Boulder Amateur Television Club
TV Repeater's REPEATER

May, 2024
2ed edition, issue #162

BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

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IC-905 - Icom's Microwave and ATV Transceiver

Dave Crump, G8GKQ, British Amateur Television Club, Salisbury, England
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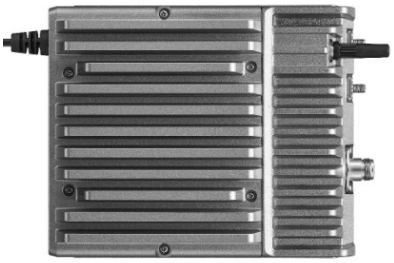
I have had 2 opportunities to test the IC-905 which is Icom's first entry into the microwave and ATV market. Here are my first impressions; I'm not sure that many BATC members will purchase one (although I know that there is at least one). It does have the potential to increase FM ATV activity.

Description --- The IC-905 is more of a system than a rig. It comprises 2 (optionally 3) units: the controller, the RF unit and the optional 10 GHz transverter. The controller has the same form factor as the popular IC-705, but has no internal battery. It requires an external 5.5 amp 13.8 volt supply and runs quite hot. The power input, microphone, audio, video and PTT sockets are on either side of the unit. The controller is connected to the RF unit by a standard shielded ethernet cable which carries both power and data. This enables it to be sited close to the aerials to reduce feeder loss.



RF Unit

10GHz Unit

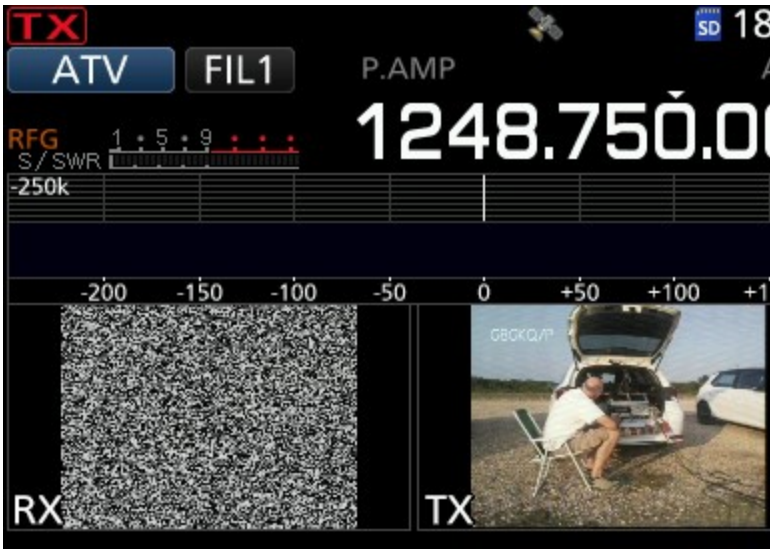
The RF Unit has a single N socket for 144, 432 and 1296 MHz aerials. It has separate SMA sockets for the 2.4 GHz and 5.7 GHz aerials. A third SMA socket is used to connect a GPS receiver aerial. A derived 10 MHz reference is output on a BNC socket. The sockets are distributed between the top and the bottom of the unit. The optional 10 GHz transverter connects to the RF Unit through a bespoke cable fitted with 10-pin connectors, and uses the RF Unit's 2.4 GHz connector. It provides a pass-through SMA output for 2.4 GHz, and another SMA socket for the 10 GHz aerial. It takes a 10 MHz reference input from the RF Unit on a BNC socket. A development prototype 24 GHz transverter was exhibited at a recent radio show in Japan.

Capabilities --- The IC-905 is capable of FM and SSB on all bands 144 MHz - 5.7 GHz, and FM ATV on the bands 1296 - 5.7 GHz. The 3.4 GHz band is not covered (as it is not available in many countries). Output is 10 W on 144, 432 and 1296, 2 W on 2.4 GHz and 5.7 GHz and 0.5 W on 10 GHz. The unit is also capable of AM (at reduced power) on all bands. Note that there is no receive (or transmit) coverage in any mode outside the amateur bands, and the upper limit on 23cm is 1300 MHz, so it does not cover the UK ATV repeater output frequencies.

The test unit performed to specification on transmit. It was not possible to perform accurate receive sensitivity measurements. The unit appeared to be sensitive enough for terrestrial operation on all bands but needed a preamp for acceptable reception of QO-100 narrowband on 10 GHz.

Amateur TV Operation --- The IC-905 will transmit and receive frequency modulated (FM) ATV pictures with a single sound sub-carrier. In the UK, this mode has gradually been replaced by digital DVB-S/S2 over the last 20 years.

Connecting a Camera --- TV transmission requires a PAL video camera to be connected to provide the picture source; this can be an old camcorder or a more modern alternative such as the BATC PAL VideoSource using a Raspberry Pi Camera. The audio can be from the fist microphone or from a mono audio source. The required leads are not supplied, but can easily be made up from a 3.5mm stereo jack plug; although the manual indicates that a 4-terminal jack is required, the ring furthest from the tip is not connected, so a standard 3-terminal stereo jack will suffice.



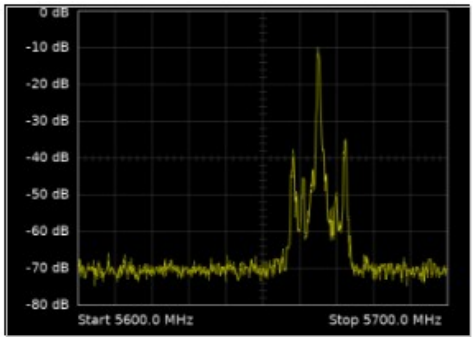
The transmitted picture can be shown alongside the received picture on the touchscreen; either picture can be enlarged to full-screen simply by touching it. Sadly, the frequency tuning control is disabled when full-screen is selected. An external monitor can be connected to display (or record) the received pictures, and stills can be saved to an SD card inserted into the controller.

Frequency Modulation --- The TV modulation standard is not specified in any of the Icom documentation. The FM ATV deviation was measured to be significantly lower than has traditionally been used for ATV in the past. Pre-emphasis is also applied in the transmitter (with matching de-emphasis in the receiver) but the exact pre-emphasis standard is not stated by Icom. The parameters are compared to those commonly used in the table below.

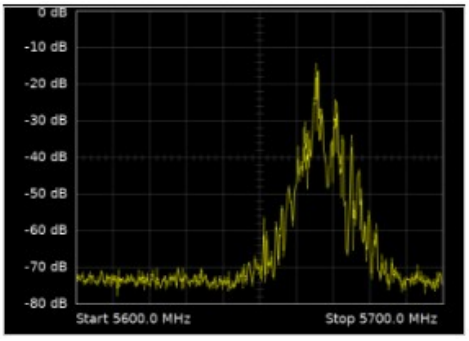
Equipment	**Deviation at Crossover**	**Pre-emphasis**	**Audio**
IC-905	5 MHz/volt	Yes - Unknown	Nil, 4.5, 6 or 6.5 MHz
BATC 23 cm	8 MHz/volt	CCIR 405-1 (625)	6 MHz
Drone 5.56 GHz	16 MHz/volt	None	6 MHz and 6.5 MHz

The FM ATV Modulation appeared to be SDR-generated and, with the low deviation, gives a tight (for FM ATV) ATV spectrum of about 14 MHz wide. The spectrum is compared with a 5.6

GHz Drone transmitter below. The occupied bandwidth of 14 MHz is approximately 30 times that occupied by a digital ATV transmitter at 333 kS carrying the same (or better) quality signal in just under 500 kHz. Note that if the video deviation is increased beyond a certain limit, the transmitter simply cuts out with no warning or explanation.



IC-905 FM-TV



Drone FM-TV

Comparison of FM-TV spectrums: center freq. = 5.650 GHz, span = 100MHz, 10dB/div & 10MHz/div

On-air testing and Compatibility --- Initial on-air tests were conducted between 2 IC-905s on 5665 MHz. The received picture quality was about P4 (over 29 km line-of-sight) with one station using the Icom AH-56 5 dBi colinear and the other using a 22 dBi ex-WiFi dish. The audio was clear, with the welcome facility of an FM squelch on the audio subcarrier - although I have heard reports that this squelch does not work on some production units. It was refreshing to have negligible delay and quick changeover between transmit and receive for video - unlike digital ATV modes.

The IC-905 received picture captured on an external recorder

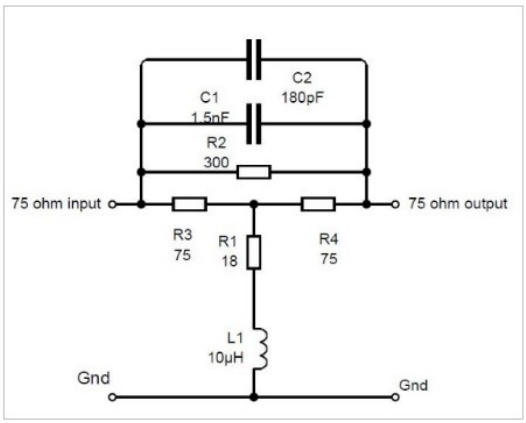
A few ATV repeaters still retain an FM receive capability. Initial tests transmitting into GB3SQ over a distance of 11 km were successful, but the picture quality was poor as it was set up for the more commonly used deviation of 8 MHz/volt. The repeater keeper, Colin G4KLB then installed a video AGC system and further tests a week later gave better results. It is likely that most UK ATV repeaters would need similar modifications to receive ATV transmissions from the IC-905.

The IC-905 showed significant crushing and tearing of the video when receiving signals from an unmodified 1255 MHz transmitter. There is no facility on the IC-905 to accommodate the wider deviation that causes this, so any such transmitter (or remaining repeaters transmitting wider bandwidth FM ATV) are incompatible with the IC-905 without modification.

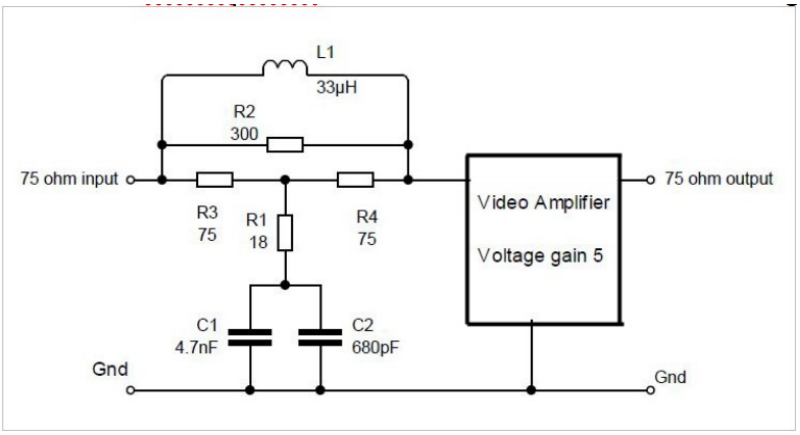
Tests were also conducted on 5665 MHz, testing compatibility with the popular (and cheap) drone transmitters and receivers. It could be achieved, but needed significant modifications

to the drone equipment. On transmit, the drone transmitter video level needed reducing and pre-emphasis needed to be applied. Some patterning from the high level of the 2 sound sub-carriers remained visible on the IC-905, but the results were acceptable.

The pre-emphasis circuit below provides enough attenuation to set approximately the correct modulation level for a drone transmitter.



PAL Pre-Emphasis Circuit



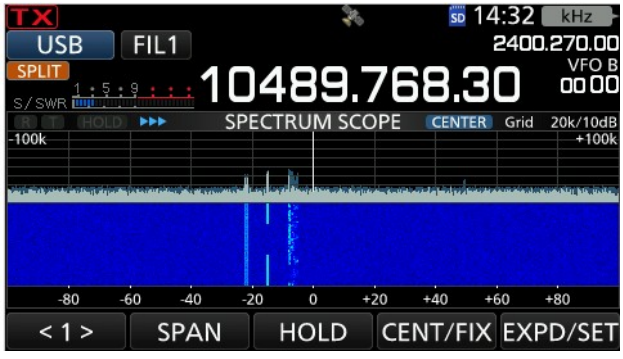
PAL De-Emphasis Circuit

On receive, significant amplification of the video signal was required, and it needed de-emphasis to be applied. The de-emphasis circuit here will need to be used with some amplification on the output of a drone receiver to view the signal from an IC-905 on a normal monitor. Note that a 75 ohm buffer amplifier might be required after the drone receiver and before the de-emphasis, as these receivers often have a high impedance output.

Digital ATV **---** The IC-905 only transmits and receives analogue FM ATV. It is a shame that no attempt has been made to handle DVB-S2 digital ATV which is now the predominant ATV mode in the UK and on the QO-100 satellite. As the unit has no 'IF' input or output, the only likely option for introducing this capability would be an internal firmware upgrade. Unfortunately, it is unlikely that the internal processor could handle the challenging error-correction processing required for reception, as this is usually handled in custom integrated circuits. The omission of digital ATV might preclude the use of this rig for any ATV operation in the 1296MHz band following the possible future implementation of restrictions to safeguard radio-navigation satellite services (RNSS).

Aerials **---** Icom are selling a number of co-linear and parabolic aerials to go with the IC-905; these are all vertically polarised, limiting compatibility with most UK microwave operation which is horizontally polarised.

Narrowband Operation **---** The unit performed well for simplex and repeater operation. However, it had no duplex capabilities at all for crossband operation. When testing QO-100 narrow-band it did not



seem possible to “gang” the transmit frequency on 2400 MHz to the receive frequency on 10.489 GHz to allow easy tuning and netting. The absence of any receive capability during transmit made QO-100 operation more difficult.

Like and Dislikes

I liked:

1. The control interface, which was very intuitive to use (very similar to the IC-705).
2. The fact that the equipment provided a very simple way to get active on many microwave bands.
3. The IC-905 performance which was exactly as claimed in the publicity and specification.
4. The spectrum and waterfall displays on the receiver (up to 50 MHz wide).

I disliked:

1. The need for a triplexer or switching to connect aerials to the combined 144/432/1296 MHz output.
2. The lack of weatherproofing for the RF unit with sockets on both top and bottom.
3. The fact that there was no DC switching signal on the RF output to allow external switching of preamps/PAs. The signal is available on a miniature jack socket on the controller, but needs a custom lead making up for the 10-pin socket on the RF Unit to make it available near where it might be used.
4. The lack of any duplex capability.
5. The lack of any digital TV capability, or the potential to add it.

Conclusion --- I am really pleased that Icom have brought this microwave/ATV transceiver to market. It can only serve to stimulate interest in these aspects of the hobby. It is a polished, capable unit; however, it is not a good fit for the current UK ATV scene - it would have been perfect 20 years ago. Despite the lack of flexibility, I would love to own one, but the price puts me off: £3549.95 for the basic system and another £1499.99 for the 10 GHz transverter.

You can find out more about the IC-905 in the TX Factor Episode 29 where Noel G8GTZ and I test it in the field, and in the article in the September 2023 issue of RadCom. Thanks to Icom UK for the loan units and to the TX Factor team for a fun day of testing and filming.

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Editor's Note: Dave, G8GKO, Noel, G8GTZ and Bob, G0FGX have posted a You-Tube video on the IC-905 (***https://www.youtube.com/watch?v=0yLnjeEGx2s***)

Boulder Amateur TV Club's -- Choice of 5.8 GHz, FM-TV Gear

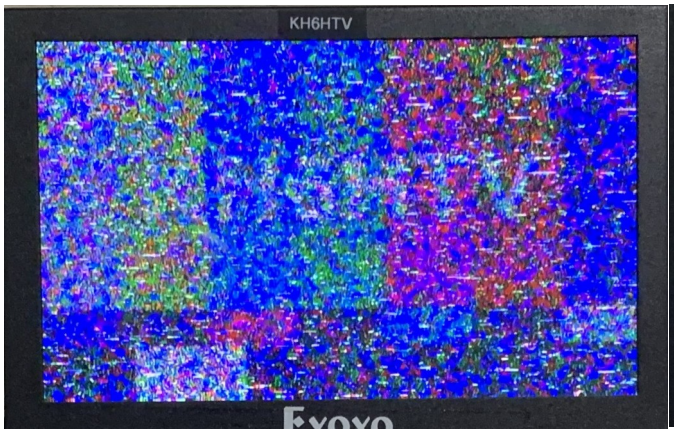
Jim, KH6HTV

After reading Dave's above review of the IC-905, I decided to again look into the technical performance of the 5.8 GHz, FM-TV gear we here in Boulder, Colorado have been using. Most all of us are using the el-cheapo, FPV (First Person View), drone gear which is readily available these days from Amazon, E-Bay, etc. for dirt cheap prices. Most of us bought for the ultra-low price of about $30 a combo package from Amazon of the model TS832 transmitter and the RC832 receiver. The combo set is no longer available on Amazon Prime for $30, but can still be found on E-Bay for about that price, but comes from China. We have been very impressed with the performance and the DX distances we have accomplished. We are also using the TS832 transmitter along with a 2 watt "After-Burner" amplifier as a 24/7 FM-TV beacon transmitter on our W0BTV - TV repeater.

Both the transmitter and receiver are frequency synthesized on 40 channels. The pre-set frequencies range from 5645 to 5945 MHz. Not all of them land in the legal amateur 5 cm band. Most of them are in the unlicensed, 5.8 GHz Wi-Fi band, which we try to avoid using. For Boulder, we are using 5.905 GHz for our TV repeater's beacon transmitter. For our simplex FM-TV, we are using 5.685 GHz. The TS832 transmitter is rated at 600mW rf output. It has a 6.5 MHz audio sub-carrier. Deviation -- Unknown, no spec. given. Pre-Emphasis / De-Emphasis -- Unknown, no spec. given. Manufacturer(s) -- also Unknown ! Country of origin = China. Both units run on 12Vdc.

RC832 Receiver: The dc current draw was 220mA at +12Vdc. The first test to report is the receiver's sensitivity. The advertised spec. was less < -90dBm. A test was set up using the TS832 as the source. A fixed video image of color bars was transmitted for easy comparison of relative P unit performance testing. The test transmitter was placed in a separate room and connected with a long, calibrated, coax cable to the receiver under test. This was done to prevent stray rf paths from contaminating the sensitivity measurement. 30dB, SMA attenuators were placed on the transmitter output and the receiver input. The test signal level was then adjusted using a Midwest Microwave, rotary step attenuator (1 & 10dB steps) at the receiver. The receiver's video output was displayed on a flat screen, 7",12Vdc, hi-res, video monitor. The monitor had a built-in video squelch, so it was not

possible to see either a P0 or weak P1 image. The monitor was found to reliably turn on it's display when the rf signal strength was at least -100 dBm. Usually with color snow, but sometimes B&W. The following photos were taken of the monitor screen for signal levels of -100, -95, -90, -85 & -80dBm. -80 dBm and greater resulted in a perfect P5 picture.



-100 dBm (P1)

-95 dBm (P2)

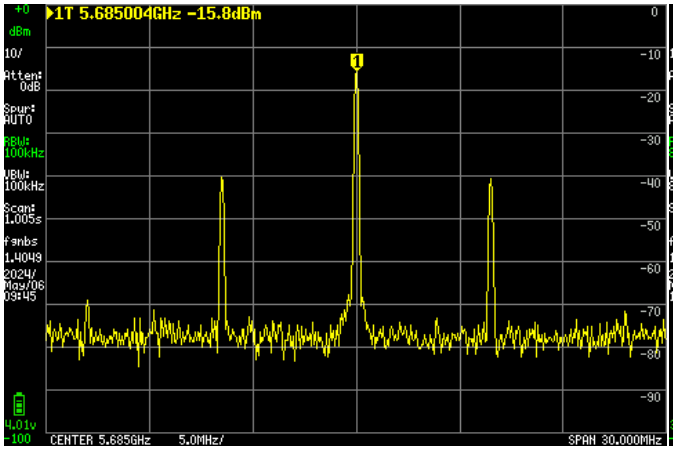
-90 dBm (P3)

-85 dBm (P4)

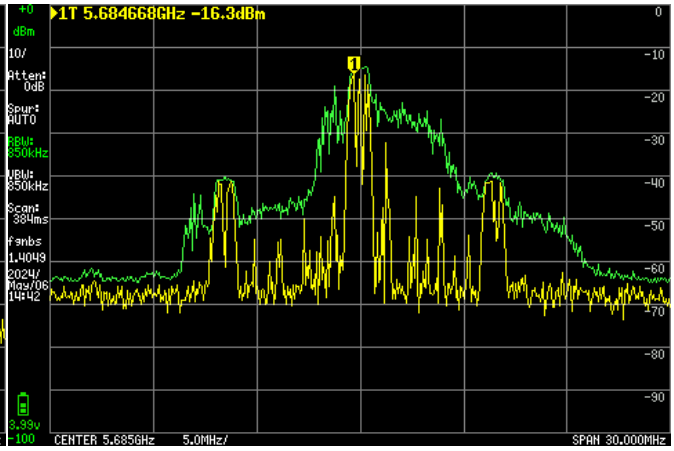
-80 dBm (P5)

For additional reading on measuring receiver sensitivity (in particular the RS-832), see the ATV newsletter from June, 2020, issue #46, pp. 6-9.

TS830 Transmitter: The companion transmitter was also tested. The DC current draw was 300 mA at +12Vdc. The first test was of it's rf output power. Spec. is 600mW. I measured 630mW (+28dBm) on my HP power meter. The RF spectrum was then observed using a TinySA-Ultra, spectrum analyzer. The analyzer was set to 5.685 GHz center frequency with a 30 MHz span. Scales were 10 dB/div & 5 MHz/div. The first test was to look at the spectrum with no input video. It shows the 6.5 MHz sound sub-carrier sidebands at -25dBc. The second test was to look at the resultant spectrum when "live" video with motion from a CANON camcorder pre-recorded video was the test signal. The green trace is the result of recording in peak hold mode.

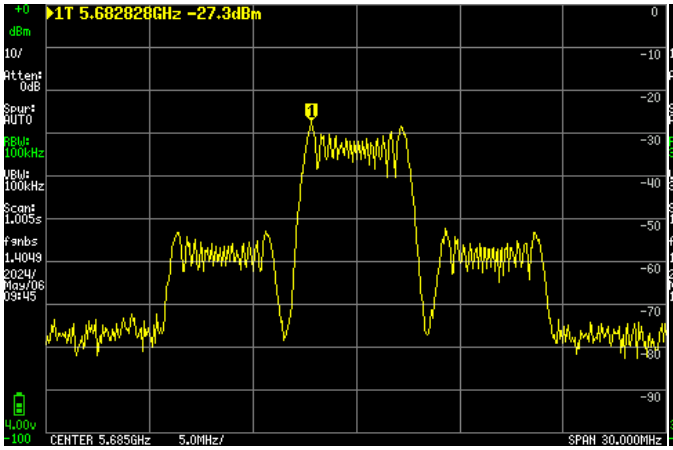


No Video Modulation - only see carrier & 6.5 MHz SSCs

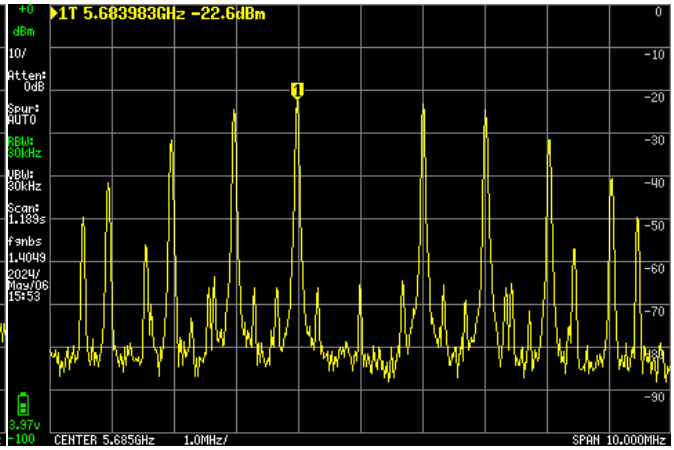


"Live" video - RBW set to max. 850kHz,

The next tests were to input sine waves of known frequencies and levels.



video input = 1.0 Vptp, 100 kHz sine wave



1st Bessel Null - Vin = 1.0 Vptp, 1.015 MHz
10 MHz span, 1 MHz/div, 30 kHz BW

Based upon the measurement of the 1st Bessel function null at about 1 MHz modulation frequency, I estimate the transmitter's deviation to be about 2.5 MHz. Based upon the "live" video measurement, it appears that the practical -20 dB occupied band-width is of the order of 7 MHz. When one includes the 6.5 MHz SSC sidebands, the occupied band-width is considerably wider at about 15 MHz.

Transmitter Mods: All of us have modified our TS830s. As it comes, it includes a built-in tiny microphone mounted on the pc board. We really wanted to instead use the audio coming from our camcorders. Fortunately, Bill, AB0MY, discovered a simple modification. It involves moving a pc board jumper and attaching wires for an external RCA audio, line level input. For details, see the ATV newsletters, issues # 27 & 29 from Dec. 2019.

TS830 --> RC830: The third test run was to measure the end to end performance from the transmitter to the receiver. The frequency response of both the video and audio channels was measured. Both showed approximately 0 dB insertion loss end to end over the mid-band frequencies.

The video channel was essentially flat from 100 Hz to 1.5 MHz. It showed some peaking at both high and low frequencies. At the high end it showed +2 dB peaking from 3.5 - 4.5 MHz. Beyond 5 MHz, it dropped rapidly to -7 dB down at 6 MHz. At the low end it showed up to 7 dB peaking in the 15-20 Hz region. It was -3dB down at 10 Hz.

The audio channel was essentially flat from 100 Hz to 7 kHz. At the high end it rolled down smoothly to -3 dB down at 15 kHz. At low frequencies, there was considerable peaking in the 20-30 Hz region with some motor-boating. The -3 dB down was at 12 Hz.

Overall, the video and audio quality through the system was excellent.

73 de Jim Andrews, KH6HTV, Boulder, Colorado

More FM-ATV Resources:

1. "FM ATV ", Tom O'Hara, W6ORG, Jan. 2015. posted on Tom's web site, ***https://hamtv.com/FMATV.html***

2. "FM Transmitter Deviation Adjustment & Calibration", Jim Andrews, KH6HTV, application note, AN-14, Aug. 2012 posted on Jim's web site. ***www.kh6htv.com***

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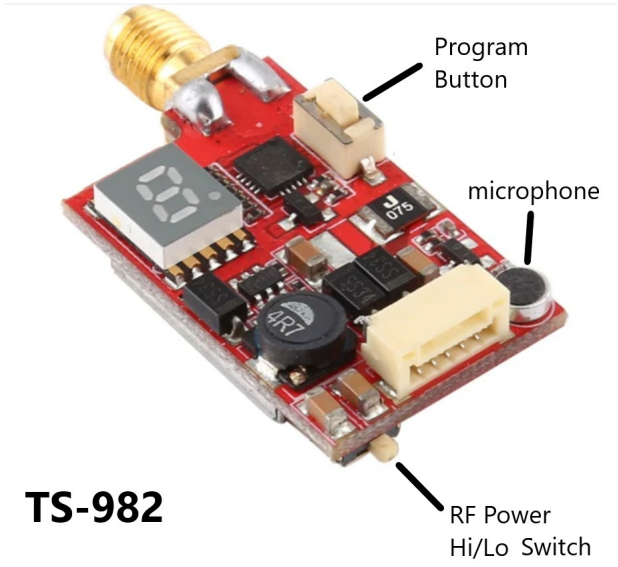
New & Old FM-TV Gear !

Ops ! -- Just after I finished writing the above article about our favorite TS832 & RC832 gear, it appears that it might already have become obsolete.

Doshia, KB0NAS, & hubby George, N0RUX, Boulder ATV hams decided they also wanted to become microwave ATVers. So based upon our recommendations they ordered via E-Bay the TS832 & RC832 combo. But what they received from the E-Bay supplier in China was not what they ordered, but something similar. What was in the package was an RC832H receiver and a TS982 transmitter.

Basic RF specs. are similar, except the new units are programmed for 48 channels vs. 40 channels. But the size is dramatically smaller as shown in this comparison photo. The transmitter pc board is only 0.8" x 1.3" in size. Biggest item on it is the RP-SMA connector

We have not done exhaustive testing on these new items. But a quick test showed they did basically work the same as before. The new receiver was able to receive a P3 picture from the W0BTV, 5.905 GHz beacon transmitter, 12 miles way, using the simple rubber duck antenna supplied with the unit. Perfect P5 with a 22dBi dish antenna.



TS-982

We then modified the wiring harness for the new transmitter. It comes with a wiring harness intended to be installed in a drone with a tiny TV camera. We needed to change this to provide an RCA connector for Doshia/George's Canon camcorder. Plus a suitable connector for their 12Vdc battery. Initially turning the transmitter on, we immediately saw a high quality video image, plus horribly tinny sounding audio from the on-board microphone. All looked fine, until we then measured the RF output power with our HP power meter. Ops ! Not 600 mW (spec. is +27dBm min. +28dBm max.), but a measly +9.4dBm (8.7 mW). Well the real issue is lack of any instruction manual. They only gave us a channel/frequency table and a few brief specs. We then noted there was a tiny slide switch on the pc board, but no indication of what it's function was. It turns out to be an RF power output selector for low or high. Moving it to the other position, our power output shot up +15dB. We now measured about +25dBm (1/3 Watt) with a dc current draw of 240mA (vs. 300ma spec.) at +12Vdc. Thus, the unit was in fact working, but the rf output power was way too low low by 2-3 dB. Not satisfactory.

Next we looked into what would be required to modify the transmitter to disable the on-board microphone, and instead insert the line level audio from a camcorder. Not going to be easy ! This transmitter is way too small for old eyes and shaky hands to even consider making these mods. So we gave up on that one.

73 de Jim, KH6HTV, Doshia, KB0NAS & George, N0RUX

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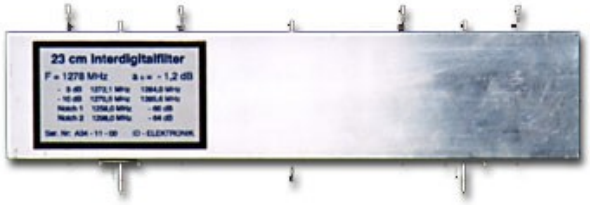
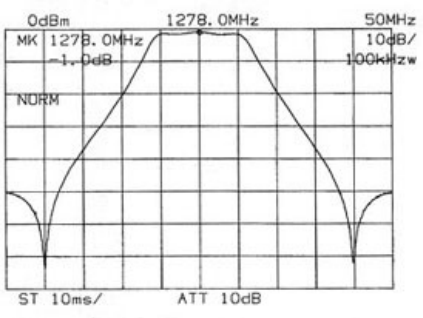
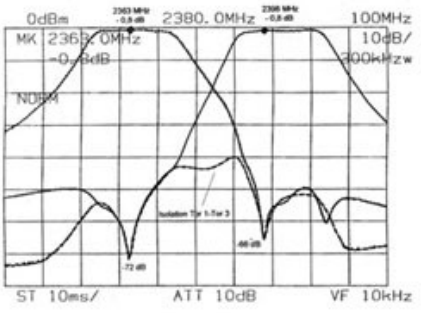
23&13cm BPFs & Duplexers



While working up an index of past newsletter articles, I came across this from Feb., 2020, issue #33. A German source for 23cm & 13cm band-pass filters & duplexers. ID-Elektronik Gmbh, in Karlsruhe ***https://www.id-elektronik.de/en/***
So, I checked out their web site. Many of their listed products are no longer available, but it appears that their BPFs & duplexers are still available, plus still at reasonable prices of 80€ and 150€.



23cm BPF S21



23cm Duplexer S21 & S31

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W0BTV Details: **Inputs:** 23 cm Primary (CCARC co-ordinated) + 70 cm secondary all digital using European Broadcast TV standard, DVB-T 23cm, 1243 MHz/6 MHz BW (primary), plus 70cm (secondary) on 441 MHz with 2 receivers of 6 & 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*).

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