# Boulder Amateur Television Club
# TV Repeater's REPEATER

**April, 2020**
**3ed edition**

**BATVC web site: www.kh6htv.com**

**ATN web site: www.amateurtelevisionnetwork.org**



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

**Future Newsletters:** If you have contributions for future newsletters, please send them to me. We also welcome news from other ATV groups around the USA. We encourage you to forward this newsletter on to other ATV ham friends in your clubs.

**SPRING TIME in the ROCKIES !** -- view from KH6HTV's ham shack

To our ATV ham readers elsewhere in the USA, we hope you at least are enjoying springtime weather. This is what it looks like today here in Colorado. On Saturday, I mowed my lawn for the first time with the temperature in the mid 60s. Sunday, the temp dropped 50 degrees and it snowed for two days. I have over a foot of snow on the ground now.

# 23cm RFI Issue Solved !


*Not RFI after all !* We have agonized for many months about Ed's (K0JOY) difficulties of getting into the TV repeater on 23cm. He had good signal strength and s/n, but was still plagued with occasional freeze frames and audio dropouts, not always at the same time. They were also rather random, but on average about every minute of so.

We actually rebuilt the repeater this past fall in an attempt to cure Ed's problems. Ed switched to using the most aggressive encoding of 720P & 1/2 FEC, to no avail. Most recently, Ed undertook a project to design and build a new, higher gain, parabolic dish antenna for his 23cm transmitter and boosted his ERP by 11dB. Still no improvement. Yet, most everyone else was able to get into the repeater on 23cm with no issues. We kept blaming some unknown source of RFI.

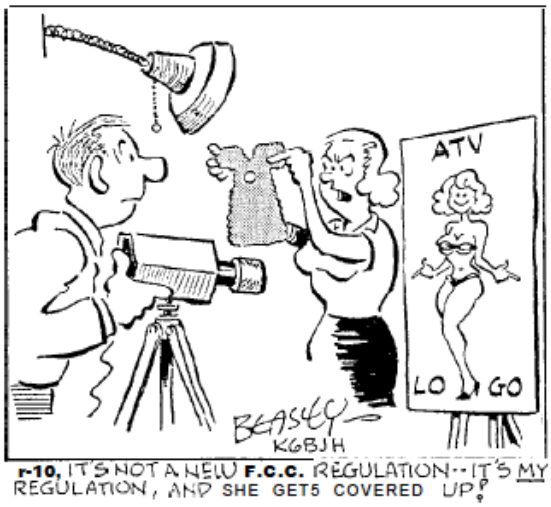
Well, Debbie, WB2DVT, finally solved the problem. On the Thursday, April 9th, ATV net, she suggested that our problem was really not an RF issue at all, but perhaps instead in Ed's A/V system. Ed has been using a complicated system of multiple video sources, a quad processor, and a separate audio inserter. All done in HDMI. The result was then pumped into Ed's HV-320E modulator. So Debbie suggested, "Ed, why don't you just try using only your camera into your modulator?" -- BINGO ! Problem solved. The photo above was taken this morning (4/10) with Ed in his shack and only using his TV camera. Before taking the photo, Ed's transmission had been running previously for over 1/2 hour with absolutely no problems, plus Ed had even switched to low RF power (300mW). The moral of the story is *"Don't have Tunnel Vision"*. Open your eyes to other possibilities than just the one obvious.


**ATN on Ham-Nation:** Search for "*You Tube Ham Nation 448*". The ATN portion starts at 30 minutes into program and runs for 13 minutes.

Roland, KC6JPG, who is ATN's Digital Systems Director & Net Control, sent out this announcement. --- "We will have a 10 minute slot as our main topic for this episode will feature "Mobile ATV, and mobilized ATV." We will showcase (especially for Amanda - K1DDN) our ATN video truck, and we will be touching about the use of ATV for ham radio club meetings. We will also feature our on-line ATV community."

Afterwards, Roland summarized the experience as -- Gary,W6KVC, brought our ATN Mobile Unit to my QTH for the "show and tell" and thank goodness he did as it began to rain again prior to our live shoot. We had to scramble and reset my camera equipment back into my studio. We made it work, but I lost my audio fold back as both Gary and I were "competing" on our microphones during our "show and tell". HI HI. We are planning to return to Ham Nation during the summer months as our next segment for ATV will be highlighting YOU as we will be highlighting ATV repeater systems and the HAM trustees that are the backbone in keeping those ATV repeaters on the air.

The ATN web site is: www.atn-tv.org ATN also streams their repeater system video via the BATC site: batc.org.uk/live They also stream via YouTube at: www.youtube.com/AmateurTelevisionNetwork


# 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.**


**Application Note**
**AN-56**

**April, 2020**

# Replacement for Crystals - PXOs

**Jim Andrews, KH6HTV**
**web site = www.kh6htv.com e-mail = kh6htv@arrl.net**

***"Where can I buy crystals ?"*** This is a lament heard often from hams owning older ham gear. Crystals were a very necessary item in many ham transmitters and receivers. The major supplier for many years, since 1951, was International Crystal Manufacturing (ICM) in Oklahoma City, OK. ICM went out of business in 2017. They were the last manufacturer in the US that made crystals to order in quantities as little as a single piece, and most recently, at a cost $35 each.

Don, N0YE, has just made an inquiry to the Microwave Reflector inquiring about sources for crystals. This search has now found a few crystal manufacturers that will make custom crystals in small quantities. In the USA, it is Bomar ( www.bomarcrystal.com ) Bowmar however requires a minimum order of $100. In the U.K., it is QuartSLab ( www.quartslab.com ). They offer more reasonable prices of about λ35 for a single crystal. In the Czech Republic, it is Krystaly ( http://old.krystaly.cz/index.htm ). It has been reported that Krystaly's crystals sell for $22. It is also reported that QuartSLab & Krystaly take credit cards and will ship to the USA. There may also be others ?

For the amateur TV market, the major supplier for many years has been Tom O'Hara, W6ORG, of PC Electronics ( www.hamtv.com ), Arcadia, CA. All of Tom's AM-TV transmitters, prior to 2004, were crystal controlled. In 2017, when ICM announced their closing, Tom and I were discussing options. With Tom's big installed base of thousands of his TV transmitters, he needed somewhere to refer hams to get crystals for them. I mentioned Programmable Crystal Oscillators (PXO) as an option. At the time, we agreed that I would investigate their possibility for use in Tom's TV transmitters. I purchased some Epson PXOs for experimenting, but found they did not work well in PCE transmitters. They had spurs in their spectrum which caused horizontal tearing of the TV picture. Thus, we dropped the project.

Most recently, in the BATVC newsletter (issues #33 & 38), we had two articles from hams about using PXOs in PCE transmitters. The hams were Dave, AH2AR, Dayton, Ohio and John, WB0CMC, Omaha, Nebraska. This revived Tom, W6ORG's interest in pursuing using PXOs as replacement crystals in his TV transmitters. So, as a result, Tom, Dave, John and I have been having four way, e-mail conversations on the topic. John and I in particular have been evaluating several Epson PXO models and comparing results.

**The result is our conclusion that a crystal is the best performer, but that the Epson, model SG-8101CA-TBGPA, PXO can work as a suitable replacement crystal in PC Electronics, AM-TV transmitters with some limitations. Plus, KH6HTV VIDEO has agreed to build and sell these to ATV hams for their PCE transmitters at a price of $20 each, including postage.**

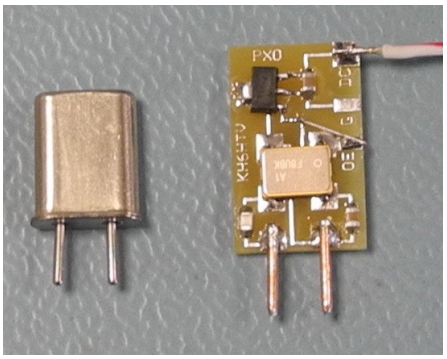



Fig. 1 an HC-50/U crystal and it's PXO replacement

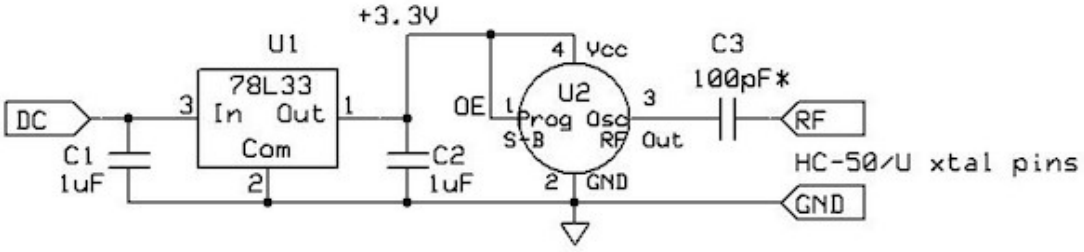



Fig. 2 KH6HTV Video PXO schematic

Fig. 1 Shows a typical crystal and the new KH6HTV Video PXO replacement using the Epson 8101 PXO. Fig. 2 is the schematic diagram. The Epson 8101 PXO, U2, is a CMOS circuit requiring +3.3Vdc. U1 is the 3.3V voltage regulator. This PXO is intended to be directly plugged into an existing crystal socket in a crystal oscillator circuit. The PXO pc board is provided with 0.04" dia. pins to match those of an HC-50/U crystal package. All connections on the board are labeled. Care must however be exercised as one pin is a DC ground pin and it must be plugged into the appropriate pin in the oscillator circuit. Another requirement is that DC power must be supplied to the PXO. A solder pad is provided on the top right hand corner. Fig. 1 shows a DC power wire attached to this pad. DC voltages from +7 to +15Vdc may be applied. There is another solder tab labeled as OE, for Output Enable. This is a logic input to U2.

Normally it is not used and a jumper wire is soldered in place to +3.3V as shown in the schematic.

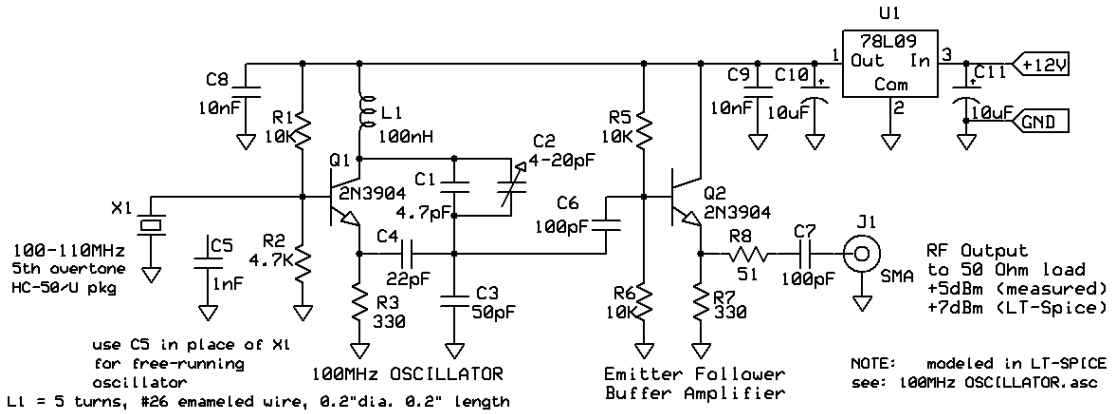



Fig. 3 100 MHz, Overtone Crystal Oscillator --- Test oscillator for crystals and PXOs

Various Epson PXOs were evaluated in the above 100 MHz, crystal oscillator circuit. This oscillator circuit is similar to those found in the PC Electronics AM-TV transmitters. The Epson model 8101, 3.3 V, CMOS was found to have the best phase noise performance, without spurs, and thus less impact on the quality of the TV transmitter's signal. Fig. 4 below shows the measured phase noise comparison between a crystal and the PXO.

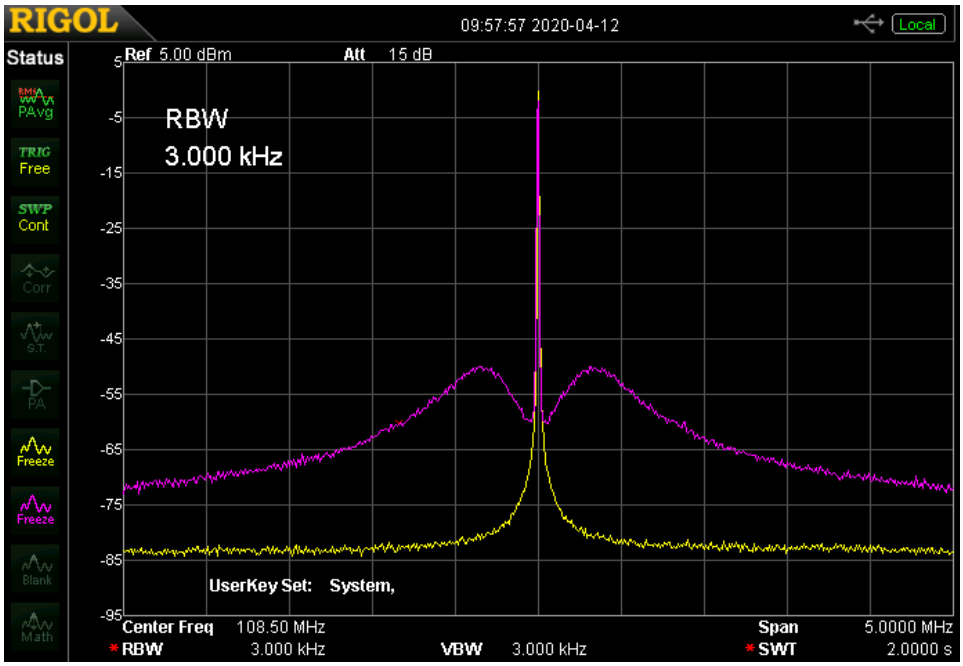



Fig. 4 Phase Noise Measurement: Comparison of a 108.5 MHz, 5th overtone crystal (yellow trace) and an Epson 8101 PXO (magenta trace). Pout = +4dBm, 3 kHz bandwidth, 108.5 MHz center frequency, 5 MHz span. 10dB/div & 500 kHz/div.

The final, acid tests were to see how the PXO performs in an actual TV transmitter. Tom, W6ORG, provided a model TC-70-1, 70cm ATV Transceiver for testing the PXOs. This is a 1 watt (pep), AM-TV transmitter capable of two channel operation. It was provided with a single crystal for 434 MHz. The transmitter design uses a crystal at 1/4 of the operating frequency. Thus the crystal was 108.5000 MHz. A 108.5000 MHz PXO was installed in the second crystal socket. A front panel switch via a relay grounds one or the other crystal in the oscillator circuit. The PXO was connected to the +13.8Vdc supply. Fig. 5 below shows the resultant transmitter's spectrum when operated in CW mode with no video modulation applied. (Note: the 4.5 MHz sound sub-carrier was disabled for these measurements). The worst case for the PXO phase noise occurs at ± 300 kHz. From Fig. 4, the PXO is about -55dBc. After being multiplied 4 X in the transmitter, the PXO noise is about -45dBc, or about 10 dB worse.

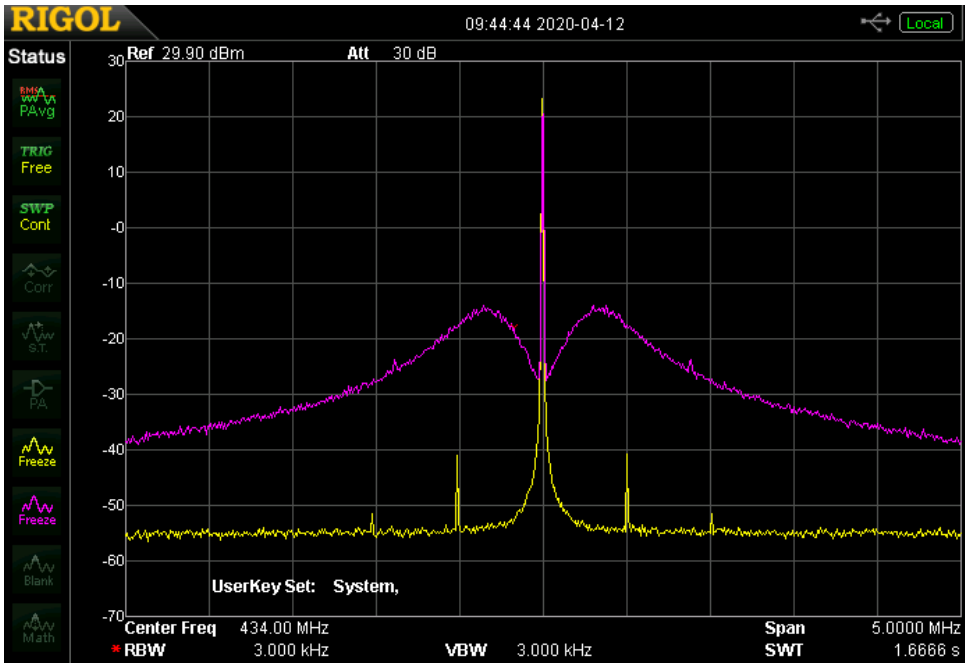



Fig. 5 Phase Noise Measurement: Comparison of the TC-70-1 transmitter's spectrum with a 434 MHz crystal (yellow trace) and an Epson 8101 PXO (magenta trace). Pout = +30dBm, 3 kHz bandwidth, 434 MHz center frequency, 5 MHz span. 10dB/div & 500 kHz/div.

The second test of the PXO in the PCE transmitter was an operational test with video modulation. These tests were performed using an NTSC, video test pattern generator with signals such as color bars, gray scale steps, etc. "Live" video was also observed using a DVD player to play pre-recorded videos. The test receiver was a Drake, model DMM-806, CATV receiver. It's video output was measured on Tektronix video instruments, including model 528 video waveform monitors and a JVC studio monitor. The rf video signal was also observed on a Toshiba 14", CRT, TV receiver.

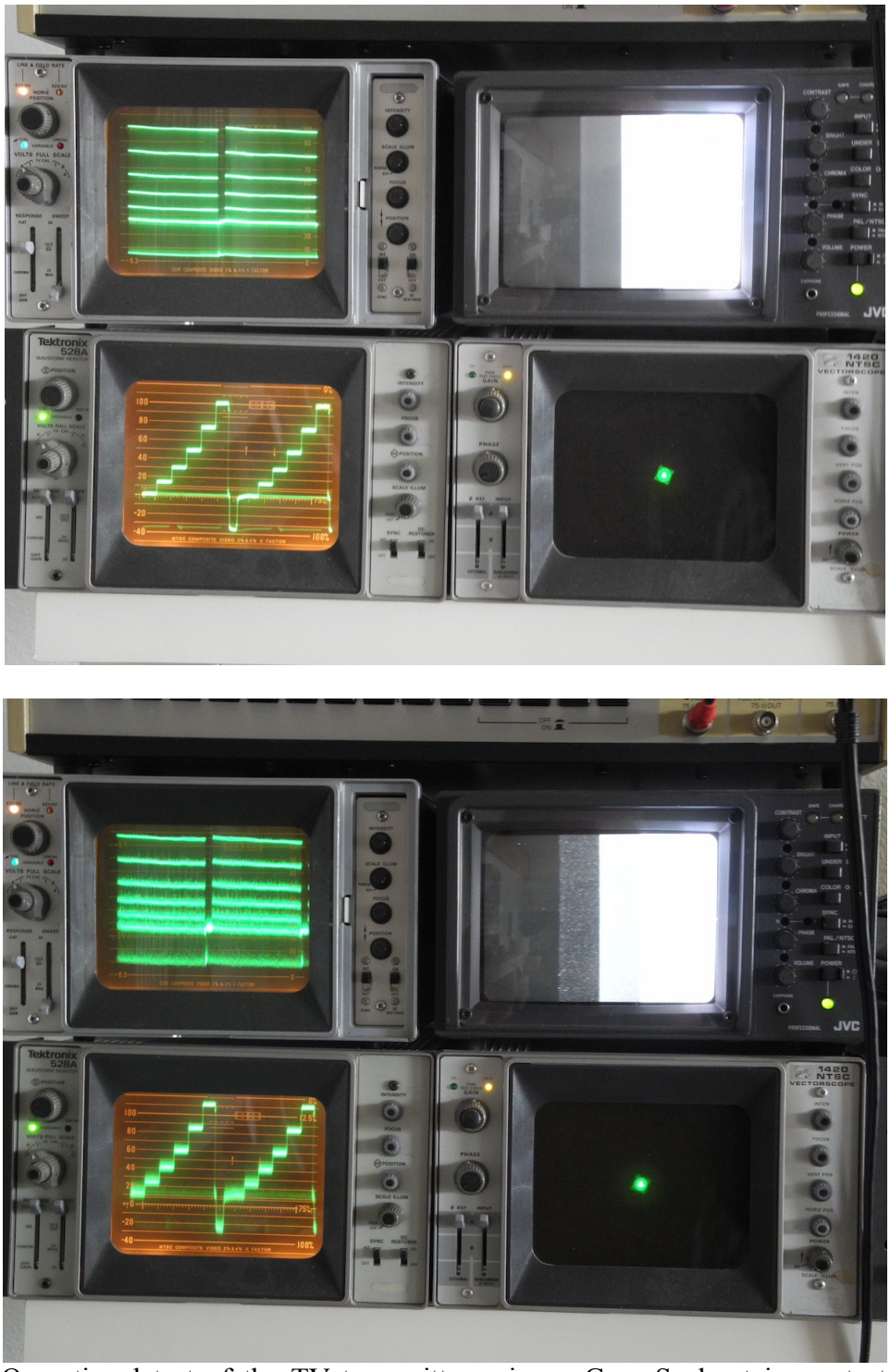


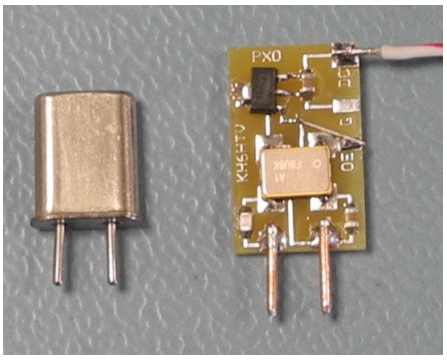

Fig 6 Operational test of the TV transmitter using a Gray Scale staircase test signal. Top photo is using the crystal. Bottom photo is using the Epson PXO. Additional noise is noted on the PXO waveform and displayed image.

The results of this test showed that the presence of the higher phase noise from the Epson PXO resulted in residual, background, "snow", always being present in the TV image. It was most noticeable on the gray scale staircase test signal. See Fig. 6 above. It was also

noticeable on color bars, but to a lesser extent. Finally when using "live video" from the DVD player, it was least objectionable. ATV hams use a P rating system to report the quality of received ATV signals. Using the crystal, the resultant "live" video was rated P5. With the Epson PXO, I would rate the received "live video" picture quality P 4, i.e. the picture was corrupted in a minor way with the background phase noise. For most ATV applications, the picture quality with the Epson PXO should be acceptable.

73 & good ATV DX de Jim, KH6HTV


# Model PXO-xxx PROGRAMMABLE XTAL OSCILLATOR



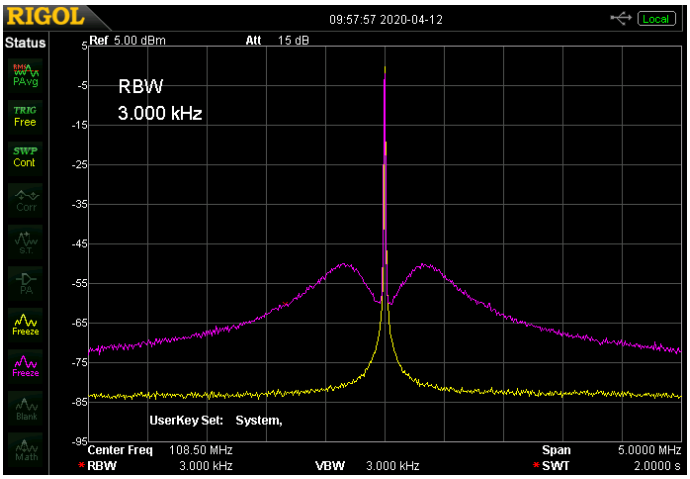

**The NEW KH6HTV VIDEO Model PXO-xxx is a Programmable Crystal Oscillator. With the demise of International Crystal, it has become very difficult for radio amateurs to obtain replacement crystals for older equipment. To assist in solving this problem, we are offering to supply HC-50/U type oscillators which can often be used in place of the original crystal. We will stock oscillators for the PC Electronics, 70cm, AM-TV transmitters for standard TV frequencies ( www.hamtv.com ) The price is $20 each, including 1st class postage. The price for any other frequencies is $30 each. When ordering, please specify: desired oscillator frequency. The frequency is programmed by the factory. It can not be reprogrammed by the user.**

**The PXO is a CMOS oscillator running from 3.3V. It includes an on board 3.3Vdc regulator. One of the "xtal" pins, labeled Gnd, goes to ground. The other "xtal" pin, labeled RF, is the ac coupled RF output. Solder a wire to the pad labeled DC. This wire must be attached to a dc power source of +7 to +15Vdc. In the PCE transmitter, the two channel crystal relay provides the ground circuit, thus disabling the power to the unused PXO. For additional details, see Application Note, AN-56.**

| PARAMETER (*) | Value |
|---|---|
| PXO Device | Epson model SG-8101CA-TBGPA, CMOS, 3.3 V |
| Frequency Range | 670 kHz to 170 MHz available. 105-110 MHz stocked, see list p. 2 |
| Frequency Tolerance | ± 15 ppm |
| Temperature Range | -40 to 85 C |
| Output Voltage | 2.5 V |
| Output Load | < 15 pF max. |
| DC Current | 18 mA |
| DC Supply Voltage | +7 to +15 V range, internal voltage regulator |
| Dimensions | similar to HC-50/U crystal package --- 0.5" x 0.8" with 0.25", 0.04" pins |

**Stock Oscillators are available for the following frequencies for use in PC Electronics, 70cm, TV Transmitters. Note: the PCE transmitter output is a 4 X multiplier of the crystal frequency.**

| PXO Frequency | 70cm Frequency | TV Channel |
|---|---|---|
| 105.5125 MHz | 421.250 MHz | 57 |
| 106.5625 MHz | 426.250 MHz | |
| 106.8125 MHz | 427.250 MHz | 58 |
| 108.3125 MHz | 433.250 MHz | 59 |
| 108.5000 MHz | 434.000 MHz | |
| 109.8125 MHz | 439.250 MHz | 60 |




**Phase Noise measurement: Comparison of 108.5 MHz, 5th overtone, crystal (yellow trace) and a PXO (magenta trace). Tested in the same oscillator circuit. Pout = +4dBm. 5 MHz span. 10dB/div & 500kHz/div, 3kHz BW. For details, see AN-56.**

**( Note: due to the higher phase noise of the PXO, some excess "white" noise will exist in the TV picture when used in a PC Electronics, AM-TV transmitter. For more details, see AN-56. )**

**KH6HTV-VIDEO** www.kh6htv.com e-mail: kh6htv@arrl.net
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