MODIFYING A MSR 2000 UHF REPEATER TO BE BOTH A VOICE REPEATER AND A PACKET DIGITAL REGENERATOR

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These notes are to assist in modifying a Motorola MSR 2000 UHF repeater aligned for the Amateur Radio Band to both operate as a voice repeater and serve as a digital regenerator at a data rate of 9k6 bits per second.

1. Verifying Operation of MSR 2000 Repeater.

   a. Make sure you are working with a repeater version of the MSR 2000 (which is also available as a base station in several configurations.) [You can use the repair/shop manual – will identify the one used if you need it email N4KOX at oderr@bellsouth.net - for the VHF or UHF base/repeater – as these points are the same for both the MSR 2000 VHF and UHF stations. This mod was made on a UHF repeater.]

   b. Determine that the repeater works on voice repeat and transmits PL. The Repeater ***has to be*** a CTCSS (or "Private Line") equipped repeater on transmit so your voice users will not hear the 9k6 data being sent.
   c. Determine that the voltages at the PTT level and the PLL insert point are within the manual voltages (some repeaters have non Motorola CW or Voice IDs that may have caused excessive voltages on the Local PTT and/or Line PTT.)

2. Verifying operation of the TNC.

   Determine that the TNC with a 9k6 modem and PACCOM digital regenerator chip works to both send and receive valid 9k6 data and regenerate the signal. (These mods used a Paccomm Tiny 2 with a Paccomm 9k6 Modem.)

3. Repeater Modification steps:

   a. On the back plane install diode from Transmit PL inhibit (Position Pin 17) to LINE PTT (position 12, Pin 19 – cathode toward pin 19 (this pulls PL down when PTT comes from TNC.)

   b. On the exciter board: jumper Channel Element Pin 4 side of Jump 501 to Pin 6 E 500-6 unused pin on the exciter to apply audio from the digital regenerator as an audio input to the channel element.

   c. On the back plane install a single throw single pole enclosed 12 v reed relay (this can be a Radio Shack PCB enclosed reed relay, either a single pole

or double pole, single or double throw relay – only needs a single throw/single pole):

(1) Coil to A+ (12 v) (Pin 20 of exciter section of the back plane)
(2) Other side of coil goes to the Line PTT at a screw contact E16 in the between positions 8 and 9 back plane.
(3) Contacts of the relay:
  (a) Pin 6 (in the exciter section of the back plane) J 102 audio (exciter connector)
  (b) Other contact goes to TX audio from TNC.

d. Receiver Audio from receiver 1 on repeater Pin 5 in receiver 1 section of the back plane J 202 to receive audio in the TNC

e. Run a wire for PTT from Line E16 (a screw terminal on the back plane) to PTT on TNC.

f. Ground on TNC goes to Ground (any convenient ground on back plane.

4. TNC modifications and adjustments..

a. On the bottom of the modem board (non component side) cut the jumper from SPTX "low" pad (the default connection) and install jumper to "HI" pad. (This modification is documented on page 8 of the Paccomm 9k6 modem manual. It allows the modem to provide up to 8 volts of output to drive the Motorola radios (we needed about .5 to .75 rotation of the level pot on the top of the modem.)

b. Set audio using the transmit audio adjustment on the 9k6 modem to a point where the data is consistently decoded by the receiving station.

c. Set the ax.25 parameter TXD to accommodate consistent repeating of packets by the regenerator. (On the test bench with the transmitting radio (Tait UHF) at 25 watts into a VHF dummy load and the repeater on a UHF dummy load the digital regenerator consistently decoded frames from the transmitting radio with a TX Delay setting of 35 on the Paccomm Spirit controller used by the transmitting station.

d. Field testing 18 miles from the repeater using the same equipment as above and 5/8 magnetic mount antenna cut for the commercial UHF band on top of vehicle worked at a TXD of 35, it was better at 37 and almost perfect every transmission was regenerated at a TXD setting of 40 ms – performance will depend on your location, terrain, conditions, etc – like any other two way radio situation. But field tests have proven to be successful at this time. Paclen (or length of packets may also need to be adjusted on the user stations under some conditions. No adjustments

should be required at the repeater after initial set up as the digital regenerator only retransmits what it properly decodes.)

5. Operation.

Voice users will send PL when they are transmitting and use PL decode when receiving. They will not hear the data being sent between voice transmissions.

Repeaters in commercial service do not send PL when the CW ID is sent. Some amateur repeaters are set up this way also. The 9k6 data input to the transmitter uses the same PTT line that the CW ID uses to strip the PL when sent.

Packet stations will not use PL when transmitting. The digital regenerator will detect the incoming data, verify it is valid data and send PTT to the LINE PTT point on the repeater. The LINE PTT strips/inhibits the PL from being transmitted, puts the repeater in transmit and the data is sent. (Thus the voice users using PL decode will not hear the data being sent.)

While this is not full duplex, it allows a reduction in the time required to send data between packet stations, eliminates the "hidden transmitter" problem of larger LANs (all using data stations hear the repeater if they are in range of the repeater) so distant user stations (while they are too far apart to hear each other directly, both hear the repeater and don't transmit if another data station is sending on the repeater frequency at 9k6 data rate.

If you are using a radio for your user stations that has PL detect and can be programmed to not transmit if there is PL present, they will not transmit while a voice user is on the repeater. The detection scheme that TAPR 2 clone 1200 AFSK packet controllers use will not work on 9K6 – they will only detect other 9k6 data. But a method of inhibiting the data transmissions while voice transmissions are being used on the repeater would be a good option.

However, unless the transmissions are long or extend over a period of time – voice users will only hear more aggressive "white noise" when the data is being sent. In normal operation, if the voice users should pause between transmissions (a good practice on all repeaters,) at 9k6 the data will flow between the data stations with little interruption even without the PL detect feature.