Recording a Whole Band in a Contest

Bill Coleman N4ES
Doug Grant K1DG

Why?

- Listen to your runs after the contest
- Listen to your competition's runs
- See what mults you missed
- Check entrants' logs
- Train new ops for the next contest
- Evaluate/compare receiver selectivity
- It's pretty cool!

Technical Issues

- Recording your own frequency is easy
  - Audio is easy to record – limited bandwidth
  - Receiver audio to sound card
  - SO2R: stereo
  - 48 hours fits in about 6 GB hard disk space
- Recording a whole band is hard
  - Too much bandwidth
  - Too much data

How to Record the 40M CW Band (7000-7080)

- Use high-speed waveform digitizer board
  - Nyquist Theorem: Fs> 2x Fmax (14.16 MSPS)
  - Need ~90-100 dB dynamic range (~16 bits)
  - Technology exists but is expensive
  - Lots of custom building
  - Lots of data !
    - 16 bits x (2 bytes/16 bits) x 15 MS/sec x 3600sec/hr = 108 GBytes/hour
    - 48 hour contest consumes 4.8 terabytes

How to Record the 40M CW Band (7000-7080), Rev. 1

- Use mixer to move 7080 to some lower IF (455 kHz)
  - Requires either surgery on a receiver or homebrew RF mixer
  - A/D converter sample rate is lowered to 1 MSPS or so; now “only” 7 Gbytes per hour
- Use an Undersampling A/D converter
  - Sample 7 MHz signal at 300 kHz or so
  - Sample rate reduced to 2-3 Gbytes/hour

How to Record the 40M CW Band (7000-7080), Rev. 2

- Why not use a PC sound card?
  - Data rate is manageable
  - Requires downconversion of whole band
  - Not enough bandwidth
    - 20 kHz typical
    - 48 kHz maximum

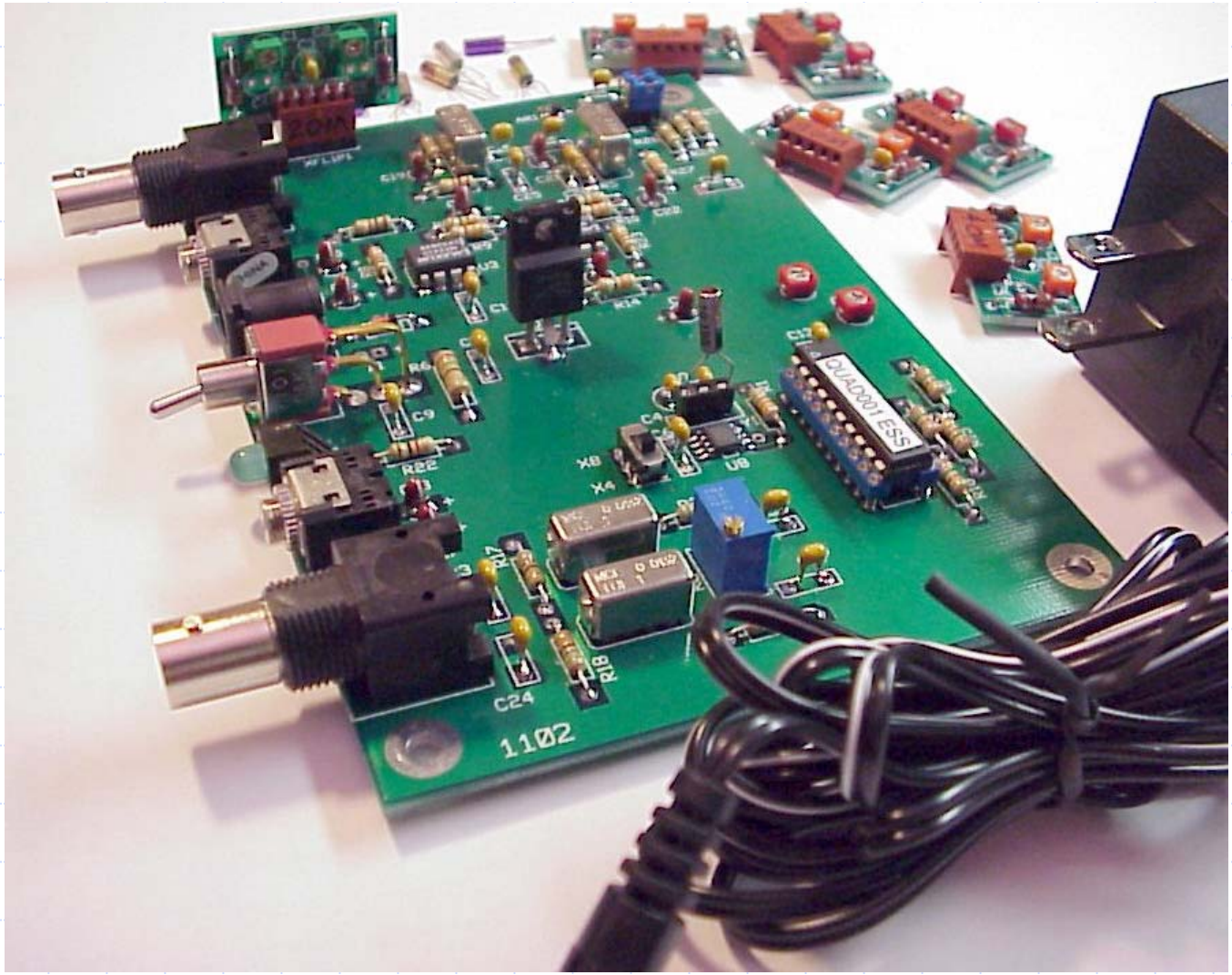
Full Band Downconverters

- Conventional direct conversion receiver
  - No image rejection - requires exotic (crystal) filter
  - Difficult to change center frequency (multiple crystal filters)
- Low IF superhet receiver
  - Multiple conversions and/or exotic filtering
  - Very wideband recorder (IF + BW/2)
- This is all very hard
- But if we use some trigonometric RF tricks…

The “Time Machine”

- Records stereo (complex) signals
  - Uses quadrature mixer
  - Left & Right = I & Q = X & Y
  - Same principle as phasing SSB
  - Cancels image frequencies
- Doubles recorder's effective bandwidth
- Very simple hardware
- Uses any stereo audio recorder
- Captures 2X the recorder's bandwidth

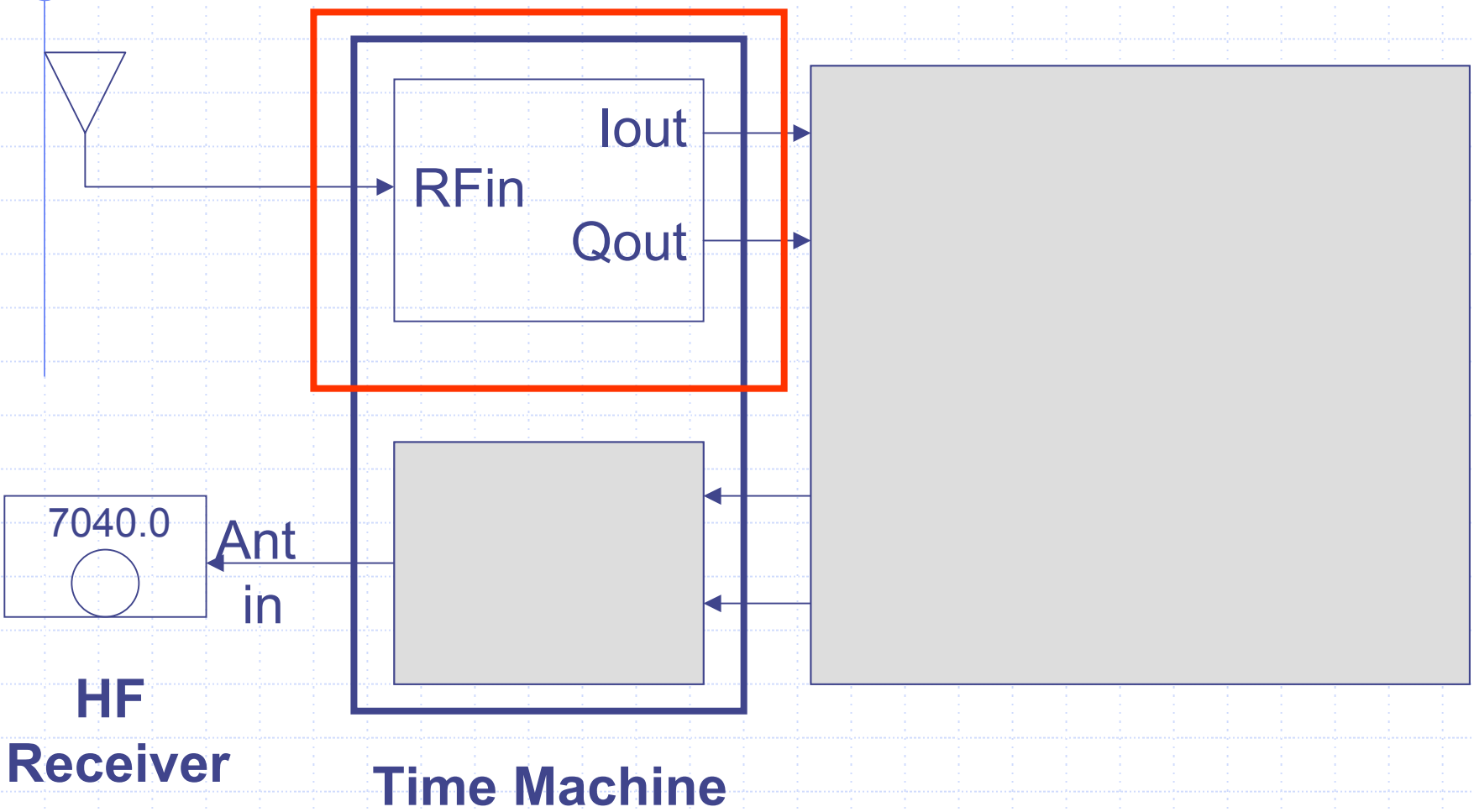
The Time Machine Board



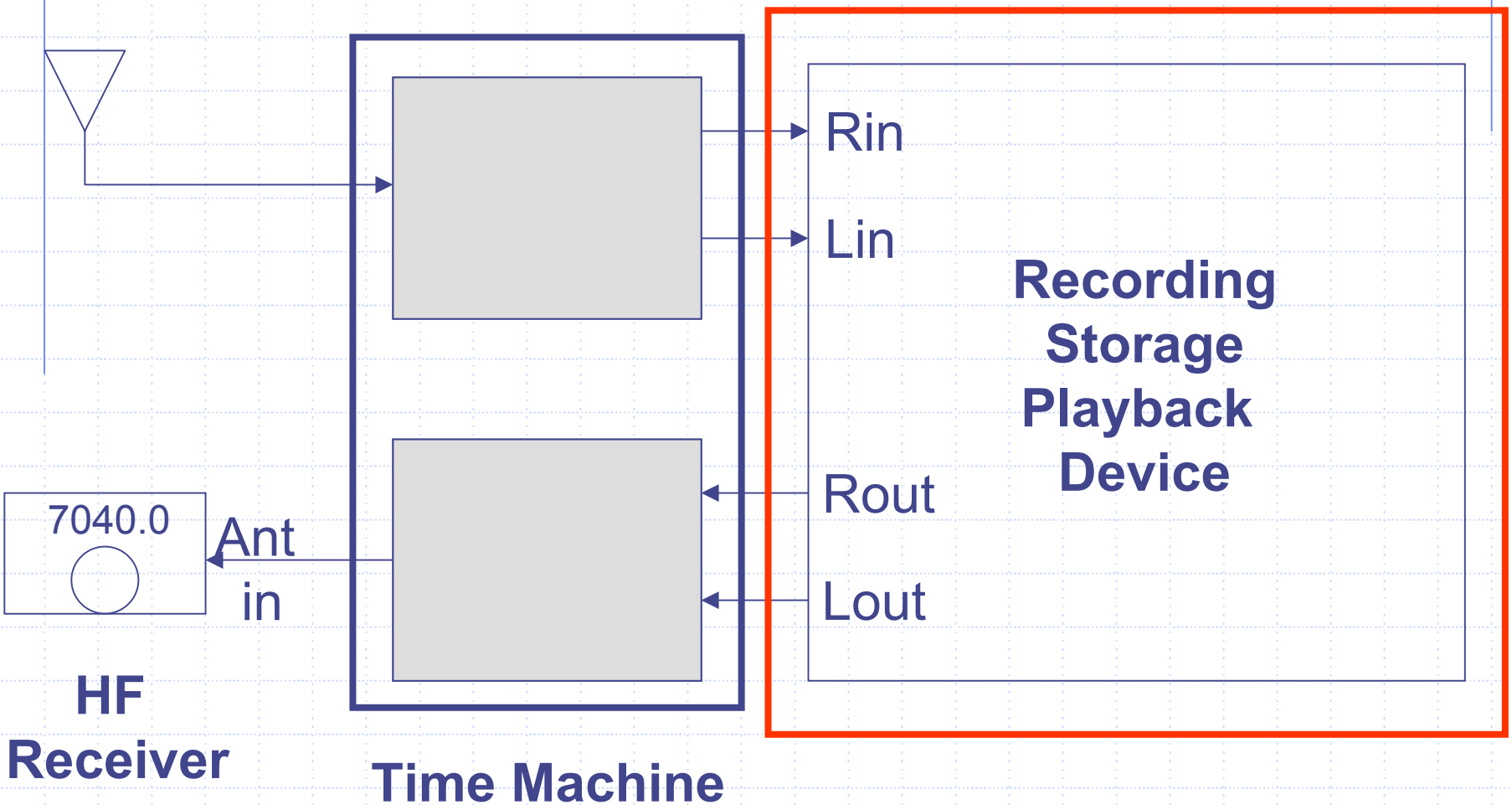
How to Record the 40M CW Band (7000-7080), Rev. 3

- Time Machine centered @ 7040 kHz
- Stereo HiFi VCR
  - > 40 kHz bandwidth @ 90 dB dynamic range
  - 6 hour capacity
- or High-end PC sound card (96 ksps)
  - > 40 kHz bandwidth @ 96 dB dynamic range
  - Capacity determined by hard drive space
  - Linrad/SpectraVue software compatible

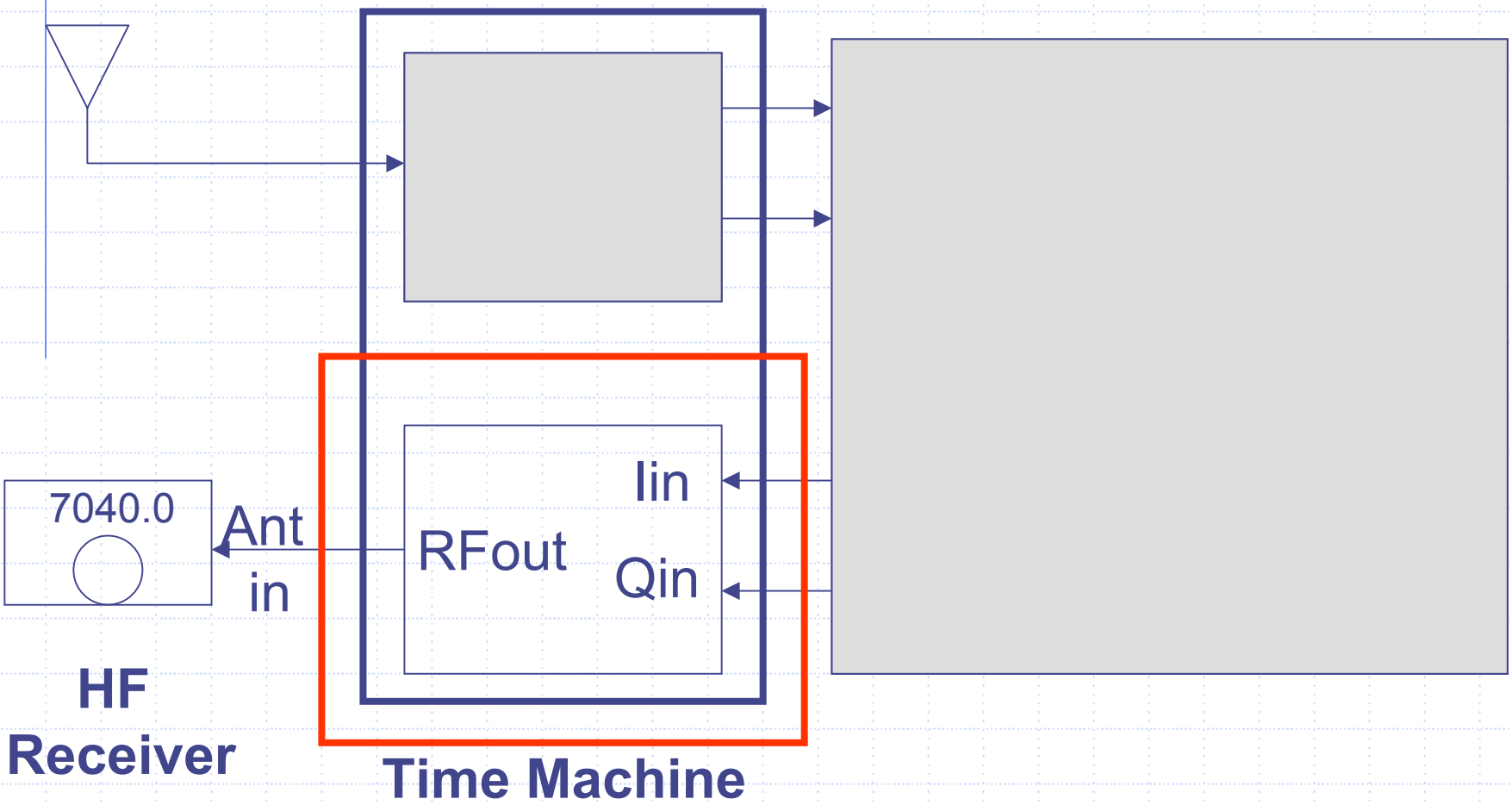
How it works: Receive-mode Processing



Recording & Storage



Time Machine connects to a (tunable) receiver



Playing the Signals Back

- Uses another quadrature mixer, this time in "transmit" or "upconversion" mode
- Magic happens
- The "Right" signals add, and the "Wrong" signals subtract
- All you hear is what was on the air
  - CW, SSB, PSK, noise, whatever

Does it Work?

- Tune around and tell me! (yes)
- September 2002 CW Sprint Recorded at K1AR on VCR (40M only…80M dipole, Aurora…)
- WRTC 2002 Recorded Digitally at KC1XX with 4-channel home-studio digital audio system on hard-disk (first 12 hours or so, three bands…)
- A few hours of WPX SSB 20M

K0EJ Log Extract (9/02 CW Sprint)

7039	0000	1	W1WEF	1	JACK	CT
7039	0000	2	AA3B	2	BUD	PA
7036	0001	3	N0SS	1	TOM	MO
7033	0002	4	K4FXN	3	DAN	KY
7034	0003	5	N9CK	5	STEVE	WI
7036	0003	6	W4PA	8	SCOTT	TN
7036	0004	7	K0AD	3	AL	MN
7049	0005	8	KT3Y	8	PHIL	VA
7049	0005	9	KA0GGI	7	TOAD	MO
7047	0006	10	KA9FOX	7	SCOTT	WI
7046	0007	11	W9TN	2	STEVE	IN
7046	0007	12	NA4K	12	STEVE	TN
7041	0008	13	K5OT	6	LARRY	WI
7041	0008	14	K4RO	14	KIRK	TN
7040	0009	15	N2GC	10	MIKE	NY
7040	0009	16	N8EA	14	JOE	MI
7038	0010	17	K9NW	16	MIKE	IN
7038	0010	18	K7SV	15	LARRY	VA
7033	0011	19	K0RAY	6	RAY	MO
7033	0012	20	W1NN	14	ACE	PA
7032	0013	21	NB1B	7	DJ	MA
7032	0013	22	W4NZ	17	TED	TN
7030	0014	23	WQ5L	17	RAY	MS

W4NZ Log Extract

7026	0000	1	K3WW	1 CHAS	PA
7036	0001	2	N2GC	2 MIKE	NY
7036	0001	3	N9CK	3 STEVE	NC
7037	0002	4	N9NE	2 TODD	WI
7037	0003	5	WQ5L	2 RAY	MS
7049	0004	6	N9RV	10 PAT	IN
7049	0004	7	KT3Y	7 PHIL	VA
7038	0006	8	K4FXN	9 DAN	KY
7038	0007	9	KA9FOX	8 SCOTT	WI
7039	0008	10	K7SV	14 LARRY	VA
7039	0008	11	W1NN	9 ACE	PA
7042	0009	12	K9ZO	16 RALPH	IL
7042	0010	13	N0SS	14 TOM	MO
7046	0010	14	NA4K	14 STEVE	TN
7050	0011	15	KJ9C	13 MEL	IN
7050	0012	16	N4GN	18 TIM	KY
7032	0013	17	K0EJ	22 MARK	TN
7032	0014	18	KU8E	21 JEFF	GA
7033	0014	19	N8NA	18 KARL	DE
7033	0015	20	W2LE	4 PAUL	NJ

What we should hear on 7032 at “0013Z”

- K0EJ works NB1B
- K0EJ is called by W4NZ (and works him)
- W4NZ is called by KU8E (and works him)
- KU8E takes the frequency
- W4NZ moves up 1 kHz and works N8NA

Did N3BB *REALLY* QSY to 40 to Work K4FXN?

14036	0009	17	W6YL	7	SCOTT	CA
14036	0009	18	K5AF	15	PAUL	TX
7032	0011	19	K4FXN	16	DAN	KY
14025	0012	20	N2IC	22	STEVE	CO
14025	0012	21	K2KQ	13	DON	NY

"Let's go to the Videotape!"

Conclusion

- The technology is almost ready to record a full band of a contest (or several bands)
- Limitations include receiver performance, accessibility of a specific QSO, and recording time
- It is a lot of fun to play with!

Want more information?

- Full documentation on ESS web site
  - Schematic, parts list, manual
  - Quadrature PLD code
- www.expandedspectrumsystems.com