

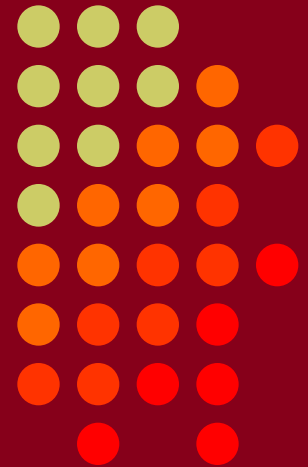
# CTU Presents

## Adding In-band to your Multi-Op

Bill W9KKN

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CONTEST  
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# About me



- Licensed 1999, became active in contesting around 2017
  - Primarily operate at ZF1A and ND7K with occasional appearances elsewhere
  - I only focus on a couple contests a year (CQ WW\*, CQ WPX\*, ARRL DX\*, CQP)
  - Career Background: Software, Security/Networking
- Active on CW, SSB, and RTTY
- WRTC 2022 2023 Referee
- Contributor on the Q5 Contest Crew Podcast
- Maintainer of the Super Check Partial callsign database



# What is In-Band Contesting?

- Two (or more) radios/operators simultaneously on a single band during a multi-op
  - **Run Station**
    - Calling CQ
  - **Mult/In-band Station**
    - Calling other stations (hopefully multipliers) that are calling CQ (In between run QSOs)
  - **Support Station**
    - Helping the run operator pull call signs from the pileup (possibly with a completely different antenna)
  - *Think: SO2R with two people*



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ARRL DX CW 2026 ZF1A M/2

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# Example



Transmitted / Received

Radio 1 (Run) 21276.0	"CQ Contest ND7K ND7K"	"@##% NR6O #@!\$"	"NR6O 59 869"	"Thanks, 59 123"	"Thanks, ND7K"	"@\$ Pileup #&\$%"
Radio 2 (Inband) 21206.9	"CQ Contest ZF1A ZF1A"	"ND7K"	"ND7K 59 2468"	"Thanks 59 870"	"Thanks, ZF1A"	QSY/Tune next station

# Why would I want to do this?



- A great way to mentor new contesters\*
  - Gives them a chance to make a significant contribution to the score
  - Exceptionally good way to learn from another operator **while actively participating**
  - Builds situational awareness and timing skills
- Fun
  - New elements of strategy such as strategic use of band change rules, what to chase/not chase, interleaving with your partner, moving stations
  - A new skill (even if you're an otherwise great single-op contester, if you haven't done this before, it will take some practice)
  - A technical challenge to implement

# Why would I want to do this?



- Significant advantage in the multiop categories of many contests
  - Significant in other contests, particularly in NAQP, CQWW, ARRL DX, ARRL Sweepstakes
  - Required to be competitive in Multi-Single, Multi-Two, and probably Multi-Multi category
  - If you were going to do a multi-multi, but you don't quite have enough people

# Ingredients



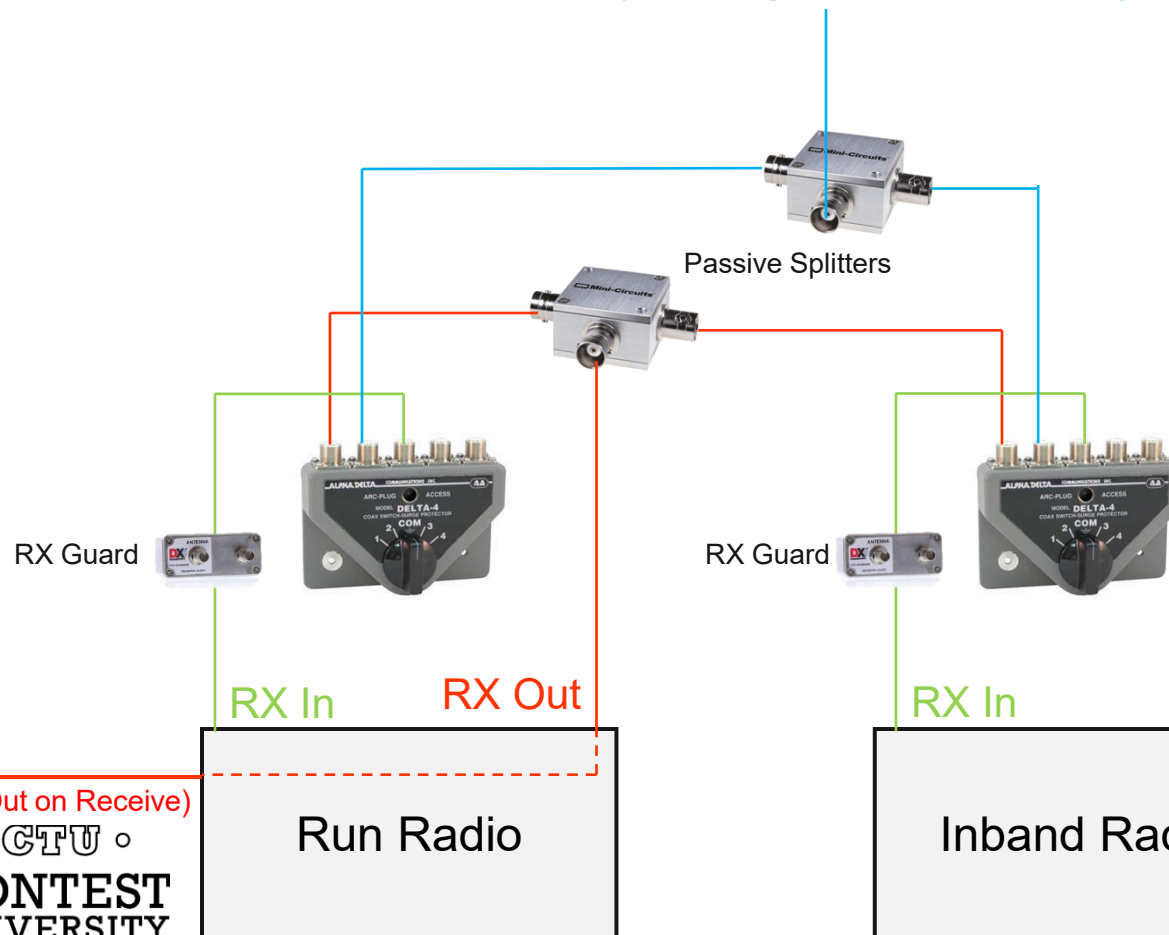
- **Receive Antenna Switching / Sharing**
- Receive Antennas
- Interlock
- Audio Sharing
- Transmit Antenna / Amplifier Sharing
- Automation
- Logging Software
- Team / Strategy



# Receive Antenna Sharing / Switching

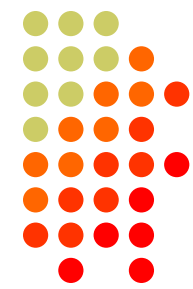
"Simple Version"

RX Antenna (Beverage, Tri-bander, etc.)



If you have the shared TX antenna selected and not the RX antenna, inband will lose all signals during run radio TX.

**TX Antenna**  
(loops to RX-Out on Receive)



# Receive Antenna Sharing / Switching

"The Upgraded Way"



Low Band Systems (RA6LBS)  
8 Antennas  
4 Receivers



AY Technologies (K9AY)  
8 Antennas  
2 Receivers (or 4, custom)



RemoteQTH (OK2ZAW)  
7 Antennas  
3 Receivers

- Very Fine Business™ to have all RX antennas available to all radios
- Careful, don't split antennas too many ways (3dB every time)

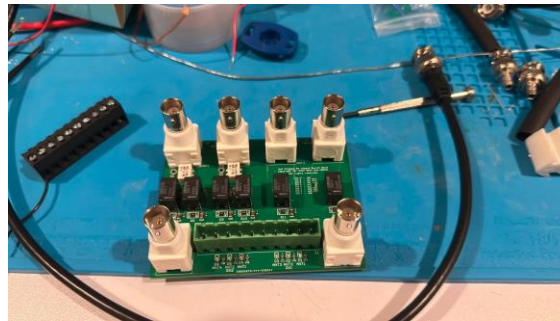


# Receive Antenna Sharing / Switching

“The ZF1A/ND7K Way”



+



+

Station  
Automation  
Magic

NN1C Custom PCB  
With some W9KKN mods  
RX Inband Switch

2 Receiver Ports  
2 RX-Out Inputs (shared/split)  
2 RX Antenna Switch Inputs  
(not shared/split)

# Ingredients

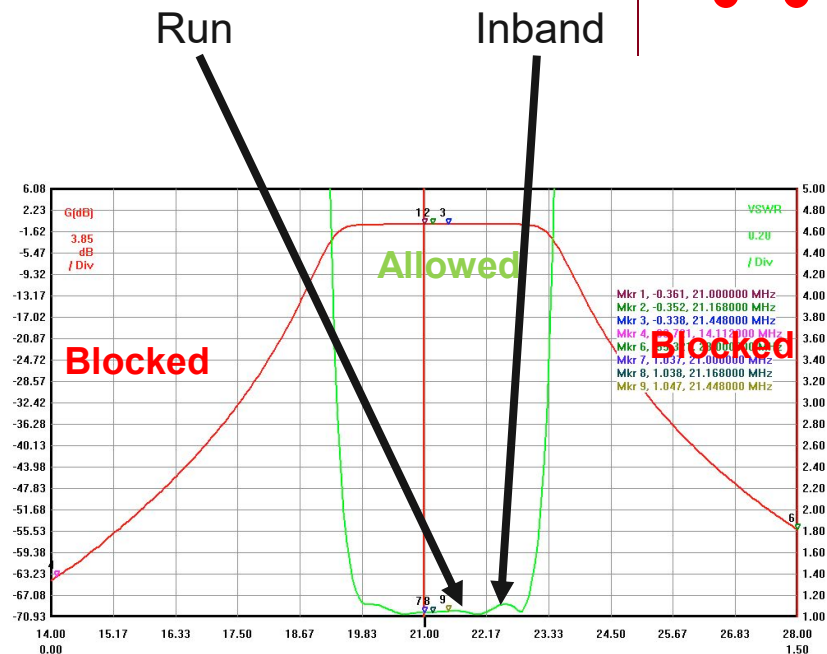


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# RX Antennas

- It's a whole other thing to be able to listen a few kHz away from where you are transmitting on the same band
  - The filters got rid of everything else, ideally not the signals on the band you're listening to
- **This is the hard part**
- **This is a great way to destroy a receiver**



VA6AM 15M HPBPF S21 Measurement

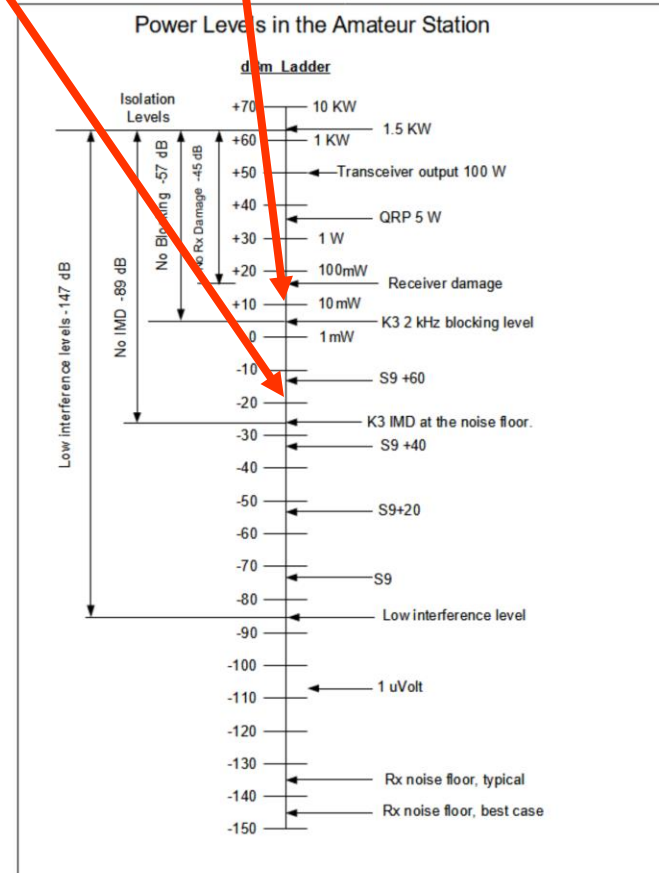


# RX Antennas

- Know your limitations
- Not every receiver can do this; you'll need to be toward the top of Sherwood's list
  - (Narrow-spaced Dynamic Range >95dB)
  - High Blocking figure / ADC overload point
  - Low Local Oscillator (LO) Noise / Phase noise
    - Prevents the other radio from QRMIing the whole band
- Start with QRP, watch the other radio's receiver in a new installation
  - When you start seeing S9+60 on the other receiver, or the "Overload" lamp illuminated, STOP

Best Case,  
HP Inband

Stay Away  
from Here



Managing Interstation Interference Second Edition, George Cutsogeorge W2JVN

# RX Antenna Ideas



- Throw land at the problem
  - CQ Rules: The area in which all the transmitters, receivers and antennas are located. All transmitters, receivers, and amplifiers **must be within a single 500-meter diameter circle**. Antennas must be physically connected by RF transmission lines to the transmitters and receivers.
  - ARRL Rules: All transmitters and receivers **must be located within a 500-meter diameter circle, excluding Antennas**. Remote receiving installations outside the 500-meter circle are prohibited. Stations remotely controlled by radio link may use necessary equipment at the control point. This does not allow using the control point as another receiving location.

*Works best if you are K3LR or K1LZ and you can just build a twin station in the circle.*



# RX Antenna Ideas

- ND7K Far Away Receive Verticals (Alternate Polarization, out of the near field of the transmit antennas)
  - ~600 feet away from transmitting stacks
  - These don't have to be amazing antennas, but much better than hearing nothing when transmit antennas are in use



# RX Antenna Ideas



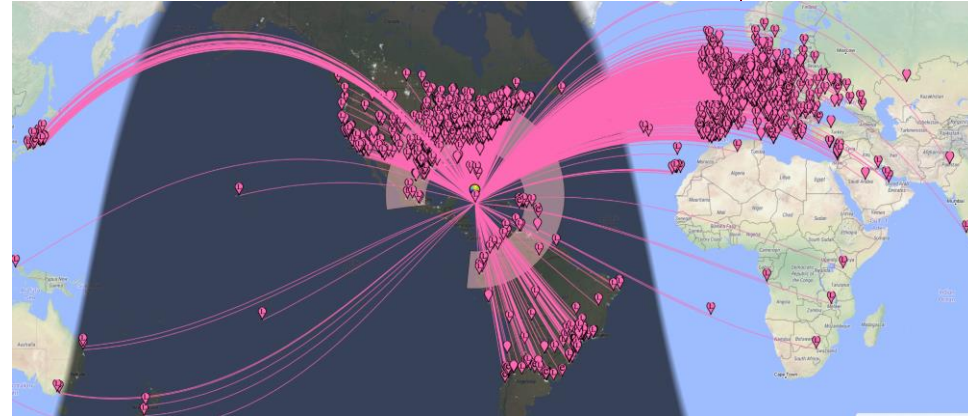
- ZF1A SpiderBeam Receive Tribander
  - ~320 feet from transmit antennas
  - It might be 25ft high
  - Suspended between a pair of coconut trees
  - Pointed at W1/EU
  - Rope Rotator



# RX Antenna Ideas



- Beverages (vertically polarized)
  - Surprisingly good receive antennas
  - Almost works up to 15m for inband
- Steerable arrays (K9AY, YCCC, Array Solutions, Hi-Z, etc.)
- Careful with preamps!
  - Both in the radio and on the far-end of a receive antenna



24 Hours of ZF1A 10M FT8 Skims – from 370' EU Bev

# Ingredients

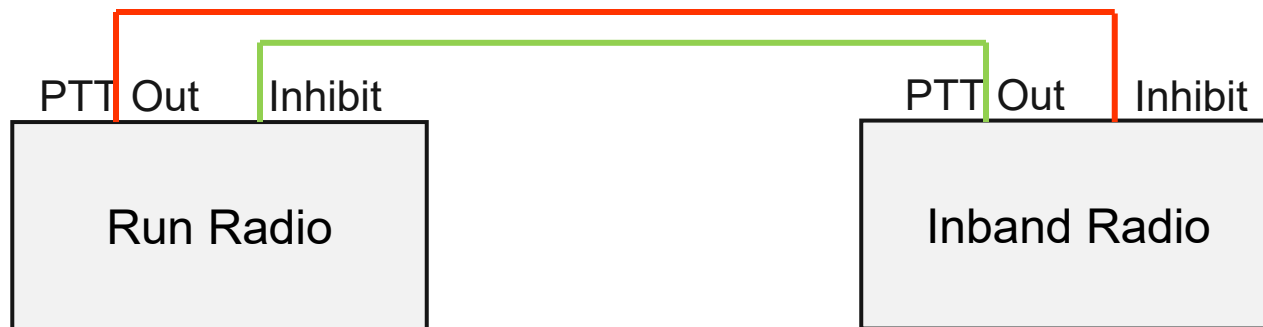


- Receive Antenna Switching / Sharing
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# Interlock



- When two radios are sharing a band, most contest rules require that only one be transmitting at a time on a band (a single signal)
- This can (sort of) be enforced by logging software, but...
- Many contest rules (CQ, ARRL) specifically **require** a hardware lockout
- Many radios implement an "inhibit" feature that blocks transmitting
  - Logic low on inhibit pin (ACC port of Elecraft Radios)
- Basic implementation is very easy:



# Interlock



- ... But the basic implementation has some limitations:
  - Not all radios implement an inhibit feature
    - Icom radios only have a “mute” function which also kills receive
  - Logging programs don't necessarily have visibility into external interlocks
  - After the other radio is done transmitting, are we midway through transmitting a message?
  - Advanced features difficult to implement:
    - Mult station always wins, vs. First to transmit
    - More than two radios?

# Interlock



- Sometimes the better way is to implement the interlock at the input:
  - Break Footswitch / CW keylines with relays
- Often times using logging software interlock in combination with hardware works well
  - Can prevent mid-message scenarios
- Very handy feature:
  - Large, bright indicator light when you are inhibited
- Or... we can involve more advanced hardware. Hold that thought :)

# Ingredients

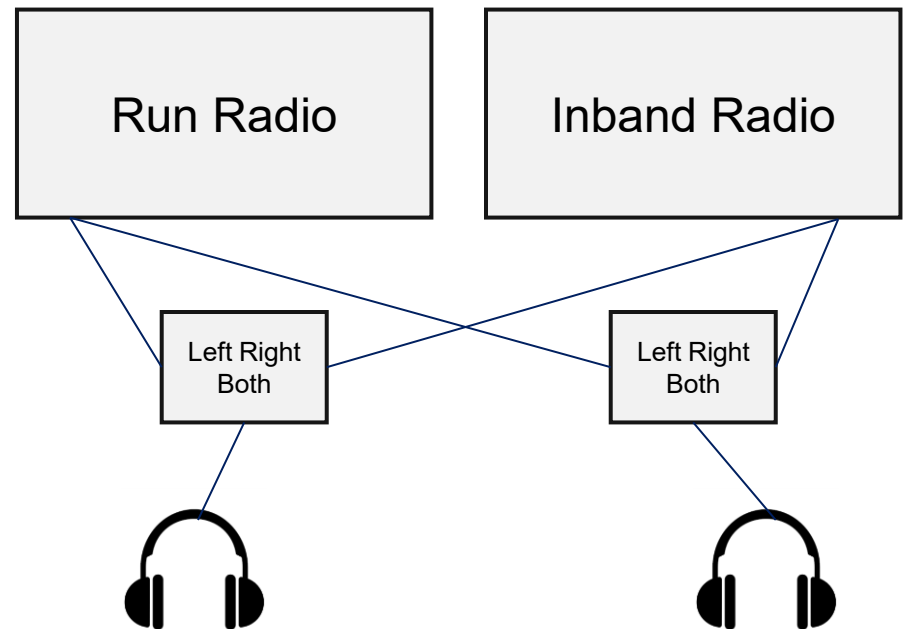


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# Audio Sharing



- Either radio should be able to hear the audio of the other radio, or only their radio's audio, or both
- This helps the operators to coordinate / synchronize
- It may also help the inband/mult operator to listen to the run pileup and help pull callsigns out
- It is possible to do all of this without audio sharing, or audio sharing on only one side, but it really helps



# Audio Sharing



- Commercial Implementation:



- Build your own:

- Manually-actuated SO2R controllers
- Basic Audio Mixer
- Custom boxes (K6AM built/designed ours with essentially a 4PDT switch)
- Don't forget isolation transformers if you do build your own



# Ingredients

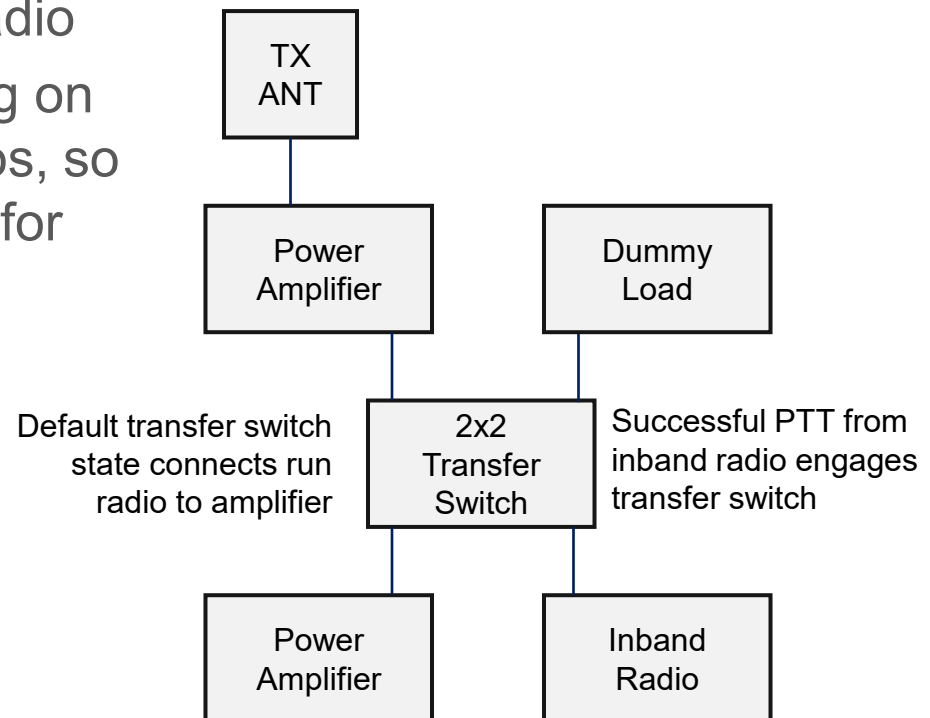


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# Amplifier / TX Antenna Sharing

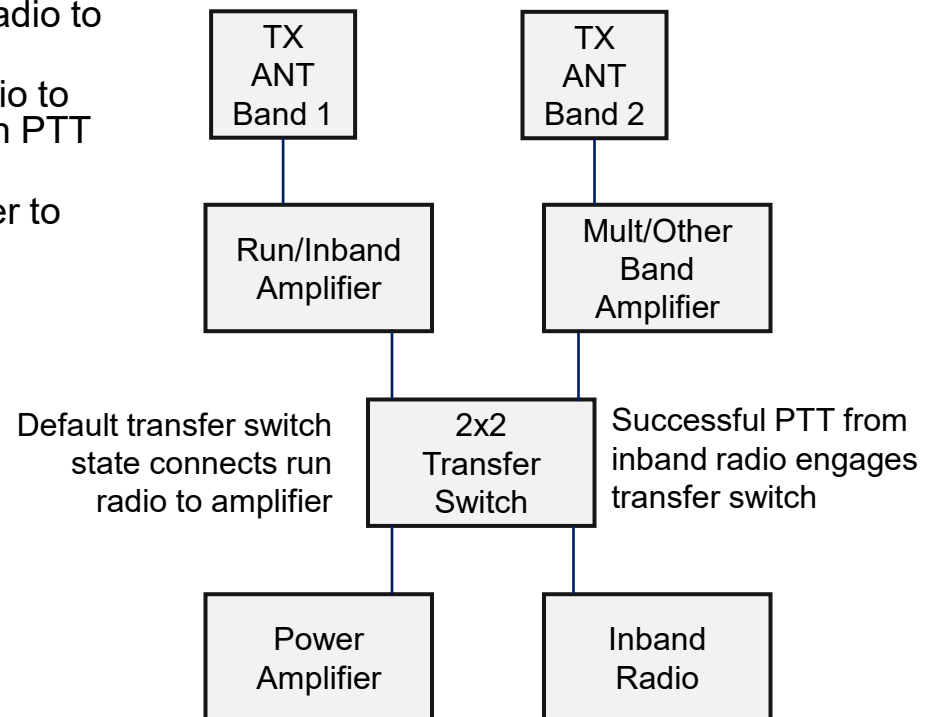
- Single amplifier can be shared between the run / inband radio
- Remember: we are listening on the RX antenna of the radios, so the TX ports aren't needed for listening



# Amplifier / TX Antenna Sharing



- Single amplifier shared between Run Radio and Inband Radio
- Second amplifier for the Inband/Mult Radio to go out of band (we'll talk about this)
- A SPST switch for the Inband/Mult Radio to decide if the transfer switch engages on PTT or not
- A SPDT switch to decide which amplifier to key



# Ingredients



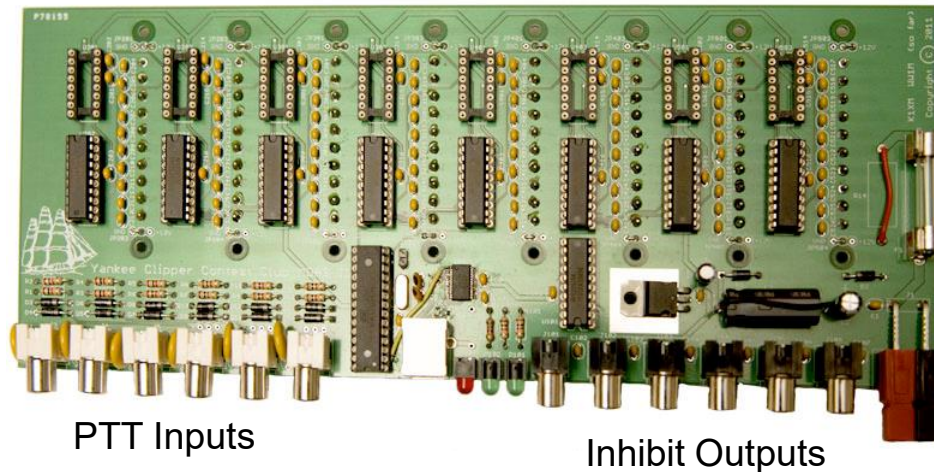
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# Automation



- All of this becomes much easier if we can involve some automation
- K1XM's MOAS II is a swiss army knife that can tie all of this together!
- Microcontroller + Shift Register Design

## High or Low-Side Relay Drivers



- Reprogrammable for different contests
- 64 outputs + 6 inhibits + 6 PTT inputs
- Controls both the RX antenna switch and the custom inband RX switch
- Automatically switch to RX antenna when partner radio is transmitting, go back to shared TX antenna when not
- Key the right amplifier
- Engage Transfer Relay
- Enforce Inhibit with complex rules
  - Eg: Radio A has precedence over Radio B and C
- CQ on same frequency, but alternate antenna systems

# Ingredients



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# Logging Software



- Logging software is a bit of a religious topic
- What's important for inband?
  - Networking with serial number reservation in contests where it matters
  - Ability to edit QSOs of partner radio
  - Partner mode call stacking
  - Software interlock
    - Helpful in addition (but not as a replacement for) hardware interlock
  - Rules enforcement / Notification
    - Does the software tell you that you've violated a band change rule?

# Logging Software



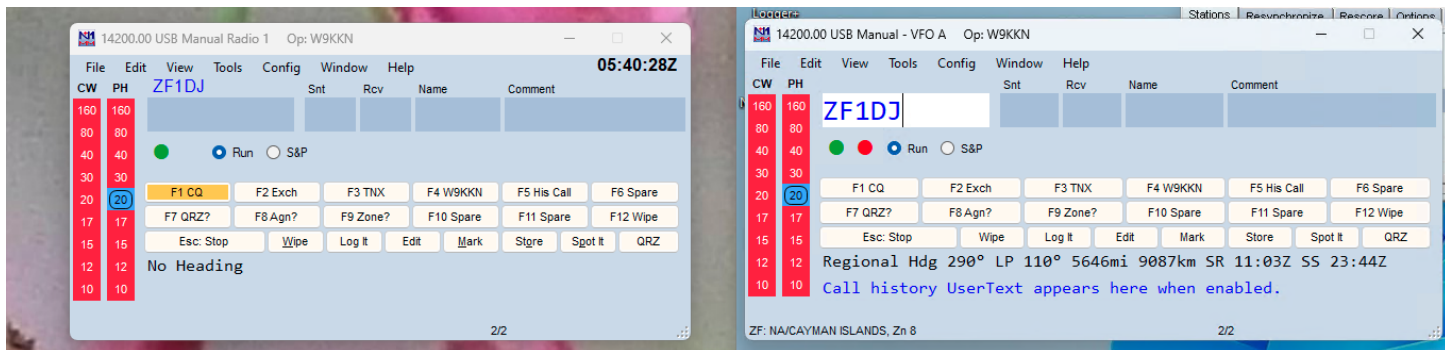
- Ability to edit QSOs of the other radio
- Old N1MM+ Behavior:
  - *“If it is necessary to edit or delete a QSO, the computer that the QSO was initially logged from must be used to perform the change. Other computers do not have permission to change the QSO. Any such change made at the originating computer will be reflected on all computers that are connected to the network at the time the change is made.” - N1MM+ Docs*
- New N1MM+ Behavior:
  - This appears to be allowed now, even though the manual says otherwise...
  - YMMV
- ... But the old behavior was silly.
  - Nice to be able to have partner operator edit old QSOs as necessary (say the exchange was wrong, or an old QSO needed to be removed) while still continuing to run stations
- DXLog / Wintest don't have this restriction.

◦ GTU ◦

# Logging Software



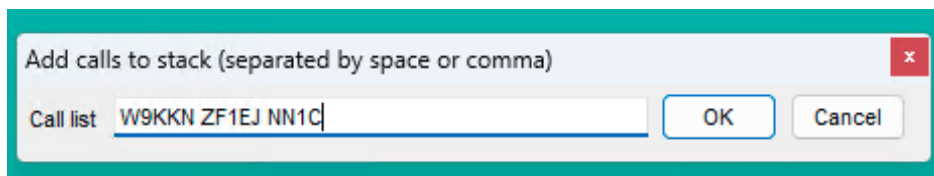
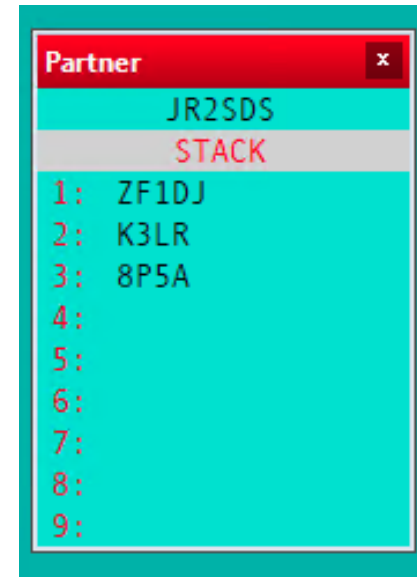
- Partner Mode / Call Stacking
- N1MM+
- If two stations on the network are tuned to the same frequency, anything typed in the call box of the other station will show up in the call box (and the run operator need only hit the spacebar to grab it)



# Logging Software



- Partner Mode / Call Stacking
- DXLog / WinTest
  - Alt+Enter to “Stack” a call OR comma key to add several
  - Alt+Space to take JR2SDS
  - Alt+1 / Alt+2 / Alt+3 to take 1, 2, or 3
  - Logging an entry removes it
  - Alt+Backspace clears all of the stacked calls



QSO	Band	Time	Callsign	Sent	Rcvd	Pts	Mult	Stn
1	160	08:31	W9KKN	599	599 04	0	DZ	R
2	160	08:37	K9PG	599	599 04	0		R
3	160	08:39	JR2SDS	599	599 25			R

\* NEW MULTIPLIER \*  
ALSO NEEDED: 80,40,20,15,10

# Ingredients



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# Team / Strategy



- Inband operation requires compatible personalities
  - Can't be too aggressive/non-strategic
    - "Why are you chasing Willy Billy Fives while I'm running JA and EU at the same time?"
  - Can't be too timid
    - "I don't want to mess up the run".... To call a multiplier worth 16 QSOs?! Get in there!
  - Must be able to check the ego at the door
  - Must be able to communicate / time effectively
  - Can't lose mind while the other operator is transmitting
  - Must be situationally aware, anticipating, cross checking
  - Requires trust (even if I didn't hear it, he probably copied it right)
- Generally, the run operator is "in charge"
- Scheduling: 3 people for 48 hours in a M/S, 8 hours on / 4 hours off
  - You probably don't need the inband station operated for 100% of Day 2

# Team / Strategy



- Read the Contest Rules!
  - CQWW (not WPX) (Multi/Single category has a dedicated multiplier station with a separate band change rule that DOES NOT have to be interlocked with the run station as long as it is working a multiplier. You can still have a dedicated inband station interlocked on the run band
  - ARRL Sweepstakes Multi/Single category does not have any band change limitations/time rules
    - You can almost do two-operator 2BSIQ that way.
  - CQP M/S category has a strange rule that almost doesn't allow inband operating (same operator can't be replaced for 10 minutes)
- Band change strategy for M/S
  - Never waste a band change, try to line up a few stations to call in rapid succession
  - In ARRL DX, if the count resets at the top of the hour, generally most of your band changes will be in the last 10 minutes of the hour
  - Make sure you save a band change if propagation shifts suddenly
  - You can usually start CQing / find a frequency on a new band while running on the old one
    - The first QSO is when the band change "occurred"



# Questions?



# Thanks!

Work me, spot me, see you on the bands!  
de W9KKN

Questions, comments:  
**bill@w9kkn.net**

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