Boulder Amateur Television Club
TV Repeater's REPEATER

July, 2023
4th edition, issue #137

BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

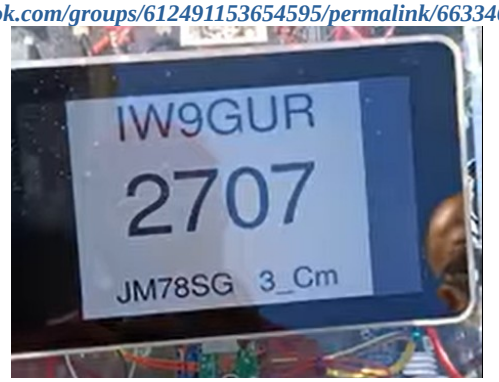
Jim Andrews, KH6HTV, editor - kh6htv@arrl.net www.kh6htv.com

899 km on 3cm DATV !

Hi Jim, my name is David IW9GUR. Last July 9, during an Italian DATV contest "CONTEST ATV TRIVENETO" I managed to make a bidirectional DATV connection in 3cm with the IZ5TEP station from Sicily to Liguria covering a distance of 899km. I'm sending you the link to view images and videos on the NET ITALIA Facebook page. if you want to highlight this news in your newsletter, you will find the details of the link in the post. thanks

73 de IW9GUR, David

https://www.facebook.com/groups/612491153654595/permalink/663346201902423/



DIGITAL TELEVISON - 1960

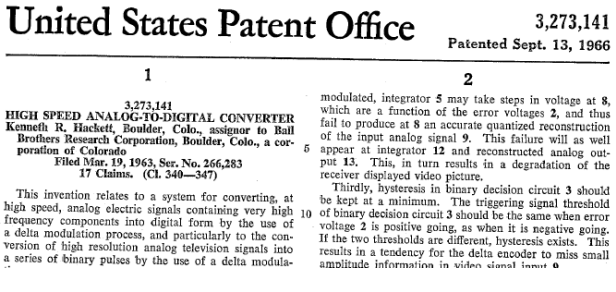
I (Jim, KH6HTV) play tennis with lots of older, retired fellas. Everyone of them has an interesting background from many different careers. Recently, I found out that one of them had actually worked on developing a scheme for digital TV way back in 1960. Ken Hacket was a recent college grad at the time. He first worked for a couple of years at Lawrence Livermore Labs in California. Then he took a job in Boulder, Colorado working for a new aerospace company here called Ball Brothers Research Corp. The company is still in existance today in Boulder and is now called Ball Aerospace & Technologies Corp. They produce space systems engineering products, telecommunications technology, electro-optics and cryogenics materials for government and commercial customers. For Ken's first job with Ball he was assigned to a group developing digital TV. Here is Ken's own story.

"Our digital TV back the 1960s was quite primitive compared to what they are doing today. The primary purpose was to digitize TV so it could be encrypted and yet produce a useable picture for military briefings between facilities in a region. Mainly around Washington DC via microwave links.

In those days there were no microprocessors and large fast memories. And no integrated circuits of any kind. There were large mainframe computers, but they were impractical for our use. Because of the unavailability of memories fast and large enough to store a single frame of video, we could not even think about manipulating the image like MPEG which had not been invented yet. We operated in real-time using delta modulation or delta-sigma. We simply transmitted one bit at a time: 1 was an increment up, 0 was an increment down. A constant level of grey would produce a series of 1s and 0s. The resulting image reconstruction was pretty rough by today's standards. However, the eye and the persistence of the phosphor on the video screen did a remarkable integration job providing a useful, relatively noise free image.

We started out with a system operating at 10 Mb/sec; later 30 Mb/sec. Finding components that operated at that speed then was challenging. We had to make a 1/0 decision within one bit period. We found the only thing that was fast enough then was a tunnel diode.

I have attached a copy of the patent that was issued for the A/D converter we developed. It was developed in about 1960-62. The patent was issued in 1966. There is a painful amount of detail in it. As you can see, all we had to work with was discrete components. In any of our literature we had to be very careful to not use the word "encrypted". We were absolutely forbidden to use it. We could use "scrambled". It's kind of funny nowadays since that word is used everywhere."



United States Patent Office 3,273,141 Patented Sept. 13, 1966

1

3,273,141
HIGH SPEED ANALOG-TO-DIGITAL CONVERTER
Kenneth R. Hackett, Boulder, Colo., assignor to Ball Brothers Research Corporation, Boulder, Colo., a corporation of Colorado
Filed Mar. 19, 1963, Ser. No. 266,283
17 Claims. (Cl. 340—347)

This invention relates to a system for converting, at high speed, analog electric signals containing very high frequency components into digital form by the use of a delta modulation process, and particularly to the conversion of high resolution analog television signals into a series of binary pulses by the use of a delta modula-

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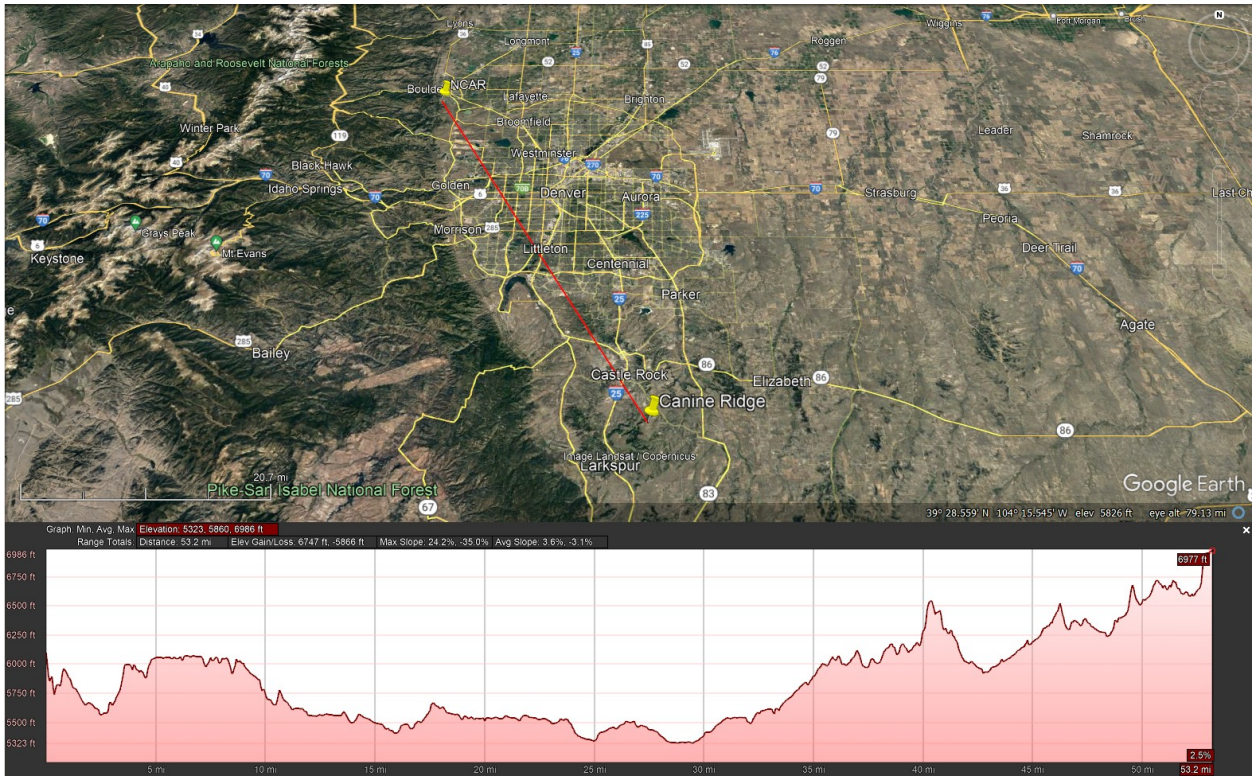
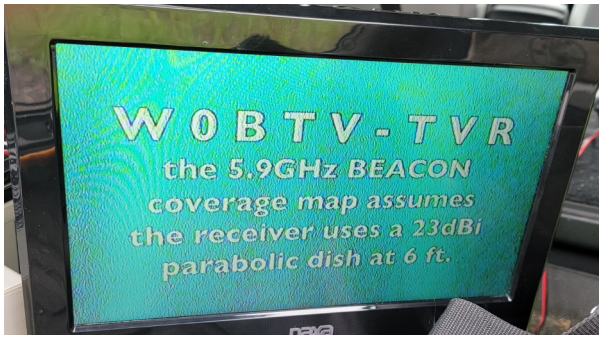
modulated, integrator 5 may take steps in voltage at 8, which are a function of the error voltages 2, and thus fail to produce at 8 an accurate quantized reconstruction of the input analog signal 9. This failure will as well appear at integrator 12 and reconstructed analog output 13. This, in turn results in a degradation of the receiver displayed video picture.

Thirdly, hysteresis in binary decision circuit 3 should be kept at a minimum. The triggering signal threshold of binary decision circuit 3 should be the same when error voltage 2 is positive going, as when it is negative going. If the two thresholds are different, hysteresis exists. This results in a tendency for the delta encoder to miss small amplitude information in video signal input 9





view toward W0BTV from Canine Ridge

W0BTV, 5 cm, FM-TV Beacon seen at 86 km !

Gary, WB5PCB, has been doing some roving recently with his 5 cm ATV gear. Our Boulder, Colorado W0BTV-ATV repeater includes a 24/7 beacon transmitter on 5.905 GHz with a 2 Watt, FM-TV signal to a 10 dBi, omni-directional antenna. Today (7/18), Gary sent us this following report.
"Aloha, Jim. Well, I have the stuff in the car, so I figured I would do some testing from places other than Daniel's Park. And, to that goal, I stopped on my way home this afternoon at a spot that I thought might have a chance of receiving the 5.8 GHz beacon. And, I got a signal at 53.2 miles (85.6 km) between NCAR and what I call Canine Ridge. It's in a private community south of Castle Rock. If I can go any further south, it might be close to the Douglas and El Paso county border. Of course, I guess I could go to the top of Pikes Peak and have a good chance."

How to Build a Simple, Digital TV Repeater

The Boulder, Colorado ARES group BCARES was blessed for several years by having a member we called "Mr. Television". He was Matt Holiday, K0DVD. I guess his personalized vanity call sign gives away his main ham radio interest ! Matt was the resident TV expert and co-ordinator for all of BCARES's ATV operations. He also built and donated some of the DATV equipment. One of his biggest and most expensive donations was a portable, 70cm, DVB-T Repeater. We are reproducing here the instruction manual for Matt's repeater. This might give other ham clubs and ARES groups elsewhere some ideas on how to contstruct a similar repeater.

Unfortunately, the disasterous Boulder, Colorado fire of 31 Dec. 2021 (called the "Marshall Fire") which destroyed over 1000+ homes, also destroyed Matt's home. As a result, Matt pulled up stakes and has since moved away from Boulder. We were sorry to see Matt go.

To find out more about Matt, check out his web site at: ***https://k0dvb.org/*** Matt had started to document a lot about DATV and ARES there. Matt also put together several excellant training classes for members of BCARES to teach them both the fundamental theory of DTV and also the operational details of setting up and using the BCARES, DATV equipment. Copies of the power-point slides Matt prepared for ATV training classes in 2018 are available on the BCARES web site at: ***https://bouldercountyares.org/our-tool-bag/bcares-amateur-tv/***

BCARES

Boulder County Amateur Radio Emergency Services, Inc.

C/O Boulder County Office of Emergency Management
McCaa Communications Center
3280 Airport Rd.
Boulder, CO 80301

70 cm, Portable DVB-T Repeater

Instruction Manual

Revision: July, 2023 by KH6HTV

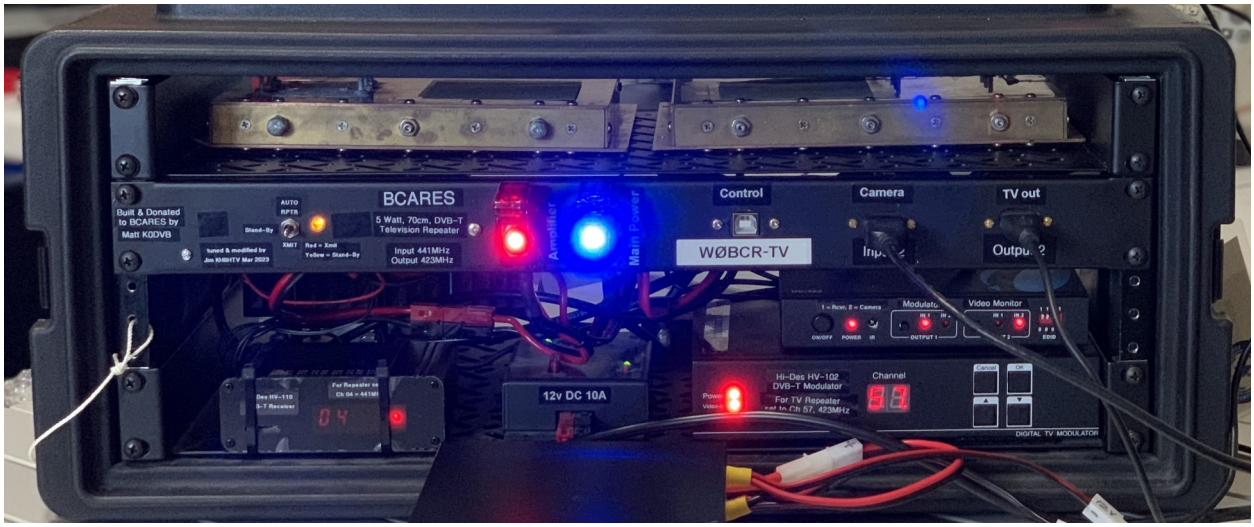


Fig. 1 Front Panel of the Repeater with the cover removed

BCARES has a digital Television Repeater which is portable and can be deployed to remote locations such as mountain tops. It was designed, built and donated to BCARES by Matt Holiday, K0DVB. The repeater is compatible with the BCARES digital ATV pack sets which were donated by the University of Colorado Police dept. It operates on the 70cm amateur radio band (420 - 450 MHz). The input frequency is Channel 06 (439 MHz, 6 MHz band-width 436-442 MHz). The output frequency is Cable Channel 57 (423 MHz, 6 MHz band-width 420-426 MHz). The repeater uses the European Digital Broadcast TV Standard called DVB-T. The repeater's output power is 5 Watts (average).

Note: *July, 2023 Revision consisted of changing the input frequency from 441 to 439MHz. This was done in an attempt to move away from some local RFI. It required retuning the input band-pass filter and reprogramming the receiver. kh6htv, 7/15/2023*

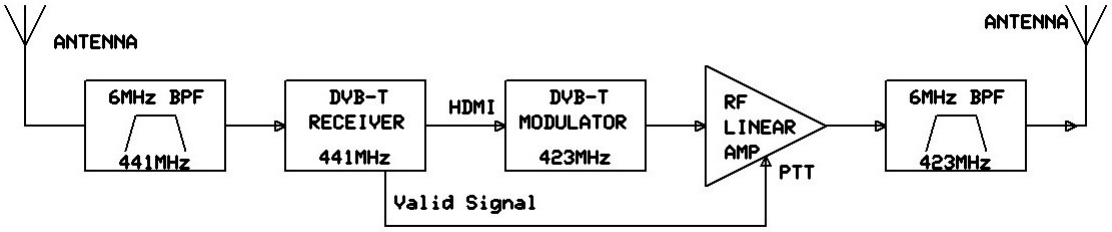


Fig. 2 70 cm, Digital TV Repeater, block diagram.

ANTENNAs: Fig. 2 shows the basic block diagram of the repeater. Note that it requires the use of two separate antennas. One for receive and one for transmit. Most typical 2m & 70cm FM voice repeaters use a single antenna and duplexer. The antennas must be separated from one another and not pointing at each other. See Fig. 3. Connect the antenna cables to the Band-Pass Filters on the rear panel, Fig. 4.

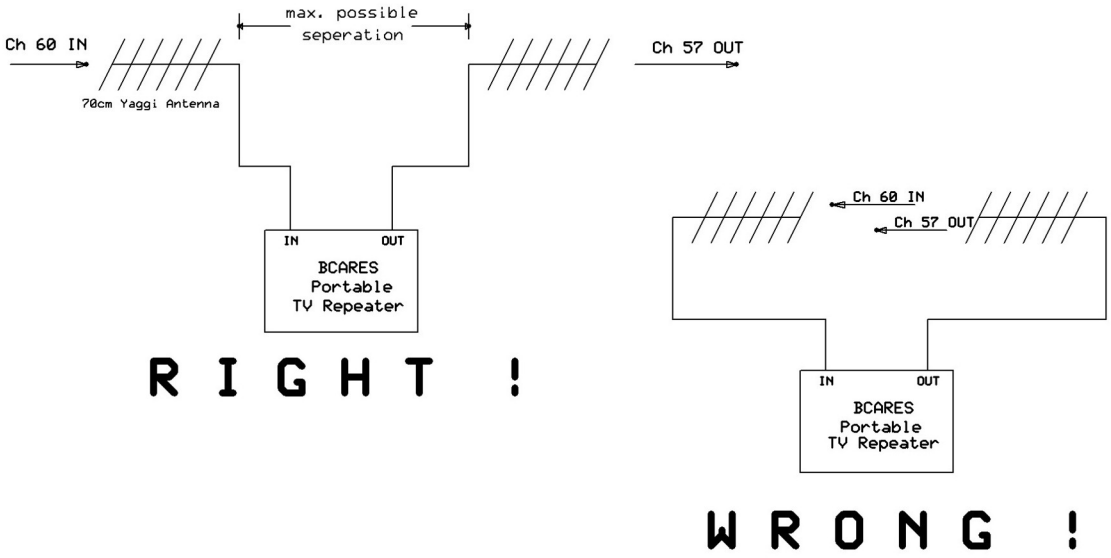


Fig. 3 Portable TV Repeater using Yagi Antennas. The secret to a repeater is high isolation between the transmitter and the receiver.

Fig. 4 Antenna Connections are found on the rear panel of the repeater.

DC POWER:

The repeater is run off of +12 Vdc power (+13.8V is OK). In stand-by mode, it draws 0.9 Amps. When transmitting, it draws 9 Amps. Connect a suitable power source to the front panel Anderson Power-Pole connector. It is located in the center bottom and labled "12V DC 10A".

The master DC power switch is labeled "Main Power". It is located on the front panel and covered with a blue protector.

Fig. 5 DC Power Connection

Optional Accessories:

If a video monitor is available, it is connected to the "TV Out" connector on the front panel via an HDMI cable.

If a TV camera is available for producing video locally at the repeater site, then it is connected to the "Camera" connector on the front panel via an HDMI cable.

The USB "Control" connector on the front panel is not used. It is only used for maintenance purposes to modify the digital parameter settings in the modulator.

Fig. 6 Front Panel - Right Side

VIDEO SELECTOR SWITCH: Also seen in Fig. 6 in the middle is an HDMI Video Matrix Switch. It has 2 inputs and 2 outputs. Output #1 goes to the repeater's modulator. Output #2 goes to the external video monitor. Input #1 is from the repeater's receiver. Input #2 is from the external video camera. Push buttons for each output select the desired input. LEDs show which input is selected.

IMPORTANT ! For normal TV repeater operation, the Modulator video output must be set to input #1, the Receiver.

If you want to transmit video from your local camera, then the Modulator video output is set to input #2, the camera.

OPERATION:

Fig. 7 Main Repeater Controls

The main repeater control panels are located on the small 19" panel. There are two, heavy duty, DC toggle switches labeled "Main Power" and "Amplifier". Set both of them to the ON position.

CAUTION: *Do NOT turn on the DC power until a proper antenna is connected to the transmitter. Failure to have an antenna connected will result in destroying the final RF power amplifier.*

The only other control is the 3 position, toggle switch seen in Fig. 7 on the left. The LED next to it shows the repeater's transmitter status. Yellow = Stand-By & Red = Transmitter ON.

For Normal Repeater Operation -- set the toggle switch to the up position, "AUTO RPTR". In this position, the transmitter is in stand-by mode until a valid digital TV signal is received. When the receiver recognizes such a signal, it puts out a "Valid Signal" logic which then automatically switches on the repeater's transmitter. When the signal disappears, the repeater turns off again. Remember, for repeater mode, you must also set the HDMI matrix switch output #1 to input #1, receiver.

For Local Repeater Operation --- When generating your own local video signal with your camera, you turn on the transmitter by setting the toggle switch to the down position "XMIT". Remember, if you want to transmit your own local video, you must also set the HDMI matrix switch output #1 to input #2, camera.

FCC ID: This is a simple repeater. It does not include a time-out timer, nor a squelch tail IDer, nor a Morse code IDer. However, the repeater is IDed continuously. As part of the digital information sent out along with video and audio is a meta-data file with information about the encoding used. The meta data also includes the transmitter's call sign. The repeater has been programmed with the BCARES call sign, W0BCR.

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SUPPLEMENTAL INFORMATION: (*not required for set-up and operation*)

Receiver & Modulator: The digital TV receiver and modulator are commercial units made by Hi-Des company in Taiwan (***www.hides.com.tw***). They are located on the bottom of the repeater. See Fig. 1. They have been pre-programmed and the user should make no changes to them. Do not touch their front panel controls. A remote control for the receiver is contained in a bag and must always be kept with the repeater. The receiver must be left on Ch 04 (441 MHz / 6 MHz BW). The modulator is programmed via USB with a Windows PC. The modulator must be left on Ch 57 (423 MHz / 6 MHz BW).

The receiver has been programmed to provide a 720P, HDMI output with a constant On-Screen-Display (OSD). It was programmed to receive the following channels: 01 = 423/6, 02 = 429/6, 03 = 435/6, 04 = 441/6, 05 = 447/6, 06 = 439/6 (repeater's input frequency), & 07 = 915/6 MHz

The modulator was programmed to have the following digital parameters: Frequency = 423 MHz, Band-Width = 6 MHz, Video encoding = H.264, Video resolution = 1280x720, encoding bit rate = 4.5 Mbps, QPSK modulation, 8K FFT, 52/3 code rate (FEC), 1/16 Guard interval. Audio encoding = MPEG2, encoding bit rate = 96 kbps, rf attenuation = -3dB.

Fig. 8 is a more detailed, overall block diagram of the repeater. Fig. 9 is the schematic diagram of the PTT control circuit for the rf power amplifier. Figs. 10 & 11 are the frequency response curves for the BPFs.

PRE-AMPLIFIER: The 70cm pre-amp was made by Advanced Receiver Research. (***www.advancedreceiver.com***) It is the model P432VDG. It uses a GaAs FET. It has 20 dB of gain. The advertised noise figure is 0.5 dB and the -1dB compression point is +12dBm.

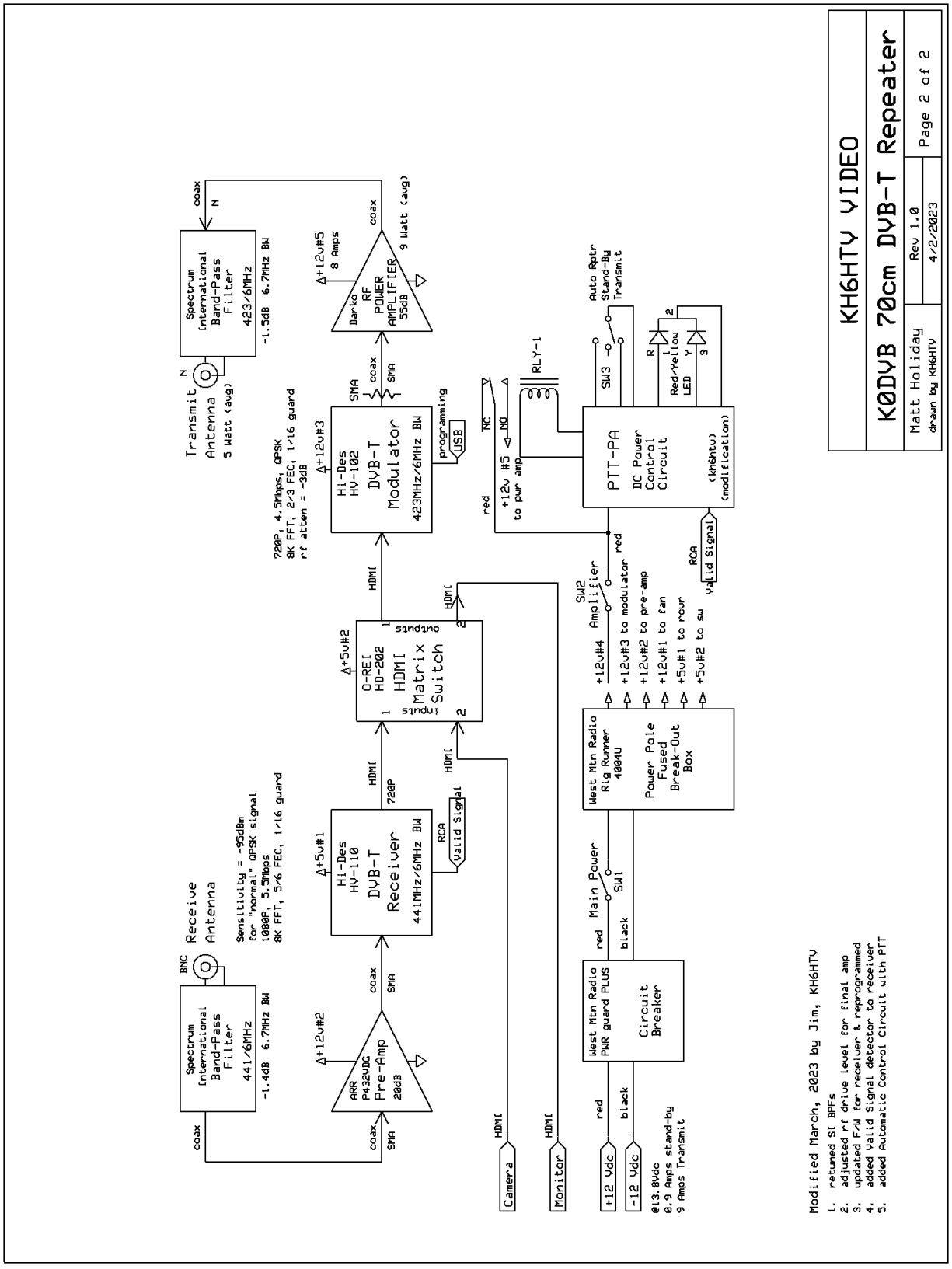
POWER AMPLIFIER: The RF Power Amplifier was built by a radio amateur in Austria. Darko Banko, OE7DBH. No detailed specs., schematic diagram, nor test data were furnished with the amplifier. The amplifier includes a large heat sink and cooling fan. The rf drive level from the modulator has been set to properly drive the final amplifier without distorting the digital signal. The rf power output from the amplifier is about 9 Watts (average).

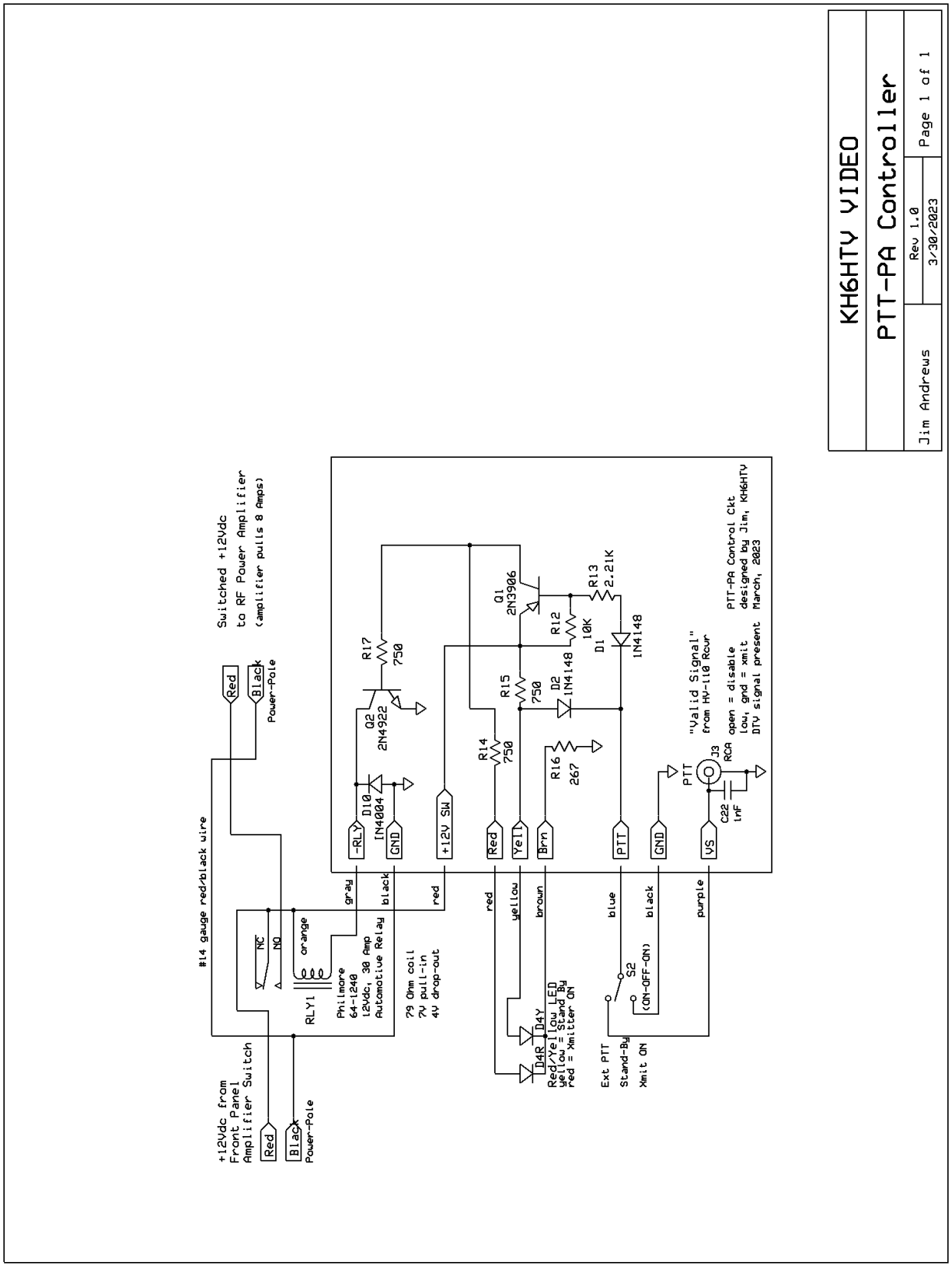
BAND-PASS FILTERS: The Band-Pass Filters (BPFs) were salvaged from BCARE's old NTSC, analog TV transmitters. They were built in the 1990s by Spectrum International. They were the model PSF-ATV-XXX. The company Spectrum International is no longer in business. They have been re-tuned by Jim, KH6HTV. Figs. 10 & 11 show their frequency responses. For the Ch 60 (441 MHz) receive BPF, the insertion loss was -1.4 dB and the -3 dB band-width was 6.7 MHz. For the Ch 57 (423 MHz) transmit BPF, the insertion loss was -1.5 dB and the -3 dB band-width was 6.7 MHz. The rf power output from the Ch 57 BPF is about 5 Watts (average). *Note: input filter retuned to 439 MHz center frequency. IL = -1.5dB, BW = 6.7 MHz, kh6htv, 7/15/23*

RECEIVER OSD: The receiver has it's on-screen-display permanently enabled. In the upper left corner is displayed the frequency and band-width (441000/6). In the lower left corner is the call sign of the incoming signal. Note: sometimes, the receiver fails to update this. In the lower right corner is the Signal / Noise ratio of the decoded digital video signal. For QPSK, the max. value will be 23 dB. For 16QAM, the max. value will be 26 dB. In the upper right corner is the S meter. It reads the received power into the receiver's antenna in dBm. It has been found to be accurate to within ± 1 dB over a very wide range (-80dBm to -10dBm) The value displayed will read high due to the gain of the pre-amp ahead of the receiver and the loss of the input BPF. A correction factor of about -18 dB should be applied to the displayed value to determine the actual input signal level at the repeater's input receive connector (i.e. the BNC on the Ch 60 BPF). For example if the OSD reads -60dBm, then the actual rf input signal level is -78dBm. With no input signal, and a 50 ohm termination on the input BPF, the receiver displays -89 to -90dBm.

RECEIVER SENSITIVITY: The repeater has been tested for sensitivity. The test signal was a "Normal" ham DVB-T signal with following digital parameters: 441 MHz, 6 MHz BW, 1080P, H.264, 5.5 Mbps, QPSK, 8K FFT, 5/6 FEC, & 1/16 Guard.

Repeater Turn-On = -95 dBm (with s/n = 8dB)
note: some picture defects and possible relay chattering
Repeater Turn-Off = -96 dBm (with s/n = 7dB)
Repeater Solidly On = >-93dBm (with higher s/n) -- perfect picture & audio


KH6HTV VIDEO
K0DVB 70cm DVB-T Repeater
Matt Holiday
drawn by KH6HTV
Rev 1.0
4/2/2023
Page 2 of 2
Receive Antenna
Spectrum International Band-Pass Filter 441/6MHz
-1.4dB 6.7MHz BW
Sensitivity = -95dBm for "normal" QPSK signal 1080P, 5.5Mbps 8K FFT, 5/6 FEC, 1/16 guard
Δ+12v#2
ARR P432VDC Pre-Amp 20dB
Δ+5v#1
Hi-Des HV-110 DVB-T Receiver 441MHz/6MHz BW
RCA Valid Signal
Δ+5v#2
O-REI HD-202 HDMI Matrix Switch
inputs
outputs
Camera
Monitor
720P, 4.5Mbps, QPSK 8K FFT, 2/3 FEC, 1/16 guard rf atten = -3dB
Δ+12v#3
Hi-Des HV-102 DVB-T Modulator 423MHz/6MHz BW
programming USB
Transmit Antenna 5 Watt (avg)
Spectrum International Band-Pass Filter 423/6MHz
-1.5dB 6.7MHz BW
Δ+12v#5 8 Amps
Darko RF POWER AMPLIFIER 55dB
9 Watt (avg)
+12v #5 to pwr amp
RLY-1
PTT-PA DC Power Control Circuit (kh6htv) (modification)
Auto Rptr Stand-By Transmit
SW3
Red-Yellow LED
Valid Signal
SW2 Amplifier
+12v#4
+12v#3 to modulator
+12v#2 to pre-amp
+12v#1 to fan
+5v#1 to rcvr
+5v#2 to sw
West Mtn Radio Rig Runner 4004U
Power Pole Fused Break-Out Box
Main Power SW1
West Mtn Radio PWR guard PLUS
Circuit Breaker
+12 Vdc
-12 Vdc
@13.8Vdc
0.9 Amps stand-by
9 Amps Transmit
Modified March, 2023 by Jim, KH6HTV
1. retuned SI BPFs
2. adjusted rf drive level for final amp
3. updated F/W for receiver & reprogrammed
4. added Valid Signal detector to receiver
5. added Automatic Control Circuit with PTT


KH6HTV VIDEO
PTT-PA Controller
Jim Andrews
Rev 1.0
3/30/2023
Page 1 of 1
PTT-PA Control Ckt
designed by Jim, KH6HTV
March, 2023
open = disable
low, gnd = xmit
DTV signal present
"Valid Signal"
from HV-110 Rcvr
+12Vdc from
Front Panel
Amplifier Switch
Red
Black
Power-Pole
#14 gauge red/black wire
Switched +12Vdc
to RF Power Amplifier
(amplifier pulls 8 Amps)
Red
Black
Power-Pole
RLY1
Philmore
64-1240
12Vdc, 30 Amp
Automotive Relay
NC
NO
orange
gray
black
red
79 Ohm coil
7V pull-in
4V drop-out
-RLY
GND
+12V SW
Red
Yell
Brn
PTT
GND
VS
D10
1N4004
Q2
2N4922
R17
750
R14
750
R15
750
R16
267
R12
10K
Q1
2N3906
R13
2.21K
D2
1N4148
D1
1N4148
J3
RCA
PTT
C22
1nF
D4R
D4Y
Red/Yellow LED
Yellow = Stand By
Red = Xmitter ON
red
yellow
brown
blue
purple
black
Ext PTT
Stand-By
Xmit ON
S2
(ON-OFF-ON)

W0BTV Details: **Inputs:** 23 cm Primary (CCARC co-ordinated) + 70 cm secondary all digital using European Broadcast TV standard, DVB-T 1243 MHz/6 MHz BW (primary), plus 439 MHz/6 MHz BW and 439 MHz/2 MHz BW
Outputs: 70 cm Primary (CCARC co-ordinated), Channel 57 -- 423 MHz/6 MHz BW, DVB-T
Also, secondary analog, NTSC, FM-TV output on 5.905 GHz (24/7 microwave beacon).
Operational details in AN-51c Technical details in AN-53c. Available at: ***https://kh6htv.com/application-notes/***

W0BTV ATV Net: We hold a social ATV net on Thursday afternoon at 3 pm local Mountain time (22:00 UTC). The net typically runs for 1 to 1 1/2 hours. A DVD ham travelogue is usually played for about one hour before and 1/2 hour after the formal net. ATV nets are streamed live using the British Amateur TV Club's server, via: ***https://batc.org.uk/live/*** Select ***ab0my or n0ye***. We use the Boulder ARES (BCARES) 2 meter FM voice repeater for intercom. 146.760 MHz *(-600 kHz, 100 Hz PL tone required to access*).

Newsletter Details: *This is a free newsletter distributed electronically via e-mail to ATV hams. The distribution list has now grown to over 500+. News and articles from other ATV groups are welcomed. Permission is granted to re-distribute it and also to re-print articles, as long as you acknowledge the source. All past issues are archived at:* ***https://kh6htv.com/newsletter/***

ATV HAM ADS

Free advertising space is offered here to ATV hams, ham clubs or ARES groups. List here amateur radio & TV gear For Sale - or - Want to Buy.

WANTED: Need a working Scientific Atlanta model 9270 modulator for a repeater I am refurbishing. --- Buford Eastep, W4HVW Contact: ***w4hvwbuford@yahoo.com*** or text 956-245-9625.