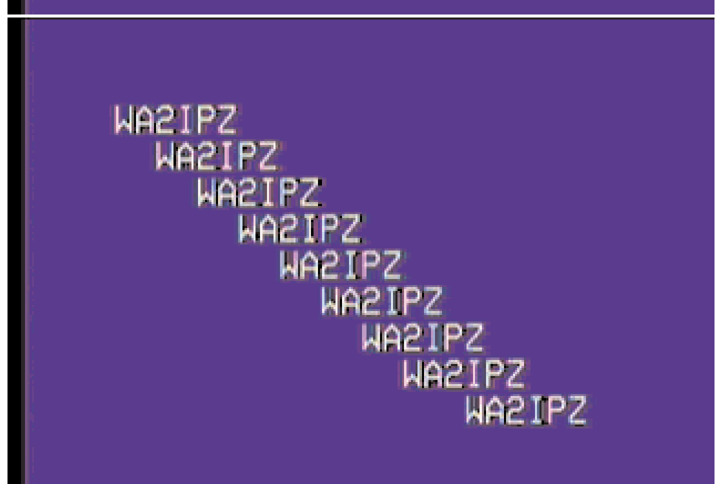
This easy to build video ID'er uses PIC 16F84 to generate a video ID screen using the BOB-II Video Text Display Module by Decade Engineering. The program has a built-in timer to activate the ID every 9min/45 secs. The ID consists of 2 screen displays, each on for 5 seconds. When the ID'er is displaying, one of the PIC ports goes "high" to signal another circuit such as a PTT line. Writing the program was greatly simplified by using a Basic Stamp2 microcontroller to design the graphics. The Basic program was compiled with PICBasic Pro to allow using the inexpensive PIC chip.

The Basic code and pictures of the 2 screen displays follow.

```
'——————-BOB2_ID.BAS——————————————
'Charles L. Stackhouse WA2IPZ Burley, Idaho
'This generates an ATV video ID screen that displays on BOB-II video text display module.
'The ID'er comes on every 9min/45 sec. Pin A.3 goes high to signal another circuit that
'the Id'er is active, such as a PTT line. Serial output is 9600 8N1 (non-inverted)
'on pin B.0 of PIC16f84 with 4MHz resonator or crystal.
'Compiled with PICBasicPro ver 2.3 on January 11, 2001.

INCLUDE "bs2defs.bas"

DEFINE DEBUG_REG PORTB              'Set Debug pin port
DEFINE DEBUG_BIT 0          'Set Debug bit=0
DEFINE DEBUG_BAUD 9600              'Set Debug baud rate
DEFINE DEBUG_MODE 0                 'Set Debug mode: 0=true, 1=inverted
DEFINE DEBUG_PACING 1000    'pause 1 millisecond between characters
TRISA=%10000                        'make PORTA all outputs except A.4
(PROGON)
TRISB=%00000000

'=== Variables and Constants ===
PROGON   var     PORTA.4            'Ground to trigger ID
i        var     byte
'==============================
_Start:
PORTA.3 = 0                         'initialize A.3 to ground

PORTA.3 = 1                 'pin A.3 goes high to signal another circuit when ID
is active

Gosub _INIT

Debug "   {Tc",$1B,"  {Tccccc",$1B,"  {Tc",$1B,"   {Tc",$1B,cr
Debug "  {Tc",$1B," {Tc",$1B,"   {Tc",$1B,"   {Tc",$1B,"  {Tc",$1B,cr
Debug "  {Tc",$1B," {Tc",$1B, " {Tc",$1B,"   {Tc",$1B,"    {Tc",$1B," {Tc",$1B,cr
Debug " {Tc",$1B,"   {Tc",$1B,"  {Tc",$1B,"     {Tc",$1B,cr,cr,"
{T__________",$1B,cr
Debug "     {T_",$1B," WA2IPZ"," {T_",$1B,cr,"     {T__________",$1B,cr,cr
Debug "    {Tn",$1B,"  BURLEY  ","{Tn",$1B,cr,"  {Ttuvw",$1B,"  IDAHO","
{Twvut",$1B,cr
Pause 5000

Gosub _INIT


Pause 10
Debug cr," WA2IPZ",cr,"  WA2IPZ",cr,"    WA2IPZ",cr,"      WA2IPZ",cr,"
WA2IPZ"
Debug cr,"         WA2IPZ",cr,"           WA2IPZ",cr,"             WA2IPZ",cr,"
WA2IPZ"
Pause 5000

Gosub _INIT:

PORTA.3 = 0                         'Ends signal on pin A.3

For i=1 to 9                'Times on/off cycle at 9min/45sec
        Pause 65000
Next I
Goto _Start

_INIT:
        Pause 10
        Debug "{A"                  'Clear Screen
        Pause 10
        Return

End
```

ATVQ





Icom R3 - Review

If you haven't noticed it yet, you should!

The Icom R3 is a pocket sized wide band monitor-scanner receiver. It covers from the low end of the AM broadcast band to 2.45 GHz. That's Gigahertz! It has several receive modes including NBFM, WFM, AM and TV. It also has HAM TV mode.

The TV mode works on all the VHF and UHF broadcast channels and the band coverage also covers 440 ATV. The HAM TV mode is FM video. It is available from 900 MHz and up. In addition, the subcarrier frequency is adjustable, so you can optimize the audio for your location.

While the book is over 60 pages, it is not difficult to operate once you understand the basic menu functions. Most functions are selected by first choosing the menu, then using a 4 way front panel button to make the selection. For those of us who inherently hate menu menu menu operation, it was surpassingly easier than many other scanner radios or ham radios that are overloaded with seldom used features. In many ways it is similar to the Icom 706 MK II G unit in the menu layout. One item I did not find is a sensitivity spec for the receiver. The book does list the 11 frequency bands (continuous coverage broken into segments).

Two nice features not usually found on such an inexpensive unit ($479 at AES) are spectrum analyzer and direction finding. Fox hunters rejoice! The spectrum analyzer is a bar graph of amplitude vs frequency. While simple, it is useful. Not as useful as a more sophisticated unit we might expect on an HF rig, but easy enough to find open or used frequencies. The directional finder is a signal strength vs time display. Thus as you rotate a directional antenna, the display saves "slices" of signal strength. By corresponding the antenna direction with the amplitude of the display, you have a crude direction finder. For those who prefer an "S" meter, and peak in that way, you can do that too using the signal level display. The advantage of the DF display is if there are multiple peaks, you can see which one was the highest or look for the deepest null if you are using null rather than peak reference.

The unit has tons of memory. One odd item I found was the TV mode for broadcast only has 10 memories (there are 14 full power and 9 LPTV stations in Chicago, so I guess I'll have to leave a few off)! yet 50 (fifty, count 'em) ATV memories! ATV must be immensely popular in Japan! (900-2450 MHz). There are also 25 separate scan modes from selected stop-start frequency, to band scan to complete dc-light scanning including several skip modes so you can skip over memory or VFO frequencies you do not have interest in.

The upper range should also be useful for the ham 2.4 Gig band, and also the ITFS, and BAS news channels in the 1800-2400 range. I will have to check on the 2 gig ENG system to see if the bandwidth is enough to capture the wide band FM we use in broadcast, it is wide enough for 4 MHz deviation HAM TV FM mode. If its truly wide, it may also serve for a demod for satellite receivers that output in the 900-1300 or lower range. You could also add a simple converter for frequencies above 2.45 Gig, to convert into the R3's range, saving a lot of effort. The R3 has audio and video outputs using a mini plug.

Battery time is a bit short! A little under 2 hrs using the supplied lithium-ion battery, and just under an hour using regular AA cells (three). Resembles the Icom GPS unit of several years back in this regard.

It also has "pager" operation using beep tone to alert signals using subaudible tone squelch, and you can also program in SA tones to ignore traffic on channel that is not from a desired tone squelch source. There is tone scan to find the SA tones if you don't know one is in use. There is also duplex and offset frequency modes to help scan repeater operations.

The unit has two video displays, one black and white and one color. Color uses a little more juice. They are stacked so the window only shows the one. The function toggles between the two displays.

The unit is shirt pocket size, and comes with a belt clip. The problem I have is the telescoping whip is on the body side of the box, and since I have some personal overhang, this pushes the antenna out into space where it can get whopped.

One of the nicest features of the R3 is a genuine BNC connector for connection to an outside or external antenna. This makes home and mobile use very enjoyable.

While the sensitivity figures are not provided in the manual, I compared the UHF TV reception to my old Radio Shack (Casio) pocket TV. For reference, the Casio picks up the Chicago ATV repeater at home about P3 on its own whip antenna (55 miles folks!) Unfortunately, the repeater is down for modifications and improvements. So I used the two to compare reception of the on Sears (55 miles away). The RS/Casio was a P2-P3 at best. The Icom R3 was much better, I rate a P4 picture. Much less noise in

Continued on Page 42

ADVERTISERS INDEX

Please mention that you saw it in
Amateur Television Quarterly!

Continued from Page 40

the video (not a function of resolution since the older Casio-RS has less from its LCD screen) and color was much stronger. The RS also picks up my commercial channel 44 signal in downtown Milwaukee (90 miles) on its whip antenna. I'll test the R3 next time I visit AES in Milwaukee and see how it differs. The aircraft band was also better at receiving than an older Radio Shack ac-dc Pro series scanner! radio. I couldn't tell any difference in FM mode, once you hit limiting, there is no difference and I had no immediate way of testing SINAD. Likely a useless number since it has to vary with frequency in any wide-band (and this is certainly that) RF device. There were a few birdies in the ham bands I checked, but none in a fast search seemed to fall on any valuable channels, i.e., not 144.34!

The accessories arrived and the desk charger and other toy enhances are very nice. The cloning software and cable will come in handy if you buy several for club or buddy operation.

Accessories include a cloning cable, earphone, desk top charger, auto power cord, etc., for additional cost.

I like it so much, I bought two!

73 - Henry AA9XW - a9xw@cs.com

ATV RFI Filters

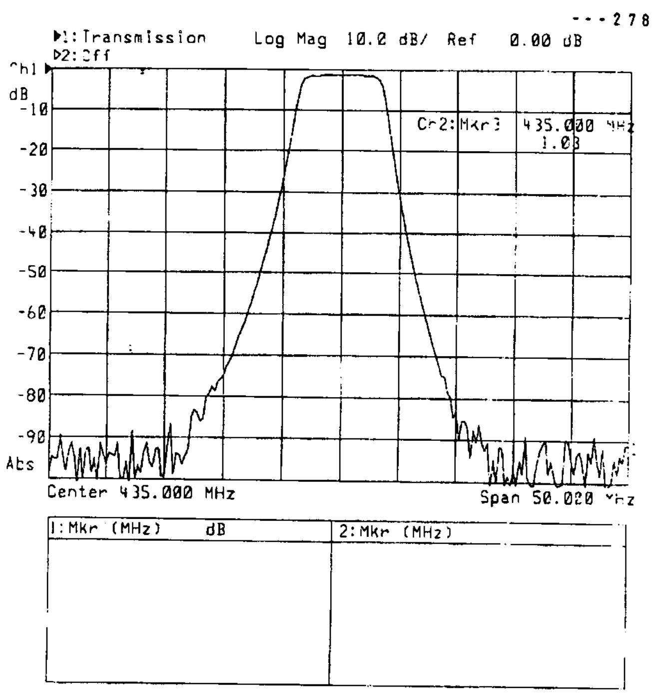
Custom tuned to your video carrier frequency

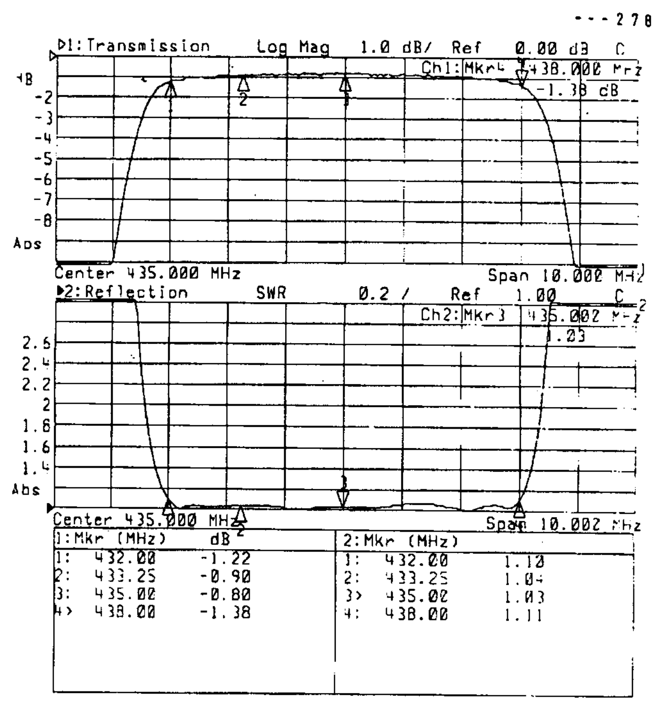
Improve your picture quality by reducing interference from pagers and other sources of RF near your reception frequency. On transmit, your signal bandwidth will be reduced so you don't interfere with other services.

DCI bandpass filters are solidly constructed from extruded aluminum and brass. DCI filters are passive and can be used in both the TX and RX pass. They are DC grounded on both inputs and outputs for additional lightning protection. Power rating is 200 watts for a 6 MHz bandpass.

Configuration	8-pole In-line	8-pole Folded	8-pole Rack-mount
Weight (approx)	12 lbs.	12 lbs.	14 lbs.
Dimensions (inches)	24 x 3 x 8	12 x 6 x 8	19 x 6 x 8

The graphs below show the characteristics of a typical DCI 8-pole ATV filter with a video carrier frequency at 433.25 MHz. We make similar filters for 900 and 1200 MHz.





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