of the case. That is the one with the two mounting holes drilled in the bottom. Use the 2 flat head 1/4" 4-40 screws to mount the circuit board to the case bottom. All that is left is to put the catches on the top of the case, snap it on, and your Cascade is finished except for painting and labeling.

We are leaving the labeling of the Cascade up to you. That is what makes a home brew rig unique and it gives you the opportunity to "customize" your rig. We are not providing a screen service as we did for the NorCal 40 and the Sierra. It just became too big of a job, and it lasted far too long.

If you decide to paint your Cascade, **DO NOT** Paint the inside of the panels!! Also, each time that you remove the back panel, be sure to apply more heat conductive grease to the final.

CASCADE OPERATION NOTES

12V POWER REQUIREMENTS

You'll need a supply capable of 2 amps on voice peaks. It's a good idea to monitor both the 12V input current and voltage during your initial check out. When operating the rig with a battery select one with enough capacity. Lead acid batteries should be rated at 4A/hr and Nicad batteries should be rated at 2.2A/hr.

ANTENNA

Avoid transmitting into an unknown VSWR or over 3:1. The PA transistor isn't protected by high SWR shut down circuitry. An inline SWR/ Pout wattmeter is recommended. It's best to do the initial rig check out into a dummy load. This insures an excellent SWR.

2 METER SPEAKER MICROPHONE

The rig accommodates a "Kenwood standard" speaker microphone. These microphones come in two sizes. The larger style will have better fidelity for SSB. The compact microphone style has a lot of distortion. Several prototype builders purchased the Radio Shack Microphone for $19.95. This gave adequate performance

Resist the natural temptation to shout or "close talk". The microphone amplifier chain has a sensitive speech processor. Holding the microphone about 3 inches from your mouth is about right. Soliciting on the air transmitted audio reports is the best way to know if everything is working as it should. If you have more the one microphone, see which one works best.

RF/AF GAIN

It's best to set the AF gain at a moderate level, RF gain fully clockwise. Lower the RF gain if extreme signal levels are present or the background noise level is to high.

INTERNAL ADJUSTMENTS

BFO

This is the critical one. It's a bit touchy to get right. The BFO trimmer sets the pitch range on the receiver and transmitted audio. Start by adjusting the 75m trimmer C90. Find a solid S9 signal on the 75m band, adjust until the the audio has enough highs and lows. You'll need to touch up the VFO as you move the BFO. As a final tweak, do an on the air transmitted audio test with a fellow ham. Try a small change and see if it is better or worse.

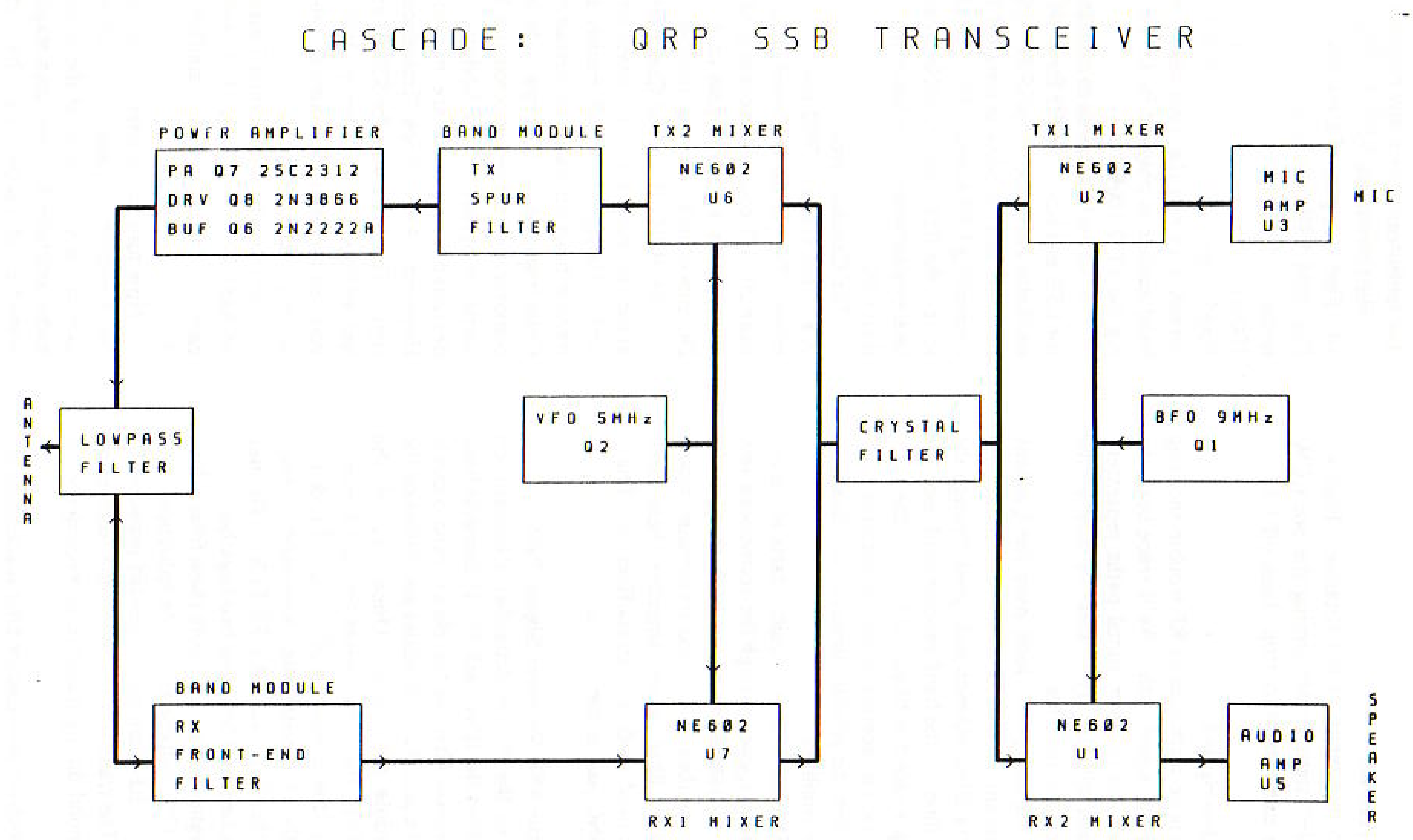
Another BFO alignment technique is to measure the 3dB passband. Here you'll adjust the BFO to set the 3dB points at 300Hz and 3000Hz. One can do this with only a DVM and station transmitter as a signal source. Use your station transmitter to radiate a steady S9 carrier into the Cascade receiver. Connect the DVM set to AC volts across the speaker terminals. Use the transmitter's incremental TX tuning to find the 3dB points in the pass band, 70% reduction in voltage. Adjust the BFO to get these at 300 and 3000Hz.

Carrier Balance

You'll need a QRP watt meter for this one. Set it to its lowest scale, 1W full-scale. Key the microphone, and without speaking adjust for minimum output.

PA Bias

Measure the voltage drop across R80. We'll want to set the voltage for Iceq = 250mA or


CASCADE: QRP SSB TRANSCEIVER
POWER AMPLIFIER
PA Q7 2SC2312
DRV Q8 2N3866
BUF Q6 2N2222A
BAND MODULE
TX
SPUR
FILTER
TX2 MIXER
NE602
U6
TX1 MIXER
NE602
U2
MIC
AMP
U3
MIC
ANTENNA
LOWPASS
FILTER
VFO 5MHz
Q2
CRYSTAL
FILTER
BFO 9MHz
Q1
BAND MODULE
RX
FRONT-END
FILTER
NE602
U7
RX1 MIXER
NE602
U1
RX2 MIXER
AUDIO
AMP
U5
SPEAKER

250mV from R80 to ground.

AGC Threshold

Set to mid-range of pot rotation. Find a " strong S9+" station start turning the pot CCW. When the audio starts to drop , back off 1/4T.

Circuit Description

A valuable technique in RF trouble shooting is tracing the signal path. We'll trace both the transmitter and receiver signal paths separately. This section will also try to clear up how all the schematics link together.

As a starting point, look over the Cascade Block diagram on page 29. The receiver circuitry starts at the BNC antenna jack, goes through the low pass filter on the band module card, into the receiver pre-selector filter, back on to the main board to the 1st receiver mixer, through the crystal filter, then the product detector and finally to the audio amplifier.

The SSB transmitter circuitry starts at the microphone input, goes through the microphone amp into the 1st transmitter mixer, back through the crystal filter, then to the 2nd transmitter mixer, transmit spur filter, power amplifier chain, back on to the band module lowpass filter, and finally out the BNC jack to the antenna.

Tracing the SSB Receiver Signal Path

Turn to the Power Amplifier schematic on page 26. Find the BNC jack J5. It connects back to the lowpass filter on the plugin band module board. The actual circuit values are shown on the band module schematic. Once through the lowpass filter, the signal passes through a narrow band pass filter consisting of C1, L1, T1, & C2. Turn to the IF Crystal filter schematic on page 20. Find the 'flag' text "RX FILTER". The flag on both schematics links the two together.

The signal loss through both these filter is low, less than 12% voltage amplitude reduction. Notice The 1K RF Gain pot connected between T1 and L1. The transistor Q1 shunts the receiver input to ground during transmit, protecting the 1st mixer IC.

The receiver pre-selector filter is adequate but not up to the task of protecting a NE602 in a field day multi-transmitter environment.

Next turn to the VFO, BFO schematic on page 14. Find Q2, part of a Hartley oscillator circuit. For 20M SSB phone band coverage, the VFO tunes 5.15MHz to 5.35MHz. It needs to be 100kHz lower to tune the 75M SSB phone band. Fixed caps C22 and C25 set the 200kHz band-spread, C17 sets the band edge. When the 75M band module is plugged in, C34 is added lowering the VFO 100kHz.

The 9Mhz BFO needs to oscillate above 9MHz for LSB and below 9MHz for USB. C19 sets the oscillator 2kHz above the IF for 75M LSB. When the 20M band module is installed D10 is bias on connecting C90 across C19. The addition of C90 lowers the BFO below 9MHz. There is some interaction between these adjustments, set C19 first then C90.

The Cascade uses four NE602 active mixer ICs. Find U7, a NE602 used as the 1st receiver mixer. Turn to the IF Crystal Filter schematic on page 20. U7 converts incoming RF to the IF frequency with a voltage gain of 4. Q11 removes DC supply to U7 during transmit.

The 9MHz IF crystal filter uses 5 "computer grade" crystals, Y2 - Y6. These were matched to within 100Hz. For SSB fidelity a Butterworth transfer function was used instead of the common Cohn response for CW rigs. The bandwidth is a compromise between opposite side band rejection, carrier suppression and fidelity. The filter was designed using software provided with Wes Hayward's ARRL book "Introduction to RF Design". This book sells for $29.95 and is an excellent addition to your library. With this software you can redesign the coupling caps to suit your desired characteristics.

Next turn to the Product Detector schematic on page 19. The 9MHz IF is converted (with a gain of 4) to audio in U1, another NE602 mixer IC.

Now turn to the final receiver schematic, Audio Amplifier on page 17. Most of the receiver gain in the Cascade is at the audio range. The audio amplifier has two gain stages. U8, a low noise NE5532, provides a voltage gain of 22. U5, a LM383 provides an additional voltage gain of 1000. You'll notice there's no IF amp in the Cascade.

AGC is a circuit right out of the NORCAL Sierra. A JFET, Q17, attenuates S9++ signal to a reasonable audio level.

Q5, a MOSFET 2N7000, mutes the speaker during transmit. During receive, the on resistance is less the 3 ohms.

Tracing The SSB Transmitter Signal Path

Tracing the transmitter signal path starts at the microphone input jack. Turn to the Product Detector schematic on page 19. Find J1, the front panel microphone jack. The radio accepts a Kenwood standard" electret microphone circuit. These microphones have the PTT switch and microphone in series, the PTT switch completes the circuit to the ground terminal.

Q3 provide the 2V microphone bias and switches the 8VTX line during transmit. U3 provides a one chip speech processor. The chip samples the microphone audio and adjusts the gain to hold its output at pin 8 at a constant 100mV RMS.

More than 20dB of speech compression is possible. R4 sets the amount of compression. R4 is set at 1K, I set the compression at a moderate level, you may want to experiment with different settings. R1 and C86 set the attack and decay times. You may want to tweak the values for some more audio punch.

Next the signal passes into Q15. Q15 mutes the transmitted audio during receive. R63 is a fixed resistor, this is a good place to adjust the microphone gain. 4.7K is about right to drive the NE602. It is easy to over-drive the NE602 active mixer IC and end up with lots of out-of-band spurs.

U2, the third NE602, generates the double side band signal at 9MHz. Carrier balance would be improved if U3 pin 5 and 4 drove a balanced transformer into the crystal filter. For now it is a single ended drive, yielding 30dB of carrier balance.

Q14 disables the transmitter mixer during receive, this stops hiss from showing up in the audio due to the TX mixer.

The double side band RF next passes back through the IF crystal filter. Turn to the IF Crystal Filter schematic on page 20. The SSB filter removes the opposite side band and suppresses the carrier. U6, the final NE602 mixer IC, translates the 9MHz RF to the final transmit frequency with a voltage gain of 4.

The output of U6 pin 5 goes to the unity gain JFET buffer. The drives the 50 ohm terminated transmit spur filter. The transmit spur filter is on the band module card, refer to the band module schematic for circuit values.

Now turn to the final transmitter schematic, Power Amplifier on page 26. The transmit spur filter is represented in the bottom right corner. The filter is driven with baluns to improve spur rejection due to signal leakage around the band module card. Both transmit filters have low signal loss when properly adjusted. Both filters match into 50 ohm terminations. Once through the appropriate filter, the low level SSB signal is amplified in 3 gain stages. The first two stages are biased for Class A operation. This takes a fair amount of idle current. The final power amplifier transistor is biased for AB operation. With no signal the 2SC2313 should draw 200mA.

D12 maintains a constant bias current as the final heats up with use. D12, which is in physical contact with the case of Q7, temperature compensates the bias network. The 2SC2312 needs a low value emitter resistor to stabilize the bias network. This did reduce the power out some. A compromise was made to help keep the Cascade cost low. A low cost 2SC2312 was selected. For those wanting more output a MRF477 can boost the power out for an extra $18. RF Parts sells these via mail order.

The SSB signal next goes back to the band module board where the lowpass filter is located. The 75M lowpass filter has two extra caps, C13 & C14. These add a deep notch at the second harmonic of 3.8MHz, to attenuate the highest spur.

That is it, now you should have an understanding of the way that the Cascade works.

DESIGNER'S NOTES:

I'd like to thank the many NorCal members that made this kit possible, and especially you who bought the kit solely on NorCal's excellent reputation.

Jim Cates, finance manager, who oversaw that NorCal standards were met.

Doug Hendricks, QRPp editor, who prepared over 200 Cascade parts kits, edited text, schematics, charts and drawings into an outstanding kit manual, acquired and sorted over 64,000 high quality parts (many purchased at unheard of savings) for NorCal members. Doug has been a joy to work with during the past 10 months. His endless enthusiasm for QRP keeps us all going.

Prototype kit builders; Dave Meacham, Doug Hendricks, Vern Wright, and John Koenig. Dave was a key technical contributor and helped refine the design.

Jeanette Hayes and Terry Sherbeck for PCB design assistance.

Early design consultants; the entire BC (SSB) QRP gang, Derry Spittle, Bruce Gellatly, and Joe Stipek. Wayne Burdick, Wes Hayward, and Roy Lewallyn.

I hope you enjoy the challenge of building a SSB transceiver. NorCal has a lot of members to team up with to build and test the Cascade. Contact Doug Hendricks, KI6DS, Dave Meacham, W6EMD, or myself, K7RO, we'll be thrilled to assist you.

Now that the kits have shipped, I'll publish a follow-up article in QRPp. I need to know what didn't go smoothly for you. If some common problems turn up, I'd like to share a solution with all the NorCal members. Likewise, if you have some exciting successes, let Doug Hendricks know about it. I have great hopes for the Cascade, I think it ties into one ofthe major interests in ham radio - TALKING! Now, chatting with friends can be done on a rig you built yourself. I suspect mostof you will want to add to the basic Cascade design. I encourage you to let Doug or I know what you've accomplished. Who will be the first to add CW? Who will add a digital display?

72, John

CASCADE TROUBLE SHOOTING GUIDE

The following is list of useful checks. As a first step visually inspect the board for missing parts, solder bridges, broken or open traces. Check for broken ceramic capacitors, verify value. If possible compare your board against another Cascade. Look for differences between the two boards ie: incorrectly installed parts, missing parts, backwards caps, broken parts, or wrong value installed. Check to see the transformers are oriented correctly. You may need to use a ohmmeter to double check resistor values if you have any doubts. I always check each resistor with a ohmmeter before installing it in the board.

Try to isolate the problem by checking the DC voltages in the chart below.

Next try to isolate the problem by tracing the signal path.

If you still have difficulties, seek help from another NorCal member nearby. Doug Hendricks, KI6DS, Dave Meacham, W6EMD, and John Liebenrood, K7RO may be able to assist you. Doug, Dave and John are on internet. If you call, please call after 6PM Pacific time. If you send a letter that requires a reply, please enclose a self addressed stamped envelope.

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415-

1. DC Voltage Chart for Active Devices

Conditions: Receiving, no signal, 14.1V power supply, using a DVM.

Device	Pin	Voltage to Ground
U1	1	1.41
	2	1.41