Scroll down to see the Hamtronics R139 and R303 product reviews--they were originally published with other amateur products--these other product reviews have been deleted to make it easier to locate the Weather Satellite Receiver Reviews.

Hamtronics R139 Weather Satellite Receiver

Reviewed by Steve Ford, WB8IMY
QST Managing Editor

People see satellite weather images every day. With coffee in one hand and a TV remote control in the other, they watch ominous storm fronts marching across the continent as they hurry through their morning rituals. Or, they take a more leisurely approach and surf the Web to find the weather images of their choice. Most folks realize that satellites provide these images, but the magic behind the technology remains a mystery (one they waste little time pondering).

For hams, however, the direct pursuit of knowledge and mystery is our *raison d'être*. If we cared only to *communicate* with people in other nations, we'd pick up our telephones or connect to the Internet. Only a lunatic in love with the magic of wireless attempts to accomplish the same goal by assembling a radio station and throwing him or herself upon the mercy of a fickle ionosphere. Hams are not content to merely communicate through the instruments of multinational corporations, we want to generate and receive signals ourselves—with equipment *we* control and operate.

That's why weather satellite image reception remains a vibrant subset of the Amateur Radio hobby. Rather than wait upon the images that TV stations and the Web can provide, we prefer to go directly to the source and see them in real time!

Weather satellites can be divided into two groups: those that zip around the Earth in low polar orbits, and those that appear to hover in distant geostationary orbits. The polar orbiters are the most popular among hobbyists. These satellites transmit strong signals on frequencies easily received by VHF radios.

Russia, the United States and China have launched polar orbiting weather satellites. As they circle the globe these satellites are continuously transmitting visible light and infrared images of the ground and clouds below. They beam the images to Earth in what is known as the APT—Automatic Picture Transmission—format. It is a wideband (about 40 kHz) FM signal composed of sync pulses and varying audio tones. The Russian Meteor satellites transmit on 137.300, 137.400 or 137.850 MHz. The American NOAA birds transmit on 137.500 and 137.620 MHz.

If you have a 2-meter FM rig that can tune through the weather-satellite frequencies, you can often hear them. As they come into range you'll notice an odd tick-tock metronome-type sound. Unfortunately, most ham receivers don't have a sufficiently wide bandwidth to enable image reception. That's where the Hamtronics R139 comes in!

Bottom Line

The R139, a simple antenna, some software and a sound card equipped PC is all that's required for receiving real-time images directly from a variety of orbiting weather satellites.

Introducing the R139

The Hamtronics R139 weather satellite receiver is essentially a five-channel crys-

Table 2
Hamtronics R139

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 137.3, 137.4, 137.5, 137.62, 137.85 MHz with supplied crystals.	As specified.
Modes of operation: WFM.	As specified.
Power requirements: 0.12 A (max volume), 10-15 V dc.	0.1 A (max volume, no signal), tested at 13.8 V dc.
Size (HWD): 2.3x4.9x4 inches; weight, 14.2 ounces.	
FM wide sensitivity (12 dB SINAD): 137 MHz, 0.2 μV.	137 MHz, 0.18 μV.
FM adjacent channel rejection: Not specified.	100 kHz spacing, 137 MHz: 48 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	100 kHz spacing, 137 MHz, 48 dB.*
Spurious and Image rejection: Not specified.	IF: 137 MHz, 105 dB; image, 53 dB.
Squelch sensitivity (threshold): Not specified.	At threshold: FM, 137 MHz, 0.05 μV.
Audio output: 1 W[1] into 8 Ω (THD not specified).	300 mW at 3.5% THD (max volume) into 8 Ω.

*Measurement was noise-limited at the value indicated.
[1]Maximum rating of the audio amplifier used in the circuit.

tal-controlled scanner that sweeps through the APT satellite frequencies mentioned above. The R139 offers the necessary bandwidth while maintaining low noise performance and good sensitivity. (I should note that the R139 could also be used as an "IF" for a microwave downconverter if you wish to capture images from the geostationary birds.)

Dual-gate FETs are at the heart of both the RF amplifier and mixer circuits. Five individual crystal oscillators are switched automatically (or manually) by a 4017 ring counter IC. Their signals are mixed to a 10.7 MHz IF, which is then processed all the way to low-level audio by a single IC (an MC3361). An LM380N provides the audio boost sufficient to drive a speaker.

The compact exterior of the R139 reflects the simplicity of the design. Sizeable **VOLUME** and **SQUELCH** controls dominate the front panel. Between and below the controls are five red LEDs numbered one through five. Small toggle switches select **POWER** and **AUTO** (scan) or **MANUAL** channel selection.

The rear panel offers a BNC antenna connector. The power, audio output, demodulator output and tape recorder controls are provided via a DB-9 socket. The choice of the DB-9 is a bit odd, but it's probably less expensive than installing separate connectors. It would have been helpful if Hamtronics had included a prewired DB-9 plug, but this is a minor nit to pick.

Setting up the R139

The Hamtronics R139 comes with an excellent manual, which makes installation and setup a breeze. The receiver requires 12 V dc and a small wall-module power supply is provided. You must wire the supply to the included DB-9 plug, which could be a problem for those unaccustomed to soldering wires onto small, multipin connectors. Just make sure you follow the manual diagram carefully. The same holds true for wiring the other DB-9 connections.

The first thing I did was to simply wire up a speaker and listen to a satellite pass. I used my satellite-tracking software to pinpoint the next NOAA-12 appearance and, sure enough, there it was—beeps, tick-tocks and all. Although my antenna was a small 2-meter Yagi in my attic, the satellite's signal was loud and clear. For most of my experiments with the R139, I used NOAA-12 and NOAA-14. Each satellite provides two overhead passes every 24 hours.

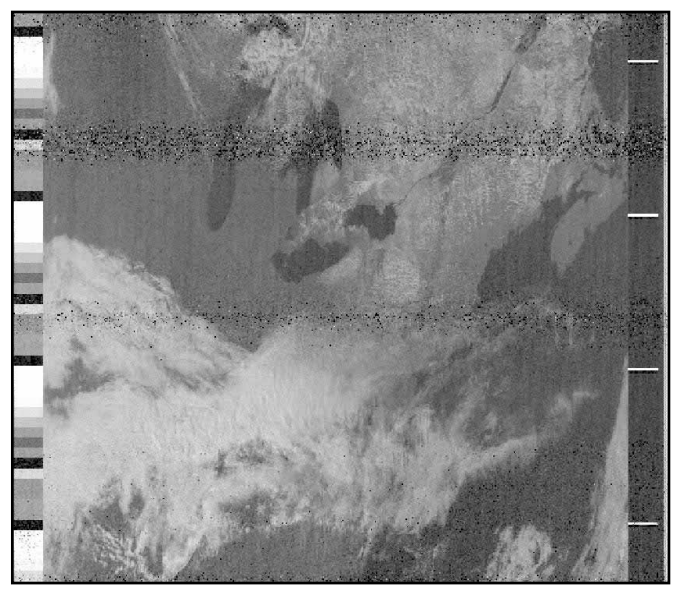
For the next NOAA-12 pass the following morning, I squelched the R139 and put it in the scanning mode. As NOAA-12 climbed to about 20° above the horizon, the R139 suddenly locked onto channel 3 (137.500 MHz) and the squelch opened to the rhythmic sound of the satellite.

Receiving and Demodulating Images

In the old days (prior to about 1996 or so) the only way to demodulate a weather satellite signal and display the resulting image on a computer was to use a stand-alone demodulator. Usually this took the form of yet another box that you placed beside your satellite receiver. And if you wanted to record images while you were away from home, you needed to have the means to store the signals, typically by using an audio tape recorder.

The R139 is equipped with a demodulator signal output line for those who still own hardware demodulators. It even includes a nifty tape-recorder control that "closes" a transistor switch whenever the squelch opens.

NOAA-14 at 3:21 AM. Night still blankets the upper Midwest and east coast, so this image was captured in infrared automatically while I slept! The satellite was passing behind my attic Yagi, which accounts for the noise in the signal. Even so, the image is fairly clear.



NOAA-12 crossed almost directly through the primary pattern of my antenna for this image. The Great Lakes and a large part of the Canadian Maritimes are clearly visible.

But for those of us who own PCs with sound cards—and that is most PCs sold today—there is a much easier method. Everything the external demodulators and tape recorders used to do can now be accomplished with software. The program of choice, and the one that I use, is *WXSAT* by Christian Bock. You can find *WXSAT* on the Web at **http://ourworld.compuserve.com/homepages/HFFax/toc20.htm**. This ingenious piece of software uses the DSP power of the sound card and PC to demodulate weather satellite images. *WXSAT* displays and analyzes the images for you. It will even do sophisticated automatic image processing and storage of both the images and the audio files.

The Hamtronics R139 and *WXSAT* are a superb combination. Connecting the two was as easy as running a shielded audio cable between the R139 and my sound card input. I was able to leave *WXSAT* and the R139 running almost continuously, grabbing satellite images whenever the birds came within range. Since *WXSAT* is *Windows* software, you can multitask, too. Believe it or not, as I was typing the previous paragraph in *Word97*, *WXSAT* was receiving an image from the Meteor 3-5 satellite!

But how well does it work?

My meager station is far from ideal for monitoring weather satellites. Not only is my antenna in the attic, it is a fixed Yagi. This is a liability because my reception is limited to only that portion of each satellite pass that travels through my Yagi's pattern. Unless you can track the satellite throughout a pass using an azimuth/elevation rotator, a beam antenna does more harm than good. You are probably better off with an omnidirectional antenna such as a turnstile (Hamtronics sells these), eggbeater or quadrifilar.

My other liabilities include the fact that my antenna is close to my PC (enough birdies to make Alfred Hitchcock envious), and that fact that I don't have a receive preamplifier. Despite all this, the R139 did a remarkable job (see the sample images).

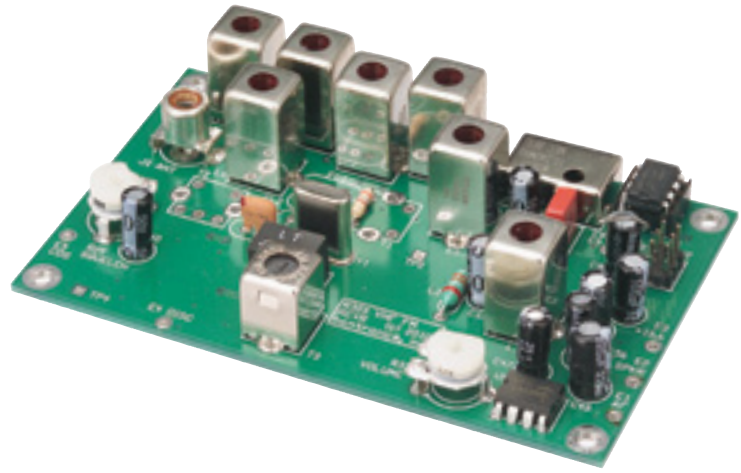
Conclusion

If you want to receive APT weather satellite images with your bare hands, you can't go wrong with the R139. It is a good receiver at an economical price. If you enjoy building, you can purchase the kit version of the R139 and save even more money.

Teachers should take note. The R139 is probably the least expensive means possible to expose your students to the awe and wonder of satellites. With the R139, the *WXSAT* software, a simple antenna and a desktop or laptop PC, students will be treated to an astronaut's view of their home planet. It's important to emphasize that the image they are seeing is not a stored picture that's hours or days old—it is a real-time snapshot taken from a spacecraft at the very moment that it's streaking over their heads! Radio doesn't get much more impressive than this. Ask any ham.

Manufacturer: Hamtronics Inc, 65 Moul Rd, Hilton, NY 14468; tel 716-392-9430; fax 716-392-9420; **jv@hamtronics.com**; **http://www.hamtronics.com**. Manufacturer's retail price, assembled with cabinet and 115 V ac adapter: $239; in kit form with cabinet and ac adapter: $189; in kit form less cabinet and ac adapter: $159.

Hamtronics R303-137 Weather Satellite Receiver Board



Reviewed by Mark Spencer, WA8SME
ARRL Educational and Technology Program Coordinator

I have been a user of the NOAA polar orbiting satellites sending *automatic picture transmission* or *APT* imagery for years. Additionally, during the ARRL Teachers Institutes, I encourage teachers to use these NOAA satellite signals and their imagery in their classrooms. A number of TI graduates have installed satellite ground stations at their schools and share imagery and weather observations across the county.

For hams interested in exploring the satellite facet of the hobby, the NOAA satellites are an excellent resource because their VHF signals at 137 MHz are relatively strong. They are easy to receive with basic equipment, and a variety of computer software packages (many freely available) make the display of the imagery from space a snap. The typical received image is illustrated in Figure 2, which was produced during this review. Though you can receive the NOAA signals with a regular 2 meter FM radio or police scanner tuned to the 137 MHz channels, quality reception of the APT signals requires a wider receiver bandwidth than FM voice. A receiver designed for APT reception gives far better results.

Overview

The Hamtronics R303-137 receiver is a replacement for the successful R139 weather satellite receiver that I have used for many years. It's is a weather satellite adaptation of the Hamtronics commercial-grade VHF FM receiver. The R303-137 has four frequency synthesized channels that cover the NOAA satellite frequency plan and it has an IF bandwidth that is optimized to receive APT imagery.

The receiver is not a plug-and-play unit and comes as a circuit board only. The user installs and solders interconnecting cables and wires to connect the board to a 12 V power source, antenna, speaker and computer sound card. (You can mount it in a suitable enclosure if desired, but that's not necessary.) Putting the receiver on the air requires only basic soldering skills and would be a good first project for those interested in hands-on construction.

The Review Setup

I tested the receiver using two antenna systems. The first was a high end antenna system that consists of a homemade eight element, right hand circularly polarized Yagi with an antenna mounted preamp and low loss hardline coax from the antenna to the shack.[1] The antenna is mounted on a computer controlled azimuth/elevation (az/el) rotator system that automatically tracks the satellite. This antenna system has been developed over the years and gives consistent horizon to horizon, noise free imagery.

The second antenna was a starter system that consisted of a homemade turnstile antenna with a run of 75 feet of RG-8X coax with and without an antenna mounted preamp.[2] The display software was *WXTOIMG* running on a typical laptop computer.[3]

From the Box to First Image

The review receiver came with the optional power supply cube and a few pages of documentation. The documentation, though it appears Spartan, is well written and contains all the information you need to set up and connect the receiver to the external parts required for operation. Following the directions, it doesn't take long to solder the required wires to the through hole solder pads and make connections to the power supply, speaker, computer sound card and antenna.

Channel selection is made by jumper-

[1]The eight element Yagi antenna is detailed online at **www.arrl.org/ariss-tracking-interface**. Though the dimensions are for 2 meters, the antenna is easily scalable for 137 MHz. Contact WA8SME at **mspencer@arrl.org** if you would like the dimensions for the weather satellite version of the antenna.

[2]The documentation refers to the turnstile antenna design as published in the *ARRL Weather Satellite Handbook* (unfortunately this excellent resource is no longer in print). If you would like the details of the turnstile antenna referenced and used in this review, contact WA8SME at **mspencer@arrl.org** and request an extract that includes the information.

[3]The display software used in the review can be downloaded from **www.wxtoimg.com**.

Bottom Line

With a little work, the R303-137 weather satellite receiver board offers a great way to receive fascinating weather satellite images.

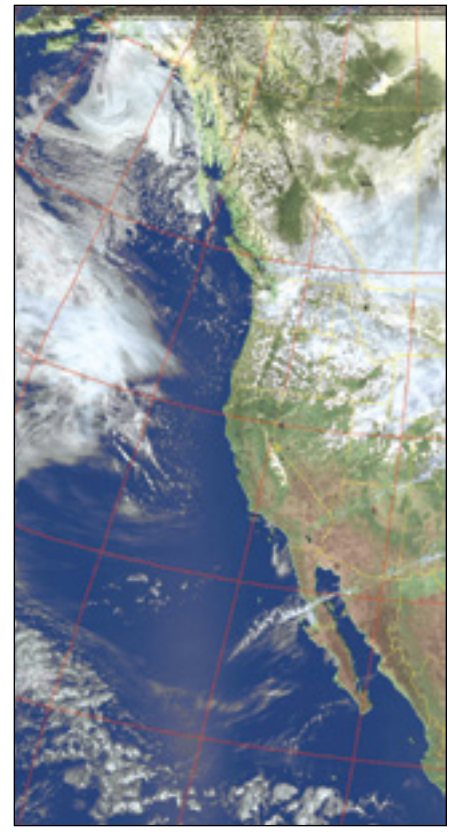


Figure 2 — This image was received with the R303-137 connected to a Yagi antenna and mast mounted preamp.

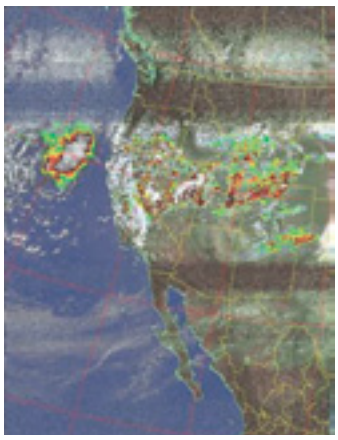


Figure 3 — Image received using a simple turnstile antenna with no preamp. Note how noise bars in the image correlate with nulls in the antenna pattern.

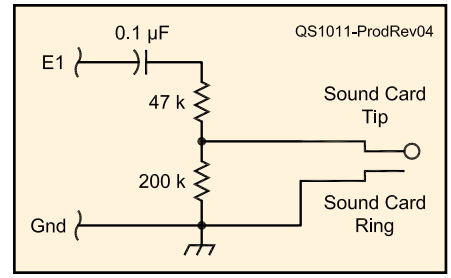


Figure 4 — Schematic of the pad used to reduce the receiver audio output for better compatibility with computer sound cards.

Table 2
Hamtronics R303-137 Weather Satellite Receiver

Manufacturer's Specifications	*Measured in the ARRL Lab*
Frequency coverage: 137.9125, 137.620, 137.100, 137.500 MHz.	As specified.
Power requirement: 13.6 V dc at 38-100 mA.	Full volume, no signal, 90 mA.
Minimum operating voltage: Not specified.	6.9 V dc.
Mode of operation: FM.	As specified.
FM sensitivity: 0.2 µV.	For 12 dB SINAD, 9 kHz deviation: 137.100 MHz, 0.27 µV; 137.5-137.9125 MHz, 0.23 µV.
FM adjacent channel rejection: Not specified.	100 kHz offset, 46 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	100 kHz offset, 46 dB.*
Squelch sensitivity: 0.15 µV.	137.5 MHz, 0.12 µV.
Speaker audio output: 1 W, 8 Ω load.	Full volume, 926 mW at 7.6% THD. THD at 1 V_{rms}, 2.1%.
Size (width, depth): 4.0 × 1.5 inches; weight, 3 ounces.	
Price: R303-137 PC board, $229; ac adapter, $9.50, LNK-137 preamp, $99.	

*Measurement was noise limited at the value indicated.

ing the appropriate pads to ground. The documentation suggests using a rotary wafer switch connected to the frequency select pads through 1N914 or similar switching diodes. During my satellite operations, I use only the newest birds (N19 and N18) of the constellation, requiring only two frequencies. Therefore an SPDT switch is all that's required.

The receiver SQUELCH and VOLUME controls are mounted on the circuit board and there is no scan function. This may seem like a limitation, but in reality it is not. In practice, the only time I listen to the audio during a satellite pass is while I am giving a demonstration; otherwise the speaker is switched out or the volume turned down so that it is not audible. Likewise, since I am not monitoring the satellite audio, I leave the squelch wide open. Finally, there are times when multiple satellites are within range at the same time, so a scan function might cause the receiver to lock on the wrong satellite. Consequently, on my R139, which does have a scan function, I leave the scan off and manually select the desired frequency.

Once wired up, I connected the R303-137 to the antenna and waited for the first pass. The receiver worked the first time and the results were identical to those obtained with my old R139 receiver as illustrated in Figure 2. Throughout the day I jumpered the frequency selection pads to the other three channels and captured similar results from the other birds. The only surprise was that the audio out of the COMPUTER INTERFACE port, E1, was at too high a level to be controlled by the *Windows* sound card control panel. The receiver produced more than adequate audio to drive the speaker and the squelch functioned as advertised.

Next I connected the receiver to the temporary turnstile antenna. The receiver produced acceptable results, consistent with the limitations of the antenna, as illustrated in Figure 3. I modeled the turnstile and displayed the elevation plot (rotated 90°) next to the imagery. There is remarkable correlation between the nulls of the antenna and the bars of noise in the image.

I inserted an antenna mounted preamp, but there was little improvement in the image quality. The preamp may help with coax line loss, but it does little to make up for marginal antenna performance. There is ample sensitivity in the R303-137 to compensate for reasonable coax line losses.

The simple turnstile antenna offers respectable results and I know of schools that produce excellent quality images with these fixed antennas (though it takes some tweaking to optimize the installation).

I Wish They Had...

In working with the R303-137 receiver, I found a few things that would improve the product.

- The documentation mentions that the power cube positive and negative leads are identified by ribbing on the positive lead (both leads are white). These ribs are a bit subtle and could be easily missed. If the power leads happen to be connected backward, the receiver will not work and there is a good possibility that the audio amplifier IC will be damaged by the reversed voltage. I wish that there were a protective diode installed in the positive voltage line to prevent damage.
- The through hole pads used to make off board connections are well marked and easy to get to. There is, however, a lack of convenient and easily identifiable ground pads for completing the interconnections. I wish that there were ground through hole pads right next to the off board connection pads to make ground returns more convenient.
- The documentation addresses two ways to feed the audio from the receiver to the computer sound card — connecting to the speaker audio output line, or connecting to a dedicated audio line that samples the audio before the audio output IC. The audio

level to the computer is critical for quality imagery. If you elect to use the speaker audio, any change in speaker volume will affect the imagery. Therefore I prefer to use a dedicated computer audio connection that is independent of the speaker volume.

The output level of the dedicated audio line, however, is fixed and at too high a level to be handled by the *Windows* sound card VOLUME control. The voltage divider circuit depicted in Figure 4 was inserted between the E1 pad on the receiver board and the computer sound card. I wish the receiver provided a way to adjust the audio output for the computer sound card connection.

■ The antenna connector mounted on the receiver board is a phono jack, I would prefer a more traditional coax connector such as a BNC jack. The phono jack works, but I found that the plugs that I had on hand in the shack would not seat all the way into the connector. Hamtronics sells an optional phono plug that probably fits just fine.

Conclusion

The last of the NOAA series of APT satellites was launched a few months ago (N19). Once the existing four birds go silent, we will lose a wonderful resource. However, I estimate that the birds will last for another 12 to 15 years, so any investment in accessing these birds is well worth the effort. The R303-137 receiver works well and is a good choice. In my view, not being plug-and-play is a plus and will encourage the development of construction skills.

Manufacturer: Hamtronics, Inc, 65 Moul Rd, Hilton, NY 14468; **www.hamtronics.com**; e-mail **sales@hamtronics.com**.