The Hellgate Static
Sep 2024

Hellgate Amateur Radio Club
P.O. Box 3811, Missoula, MT. 59806-3811
Web: www.w7px.org

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HARC Events

Coming Events 2024

Sep 07 Fox Hunt 10-2 – CANCELED – go bake some bread its World Bread Day
Sep 09 HARC Testing, Meeting
Voting on HARC Constituation and By-Laws
Sep 11 Patriot Day
Sep 22 First Day of Autumn
Oct 14 HARC Testing, Meeting
Columbus Day

Officers:

President: NZ7S
Vice-President: W7RPG
Treasurer: KJ7YHG
Secretary: K7MSO

Positions:

Emergency Coordinator: contact_us@w7px.org
QSLs, Awards: contact_us@w7px.org
Webmaster: contact_us@w7px.org
Asst Webmaster: editor@w7px.org
License Exams Contact VE:
harc.ve.testing@gmail.com
Static Editor: editor@w7px.org

Repeater Committee:

W7RPG (Chair)
K7QA --- Dec 2022 for (23/24)
KG7WYO – Dec 2022 for (23/24)
N7PAS -- Dec 2023 for (24/25)
KI7PCR -- Dec 2023 for (24/25)

C&BL – Board + N7PAS and K7MTD

Buy-Sell Operations hfc@w7px.org
W7XT, K0SN, K7QA

HARC Sep Meeting

Program: DR-2X Repeater Demonstration/ Operation By NZ7S

RADIO TESTING EXAMS AND MEETING

The testing and meeting are on the 2nd Monday of each Month.
We are having in-person, electronic testing and monthly meetings.
The Radio license Exams are from 5:30-6:30PM
Meetings which start at 7:00PM (Program & Business).
Both will be held at **The Church of Jesus Christ of Latter Day Saints**, 3026 South Avenue West, across the street from Big Sky High School.
Use the North entrance as all others will be locked.

Published: 4 Sep 2024 @2:00 PM by N7PAS

12 Aug 2024 Exam Testing Results

Congratulations to:

1. **Brian Johnson** of Missoula has passed his **Technnician** exam. His call sign is **KK7UVJ**.
2. **Ronald Kay** of Clinton has passed his **Technnician** exam. His call sign is **KK7UWB**.
3. **William Schmidt** of Florence has passed his **Technnician** exam. His call sign is **KK7UVK**.

12 Aug 2024 HARC Meeting Minutes

Meeting called to order @ 7:05 PM

1. **Attendance:** N7PAS, W7RPG, KK7NOM, KK7QJH, N7DLP, KF7GZR, K7MSO, K7QA, K0SN, W7XT. Quorum - **Y**

   Visitors: Hunter Abbott, Jerry Ehli N7GE, Scott Holgate

   NOTE: 10 Members / 3 Visitors present. Thank you to all that attended.
2. **Last meeting minutes, Jun:** Motion to approve minutes: 1st N7DLP 2nd K0SN
   Discussion __None_____ Vote: Passed
3. **Treasurer's report Jun, KJ7YHG:** _Absent, Nothing to report _____
   _____ Motion to approve report 1st _____ 2nd _____Vote: Tabled
4. **Repeater Committee W7RPG:** New repeaters arrived. _____ 1st _____ 2nd _____
   Yaesu DR2X, Fit in rack, Dual band 2m/70cm, 50W, Analog/Digtal(C4FM), Replace 04__Vote: _____
5. **HF Committee Report K0SN:** _Nothing to report ____Motion to approve report 1st _____ 2nd _____
   _____Vote: _____
6. **New Business:** **a.** Repeaters arrived, - Install in September.
   b. Constitution and By-Laws Discussed, Cover letter read -- Vote on at Sept mtg.
7. **Up Coming Events:**
   1.) Fox Hunt 1st Saturday in September 10:00A-2:00p – No one called - Cancelled
   2.)
8. **Net Control Operators**

Aug	03	N7PAS	Sep	04	N7PAS
Aug	10	N7NHS	Sep	11	_____
Aug	17	NZ7S	Sep	18	_____
Aug	24	K7MSO	Sep	25	_____
___	__	_____	___	__	_____

9. **Good & Welfare:** 1.)

Meeting adjourned at 7:47 PM. Minutes by K7MSO

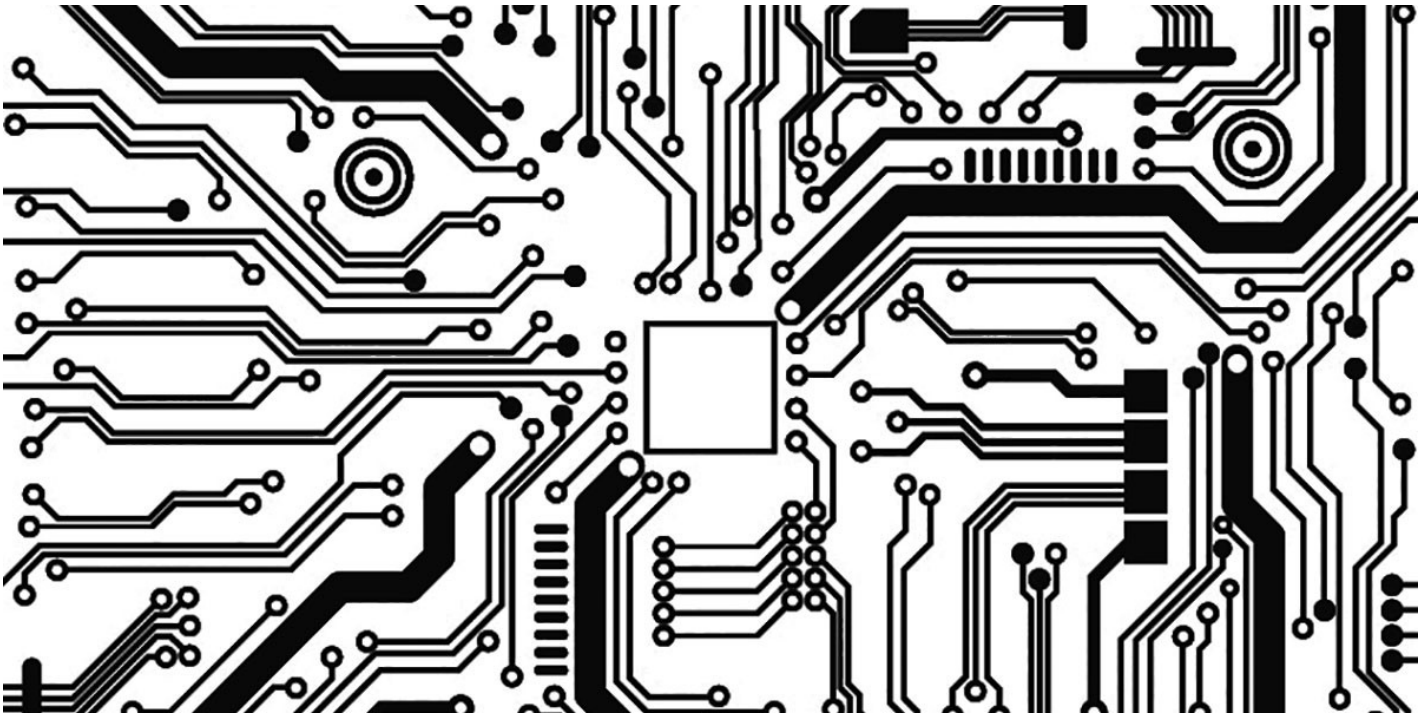
Program: Was DR-2x Repeater show and tell by NZ7S.

HARC INVENTORY -- FOR SALE

IF YOU DON'T LIKE PRICE, MAKE AN OFFER!
SEND EMAIL TO hfc@w7px.org FOR INFO OR TO MAKE PURCHASE.

Line	ITEM	MAKE	MODEL	CONDITION	VALUE	STORED
1	Computer	Dell	Latitude	Fair	100	?
2	Pow Supply 220-225mhz	Mirage	C106G	Good	25	?
3	Radio-Hand Held 2 met.	Realistic	HTX 202	Good	50	?
4	Portable Repeater		TM-241X2	?		?
5	Triband Beam	Hy-Gain		Few Missing parts	100	K0SN
6	Tuner	Signal Corps	BC939B	Parts only	25	K0SN
7	Speaker + Power Supply	Drake	MS-4 + AC4	Not tested	75	K7QA
8	Reflected Pwr Mtr	Heathkit	HM-15	Works	10	K7QA
9	Mobile Tuning Mtr	Heathkit	PM-2	Untested	10	K7QA
10	Trap Vertical	Hygain	14AVQ	Untested	150	K7QA
11	2 Mtr HH Transceiver	Realistic	HTX-202	Error Code	25	K7QA
12	Spkr. w/vol. control	Yaesu		Untested	50	K7QA
13	1993 ARRL Handbook			like new	free	K7QA
14	Handbooks	ARRL	1950-1980	OK	Free	KGVO
15	Vintage Mic	Astatic	JT-30	Untested	50	KGVO
16	13.8V, 20A power supp.	Astron	RS20A	No output	15	KGVO
17	RC checker	CDE		untested	30	KGVO
18	Rotor	CDE?		untested	50	KGVO
19	Transceiver	Collins	RT-91ARC-2	untested	100	KGVO
20	Transverter Interface	Down E. Micro		untested	offer	KGVO
21	Low pass Filter	Drake	TV-3300	untested	20	KGVO
22	Receiver	Hallicrafters	SX-100	fair	150	KGVO
23	Receiver	Hallicrafters	SX-62B	untested, poor	75	KGVO
24	Vintage Speaker	Hallicrafters	PM 23	Nice, untested	150	KGVO
25	Vintage Speaker	Hammarlund	S-100	Nice, untested	60	KGVO
26	AC Power Supply	Heath Kit	HP-23-A	works		KGVO
27	SSB Transceiver	Heath Kit	HW-101	needs repair		KGVO
28	HF Xcvr + Power Supply	Heathkit		untested	150	KGVO
29	Oscilloscope	Heathkit	IO-4105	untested	30	KGVO
30	Power/SWR Meter	Heathkit	HM15	untested		KGVO
31	Vertical antenna		Dipole 80	?		NOAA
32	Receiver	Heathkit	HR-10	untested, poor	offer	KGVO
33	SSB Adapter	Heathkit		untested	40	KGVO
34	Test Oscillator	HP	650A	untested	offer	KGVO
35	Rotor Control	Hygain	DCU-1	untested	200	KGVO
36	2M FM Transceiver	Kenwood	TR7400A	no output	10	KGVO
37	HF Transceiver +Man	Kenwood	TS-520	non-working	100	KGVO
38	Transmitter	Meissner	9-1160 (tube)	good		KGVO
39	Voice Keyer	MFJ	MFJ-432	untested	30	KGVO
40	Fwd/Refl. pwr meter	Midland	23-126	untested	10	KGVO
41	2 mtr mobile Xcvr	Radio Shack	HTX-242	untested	40	KGVO
42	Field str/SWR meter	Radio Shack		untested	10	KGVO
43	VHF/UHF/FM amp	Radio Shack		untested	20	KGVO
44	Gen. Coverage Rvr.	Realistic	DX302	untested	125	K7MTD

45	Receiver	Signal Corps	R-392/URR	fair	300	KGVO
46	VTVM	Simpson	311	untested	25	KGVO
47	Oscilloscope	Telequip.		untested	20	KGVO
48	Var. power resistors	Tru-ohm, etc		untested	10	KGVO
49	Scanner	Uniden	BC9000	works	50	KGVO
50	BUG KEY	unknown		fair		KGVO
51	Speaker	Yaesu	SP-8	Good,works	125	K0SN
52	Many electronic parts too numerous to list.				offer	KGVO
53	Misc. meters			untested,	40	KGVO
54	RCA male Patch cords			good	10	KGVO
55	Peter Dahl 10 HY @ 1 A		new	new		KGVO
56	Peter Dahl 40 HY @ .6 A		new	new		KGVO
57	Peter Dahl 9 HY @ 1.5A		NEW	NEW	200	KGVO
58	Peter Dahl Swgng Choke		new	new		KGVO
59	Antenna Tuner	Icom	AH-4			?
60	Voice Synthesizer	Icom	UT-102			?
61	Antenna Tuner + man	MFJ	MFJ-934			?
62	RTTY CW	MFJ		?		?
63	TRIPLEXER	Comet	CFX-324			K7MTD
64	DUPLEXER	Comet		works		KGVO
65	WATTMETER/SWR	MFJ	864	works	10	K7MTD
66	2 mtr, 30 Watt amp	Mirage	B23	works	25	K7MTD
67	Microphone	Astatic	D104, SE	needs work	offer	K7QA
68	Vintage Mic	Astatic	JT-30	worn,untested	50	KGVO
69	Rotor Control	Hygain	DCU-1	untested	100	KGVO
70	Power Supply	Heathkit	HP23C	untested		KGVO
71	VHF/UHF Transverter	Yaesu	FTV-700	untested		KGVO
72	Transceiver-HF	Heathkit	SB-101	untested		KGVO
73	Transmitter-HF	Heathkit	DX-20	untested		KGVO
74	Receiver	Knight	R-100	untested		KGVO
75	Tube Tester	Sencore	MightyMite7	untested		KGVO
76	RF Signal Generator	Heathkit		untested		KGVO
77	HF Transceiver	Yaesu	FT757GX	untested		KGVO
78	Auto Antenna Tuner	Yaesu	FC-757AT	untested		KGVO
79	Transmitter	Heathkit	DX-100B	untested		KGVO
80						



How To Succeed At Circuit Design By Learning From These Mistakes

By Bob Colwell

The only way to avoid ever making a mistake is to do nothing — but that would be a mistake! Just try not to make the same mistakes twice; better yet, learn from someone else's.

This article is intended to pass along some of the things I learned while designing and developing a Wi-Fi sprinkler project a while back. Some of my errors were outright blunders; some were fairly subtle; and some were tool related. A few might suggest to my alma maters that they reconsider whether granting me my EE degrees was a good idea. Please don't tell them.

Get the Physical Dimensions Right

If you intend to deploy something that you have designed — like a water sprinkler controller — into a functional role in your household, then to maintain marital harmony your design had better work reliably. That means that some lashed-together prototype board festooned with wires is out; you need a printed circuit board (PCB). If you have not designed one of these before, I encourage you to consider it. They're really fun, and they don't cost very much. Using very inexpensive (or free) downloadable software, you "capture" your schematic, map that schematic into a library of parts for their board footprint, place and route the board, then upload that new database to a board fabrication house. For around $100, you can get three boards with your own silkscreening — looking every bit as professional as the commercial boards inside your computer or television.

Despite many verification steps along the way, there are ways to goof up the PCB. One way that I did more than once was to not pay enough attention to the sizes of the holes associated with various components. The DipTrace software that I used for schematic capture and board layout did not have preexisting library entries for the Rabbit Semiconductor RCM5450W wireless module I wanted to use, so I had to create my own. Physically, this module has three bolt holes for the standoffs, and one 50-pin connector on a 0.05” pitch. I wanted to use a through-hole connector (for ease of soldering), so I found such a connector at Mouser and bought a few. Using their datasheets, I drew up the physical component and entered it into my private DipTrace component library. My RCM5450W module footprint looked like **Figure 1**.

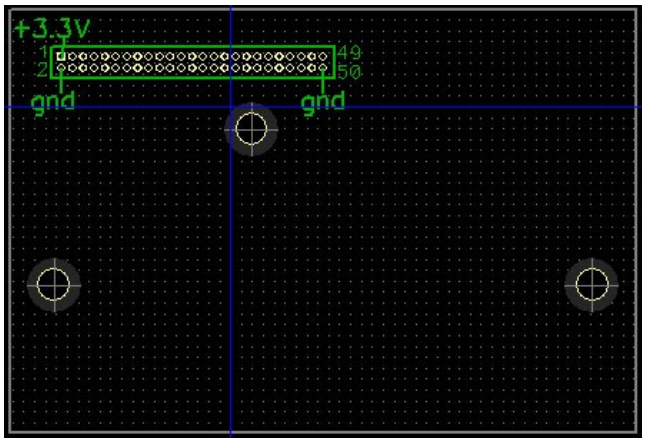


FIGURE 1. RCM5450W module PCB footprint.

On my first board revision, I got the bolt holes exactly in the right places by carefully reading the Rabbit documentation, and also by carefully measuring the actual module with a digital caliper — a procedure I highly recommend. (These calipers are inexpensive and extremely accurate.) However, I generally just eyeballed the hole sizes for the leads on the 50-pin connector, and that was dumb. I did that because when I used this new component in the PCB layout program, I got verification check errors about not enough clearance between the pins. Fixing that issue by shrinking the hole diameters was not my best idea ever. The real connector pins were then exactly the same size as the real holes in the real board, and all 50 pins did not want to go into their respective holes. Respin the PCB: $100.

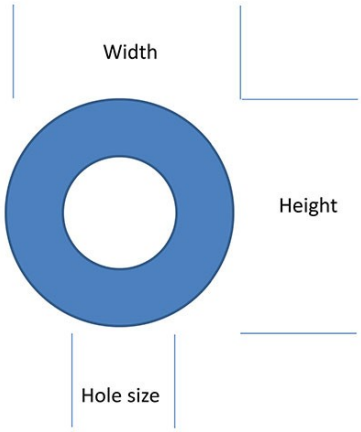


FIGURE 2. PCB through-hole dimensions.

Get the Pins in the Right Places

Then, things got worse. While fixing the hole sizes of the 50-pin connector, I managed to get the two rows of pins interchanged. I think this happened because the default pin numbering facility on my schematic capture software likes to start at pin 1 and number sequentially around the perimeter in a counterclockwise direction, looking down on the component from above. Since Rabbit wants all of the even-numbered pins on one side and odds on the other, I had to manually renumber all the pins, and along the way I accidentally swapped the rows.

Swapping the rows reverses the power and ground connections to the Rabbit module — something Rabbit explicitly warns you not to do. Chips don’t like to be powered up backwards. I once was working next to a technician who had inadvertently reverse-powered all 25 CMOS chips on a board. When he hit the power supply switch for the first time, it was like July 4th fireworks. Chip lids were blasting off and hitting the lab ceiling all over the place, with smoke, flashes, and loud bangs. Fortunately, my Rabbit module took the error in stride while I roundly cursed the dummy (me) who botched the design of this batch of boards. Another $100 mistake.

With the subminiature relays I was using, I not only made the same hole size error, I also didn't pay enough attention to the fact that these relays were 0.3" wide — pin to pin — not the 0.2" wide that the relay template I was using had assumed. If the holes are too big, that's generally not a problem, but if they're too small, it generally is. So, if the spec for a component says its leads have a 0.045" diameter, don't make the hole 0.045"! Make it slightly bigger. For instance, the 50-pin connector spec says the connector pins are 0.020" in diameter, so I made the PCB holes 0.024" and everything fits great.

Also note that if you set the hole size to be bigger than the width or height, you will have violated the laws of physics, and that never works in your favor.

Board Placement and Routing Dos and Don'ts

I always do board placement manually. There are some provisions in the board layout software for doing auto-place, but I generally have constraints that the program knows nothing about, e.g., where should the wireless module go on the board, if I want its antenna to stick out the top of the chassis in a certain spot. Besides, placement is easy: You just put things where they make logical sense to you. (It's kinda like when you buy something small and want to know where to keep it. Put it where you would look for it first, in case it goes missing.)

If you possibly can, do a one- or two-layer board because these are significantly cheaper than boards with more layers. Modern boards have a feature called copper fill which lets you fill otherwise unused portions of the PCB with fields of copper that can largely mimic the electrical characteristics of having a true ground plane. If you have a high speed board, you will probably need ground and power planes in it.

The trouble with two-layer boards is that routing all the wires where they need to go can be a challenge, particularly around components with dense pinouts. The RCM5450W, for example, packs 50 pins into a connector with 0.05" pitch which means you cannot route wires between the pins the way you can when the pitch is a more forgiving 0.1".

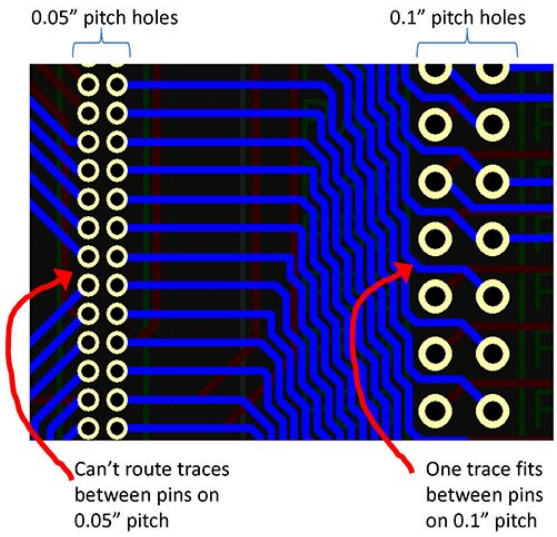


FIGURE 3. Routing between pins.

I also do routing manually. This is related to the two-layer board having no ground plane — there are traces that must be wider than normal signal traces, in order to minimize IR voltage drops for higher currents. I discovered something obvious by doing it the hard way on one board: I auto-routed it, and then hand-edited the result to make sure the fat traces were okay. They weren't, and it was extremely hard to snake them through the dense underbrush of signals that had been routed hither and yon by the auto-router.

Using the auto-router in that way does not save you any time or effort. It only means you won't enjoy the experience. Instead, hand-route the power and grounds, and then do any critical signals. Save the resulting file as a checkpoint, then save it again to a new file name. That way, if you don't like what happens on ensuing steps, it's easy to get back to the point where power and ground are still the way you wanted them.

I think hand-routing a board is fun. It's a logical puzzle but with a point: When you're finished, the result actually does something useful. You can always put jumper wires into your design to "jump over" problem areas, and if you're going for a one-layer board jumpers will be unavoidable. For two-layer designs, show some pride and design them out.

One of my board revisions came back without the extensive silkscreening I had expected (and paid for). My name wasn't on the board, nor was the date, board revision, and various labels of switches and other components. It wasn't the board layout software's fault. When I entered all that text, I had forgotten to switch that text from the default non-printing layer to the top silkscreen. I did not realize yet one should always check the Gerber output files to make absolutely sure that what you are sending to the PCB fabrication house is what was intended. I do now. The Gerbers are the files that the board fabrication house will actually be using to make your board. Your schematic capture and board layout software probably has a Gerber previewer built in. Use it. If they don't, there are free Gerber viewers online.

Feature Creep Will Cost You

I had already done several board revisions and debugged them before it dawned on me that without a display on the Wi-Fi Sprinkler (WFS) chassis, there would be no way of telling what state the machine was in by looking at it. If the power was off to the WFS, or its program was malfunctioning, or the wireless wasn't working, or the home network was down, or the iPod had depleted its batteries, the WFS would not be fulfilling its mission of timed or manual sprinkling, and the user would not know why. LCD modules are cheap and easy to interface to, but I had to again respin the PCB to accommodate this new feature that I should have anticipated from day one.

When I first designed the LCD module in, I figured the software would either be updating the LCD module or sprinkling. I didn't think I would want to do both at the same time. Later on, I realized I would have to come up with a way to have the WFS do automatic time/date sprinkling, and to do that it would have to know the actual time and date. Using Rabbit example code, I figured out how to use the LCD as a real time clock. But that meant I needed to update the LCD module periodically. If the WFS happened to have a zone sprinkling, it might well sprinkle for 10 or 20 minutes straight. All during that time, port A would not be available to talk to the LCD module. On my last revision of the board, I changed the 4:16 decoder chip to a similar chip with an internal four-bit latch (CD4515). Now, port A could write that latch, and talk to the LCD while the sprinkling continued. I should have worked this all out at the beginning.

I also did not anticipate the need for a 50-pin field of stakes on the board, so that test equipment could readily be attached to known signals on the board. I added this facility after spending many hours with previous revisions of the board, with the usual time wastage associated with connecting a logic analyzer probe to one signal while thinking it was a different one, then wondering why the resulting measurement looked so weird. Thinking ahead to how you'll debug problems is always a good idea, and will often turn up problems in the design that you can then avoid in the first place. Routing those 50 close pins from the RCM module over to their counterparts on this pin field was a challenge, but I ultimately found a routing pattern that would fit. Silkscreening the name of every pin is a great idea and really cuts down on scope probe placement errors.

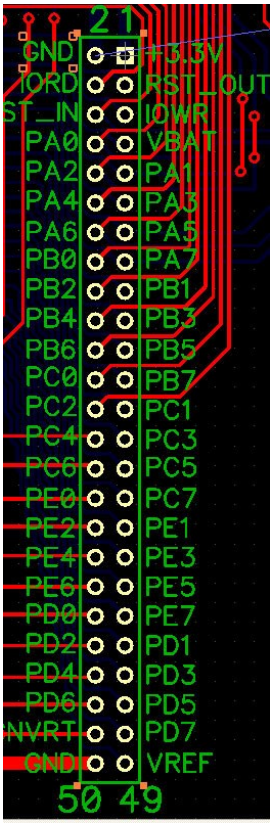


FIGURE 4. Rabbit pins brought to labeled stakes.

Rats, Didn’t See That One Coming

On one revision of the PCB, I had partially populated the board with a few relays and their drivers, and I was wrestling with a peculiar problem: a couple of the relays worked as expected, and a few didn’t. Occasionally, one of the ones that didn’t would chatter and buzz instead of locking in. I wondered if I had miscalculated the base drive resistor values, or if there was a software error, a grounding problem, or the transistors didn’t have the gain I expected. After multiple days of headscratching debug, I finally paid careful attention to what my scope was telling me: Logic lows were as expected, but logic highs into the relay drivers were only 3.3V — not the 5V I had assumed in sizing the resistors. Well, duh ... that’s because my schematic was calling for the CD4515 4:16 decoder chip to run off +3.3V, while the relay driver transistors were connected to +5V. I cut the trace to the 4515 power connection, wired it to +5V, recalculated the base resistor values, and Voila! It was hard for me to see this error because I had assumed one thing while designing the base drive circuit and another thing while drawing up the schematics.

I’ve learned that particular lesson repeatedly in my career: When you’re stuck, it’s always because you’re blinded by some wrong assumption you are making. Question the right assumption, and enlightenment will surely follow.

I remember an incident at Intel when my team was simulating what would eventually become known as the Pentium Pro microprocessor. The man who had written the simulator offhandedly mentioned to me that it was possible to make the simulator initialize flip-flop values pseudo randomly. I said I had been under the assumption we had been testing that way all along. He shrugged and walked away, but the next morning he came back and said he checked; we had not been testing with random initial states, but instead had been simulating our design as though every flip-flop was coming up reset on powerup (which in hardware they most certainly do not). He changed the simulator’s startup configuration to the random initial setting, and re-ran some of the validation regression tests. Many failed. This simple check exposed dozens of design shortcomings that were easy to fix but would potentially have been fatal had they survived into silicon. Assumptions are necessary to make, but some of them will bite you.

Don’t Share Grounds With Noisy Circuits

As Arthur Delagrange said in The Art and Science of Analog Circuit Design, “WARNING: The [board] layout is part of the circuit.” Grounding paths included.

When a relay coil is deasserted, the magnetic field around the coil collapses and induces a current in the coil. That induced current attempts to establish a substantial voltage potential on the transistor’s collector, and a “snubber” diode is connected so as to discharge that current.

However, diodes aren’t perfect. When conducting, silicon diodes drop approximately 0.7 volts across their junctions. That means that the coils can still drive enough current onto their ground connections to make it seem to any logic nearby that ground has dropped by a few tenths of a volt. The Rabbit module itself seemed immune to this, but the LCD module didn’t like it at all and would act as though it had been written with some new value that caused its screen to go blank.

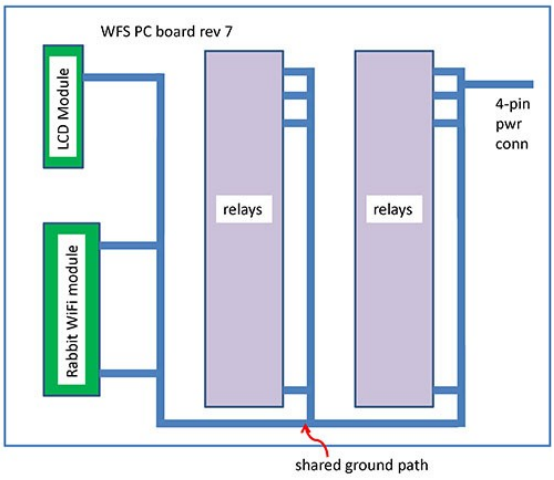


FIGURE 5. Early design with shared grounds.

Figure 5 shows the original ground routing of my rev WFS 7 board. This layout mostly worked. Only when the relay that was electrically farthest from the four-pin power connector at the top right was deactivated, would a large enough current spike occur to cause an LCD module malfunction. The first remedy I tried was to strap a lot of extra ground wires across the top of the board, hoping to drive the aggregate ground impedance down. (This was to gather information only; I would not consider this a permanent fix to a production board, even if it eliminated the problem.)

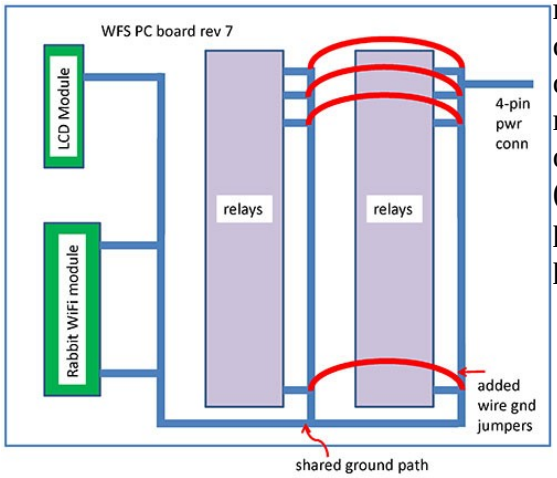


FIGURE 6. Experiment with extra ground straps.

That helped, but the LCD module would still blank out occasionally. So then I got serious, and cut the LCD and Rabbit grounds away from the relays entirely — even at the four-pin power connector. This allowed the relays and the logic to have their own ground current paths all the way back to the power supply itself. With no shared paths, the relays were no longer able to interfere with the logic of the LCD module. Problem solved.

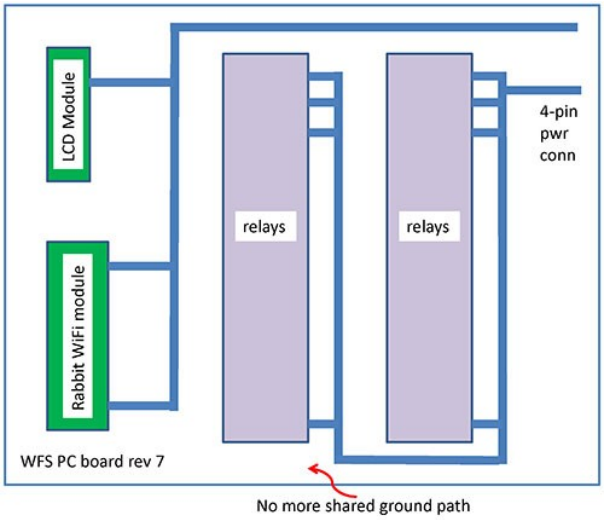


FIGURE 7. Final solution: separate ground paths.

Measure Twice, Cut Once

In woodworking, they have a saying: Measure twice, cut once. The idea is to double-check what you're about to do because once you've cut a board, you can't uncut it. Don't take that idea too far though, or you'll be paralyzed by the fear that you're overlooking something. Often, you have to simply do your best, fix what didn't come out right, and keep repeating that loop until you're finished. If you never make a mistake, you're not trying hard enough.

Getting better at your craft requires that you learn from mistakes. If you really want to accelerate your learning, learn from other people's mistakes too! NV

HELLGATE AMATEUR RADIO CLUB

AGENDA – 9 Sep 2024 meeting

Meeting called to order at 7:__ PM (8 needed for business)
Introductions. Please make sure you signed the attendance sheet **Quorum Y/N ____**

Last meeting minutes, Jun: _____ Motion to approve minutes: 1St_____ 2nd_____
Discussion _____ Vote: P/F/T

Treasurer's report: KJ7HYG, _____Motion to approve report: 1St _____2nd _____
Discussion_____ _ Vote: P/F/T

Repeater Committee Report: W7RPG, _____Motion to approve report: 1St _____2nd _____
Discussion_____ _ Vote: P/F/T

HF Committee Report: K0SN, _____Motion to approve report: 1St_____2nd_____
Discussion _____ Vote: P/F/T

Events for 2024:

Sep 07 Fox Hunt 10:00a-2:00p – if any interest? – NONE - CANCLED
Sep 09 HARC Testing, Meeting

HARC Net every Saturday morning @ 9:00 AM on 147.040 Repeater – Buy/Sell – During.

HARC Discussion List

1. _____
2. _____
3. _____

VHF Net Control Station assignments:

Aug	07	N7PAS	Sep	04	N7PAS
Aug	14	K7MSO	Sep	11	_____
Aug	21	W7RPG	Sep	18	_____
Aug	28	N7JGS	Sep	25	_____
___	__	_____	___	__	_____

Reminder: Backup is always the next person in line as the net control.

Good and Welfare. _____

*** Next Club meeting: Oct 14 ***
Is there any other business? _____
_____ Meeting is Adjourned at _:__ PM.

Program: DR-2X Repeater Demonstration By NZ7S

September 2024

Hellgate Amateur Radio Club

Calendar of Events

Board: NZ7S, W7RPG, KJ7THG, K7MSO

Editor - N7PAS

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4 ERC Net 7:30 on 146.900-88.5T BARC Net 8:15 on 146.720-203.5T HARC Net 9:00 on 147.040-No Tone	5	6	7 HARC Saturday Net 9:00AM on 147.040 Repeater.
8	9 HARC Testing 5:30 & Meeting 7:00PM Program: DR-2X Rptr Demonstration	10	11 ERC Net 7:30 on 146.900-88.5T BARC Net 8:15 on 146.720-203.5T HARC Net 9:00 on 147.040-No Tone	12	13	14 HARC Saturday Net 9:00AM on 147.040 Repeater.
15	16	17	18 ERC Net 7:30 on 146.900-88.5T BARC Net 8:15 on 146.720-203.5T HARC Net 9:00 on 147.040-No Tone	19	20	21 HARC Saturday Net 9:00AM on 147.040 Repeater
22	23	24	25 ERC Net 7:30 on 146.900-88.5T BARC Net 8:15 on 146.720-203.5T HARC Net 9:00 on 147.040-No Tone	26	27	28 HARC Saturday Net 9:00AM on 147.040 Repeater
29	30					

HARC Events: (Actual Dates Unknown)

#	Month		Activity
1.	Monthly		MARS Interoperability Exercises – Eric NZ7S will keep us advised. 1st week of each month for 2024. Check in on 60 meters. Noon and 8 pm Channel
2.	April		Grizzly Triathlon
3.	April	27	Riverbank Run
4.	June	04	Trail Rail Run
5.	June	22-23	Field Day
6.	June	28-30	Missoula Marathon – See Coming Events – pg 1
7.	July	04	W7PX Special 4th of July Event – Cabin needs to be reserved.
8	July	19-21	Glacier Waterton Hamfest
9.	Sept	03	Fox Hunt ?? 1 per year on Saturday from 10:00AM to 4:00PM ←------- We are here
10.	October		JOTA/JOTI
11.	October		Great Montana Shakeout Drill
12.	October		Bitterroot Mushers Dirt Dash
13.	November		Election Day - 5th
14.	December		Sky Warn Recognition Day (0000Z-2359Z)
15.	December	9	HARC Christmas Dinner Meeting