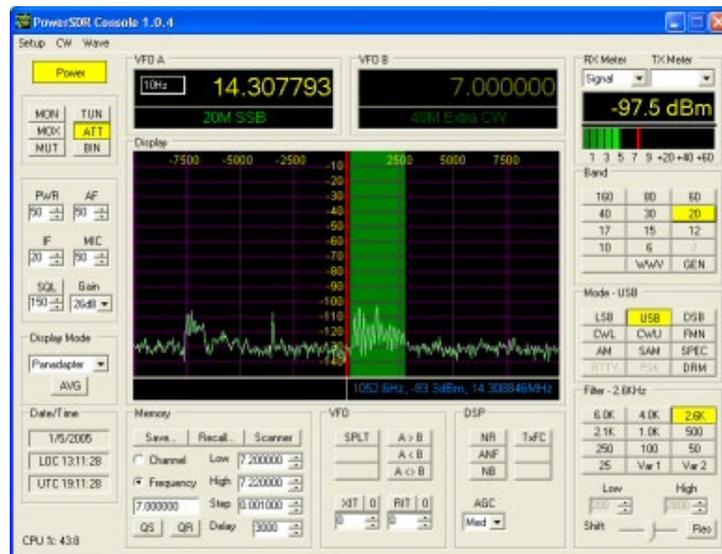


Software Defined Radios for VHF Through SHF
By
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FlexRadio Systems

The FlexRadio Systems' SDR-1000 is the first commercially available Software Defined Radio (SDR) transceiver for the amateur radio market. The SDR-1000 began shipping in April of 2003 with GPL open source software, a first for a commercial transceiver. This has created a groundswell of support for the radio from contributors worldwide. This is evidenced by the constant improvement available through free software downloads on almost a weekly basis. These enhancements are well documented in the October 2005 *QST* product review, "FlexRadio Systems SDR-1000 HF+VHF Software Defined Radio *Redux*." The current SDR-1000 now boasts dynamic range performance that meets or exceeds that of radios costing ten times its cost.

Frank Brickle, AB2KT, Bob McGwier, N4HY, and Eric Wachsmann, KE5DTO, have collaborated for almost two years on the latest open source version of the PowerSDR software that runs the SDR-1000. The figure below shows a screen shot of the software in the real time pan adapter mode that allows signal location and instant click tuning with a mouse.



The SDR-1000 Moves to VHF and Beyond

While the SDR-1000 has been thought of as a HF radio, many prominent amateurs are moving to the SDR-1000 as their IF radio of choice for VHF, UHF and microwave. Key features that are available on the SDR-1000 for VHF+ enthusiasts are:

- Real time click to tune pan adapter spotting
- No ring filters to 25Hz
- SDRAM impulse noise removal
- 10 or 20MHz LO reference input option
- Extremely high dynamic range IF (99dB IMD DR3)
- 2m DEMI IF option
- Integrated transverter and antenna software control with UCB
- 48KHz Bandwidth IF Record/Playback

Through collaboration between Mike King, KM0T, Tony Parks, KB9YIG, Terry van Benschoten, W0VB, and FlexRadio Systems, a Universal Controller Board (UCB) has been developed and integrated with the SDR-1000 to allow transparent software control of up to 16 external transverters and/or antennas. In fact, there are also 16 possible combinations of those 16 devices that may be controlled under the software. It allows for full control of band switching, sequencing, and PTT by simply changing the frequency on the PowerSDR console. By the time this paper is in print, the software will provide direct frequency readout in GHz with transverter-offset correction. That means that one could within seconds QSY from 144MHz to 24GHz with a single click, find the signal on the real time spectrum and click to tune on frequency.

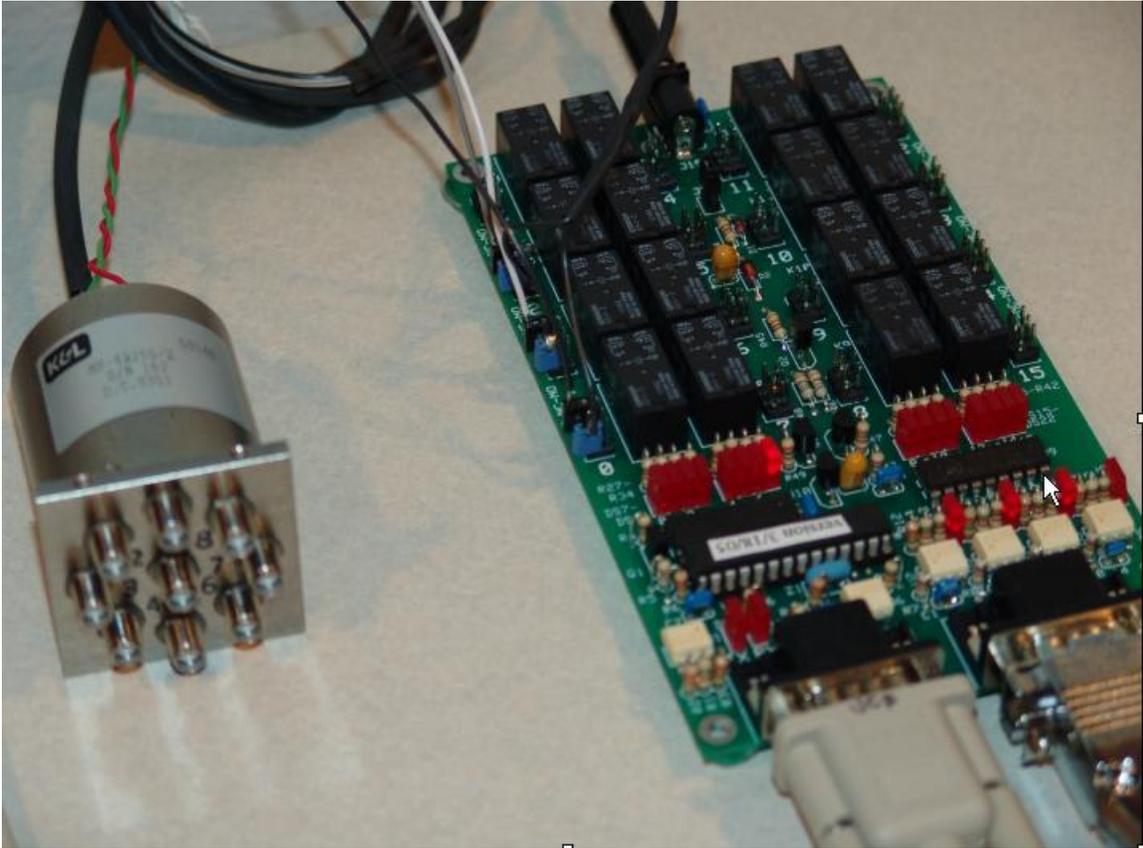
This paper will describe the integration and operation of the UCB with the SDR-1000 IF for microwave operation at the KM0T location. A special thanks goes to KM0T and W0VB for allowing FlexRadio to use their materials to show a real world user application of the SDR-1000.

The UCB hardware was designed and has been produced by W9YIG. While the UCB is currently available only through W9YIG, FlexRadio Systems is considering its addition to the standard product line.

The UCB is a single PCB with a 15-pin connection to the External Control (X2) connector on the back panel of the SDR-1000. The X2 connector provides PTT input and output as well as six spare open collector switched outputs. These six outputs can be set under software control for simple external control by band with no other external hardware. However, with the addition of the UCB, very sophisticated control options are available including separate antenna, transverter and PTT control. It even allows the choice of binary or BCD control of antenna switching relays as seen in the KM0T installation.

The photo below shows the UCB on the right with an 8-position SMA coaxial relay on the left. The coax relay uses BCD encoding for control so the UCB must provide the

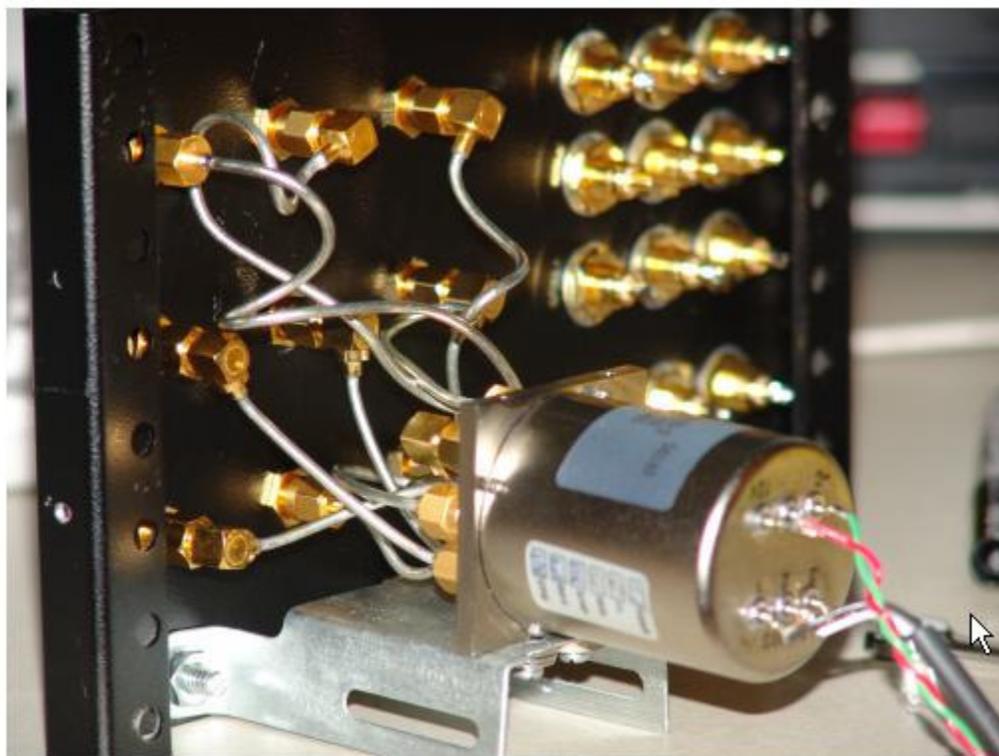
necessary codes to select each band. Headers are provided for the normally open and normally closed contacts on each of the 16 relays. LEDs provide status indication for each relay as well as other control and data lines. The board is powered by an external ___V supply. A 15-pin loop through connector allows dedicated control signals from the X2 connector to be passed through the UCB.



KM0T has designed his new station for operation on all microwave bands from 50MHz to 47GHz, with room to grow. He decided to integrate the UCB, 8-position coax relay, and all PTT connections in a single enclosure for a clean installation in the shack. The following two photos show the rear panel layout in progress. The coax relay is mounted on a bracket on the left with semi rigid coax connections to the panel mounted SMA connectors. A bank of 12 gold plated RCA connectors are mounted on the right hand side for PTT control outputs.

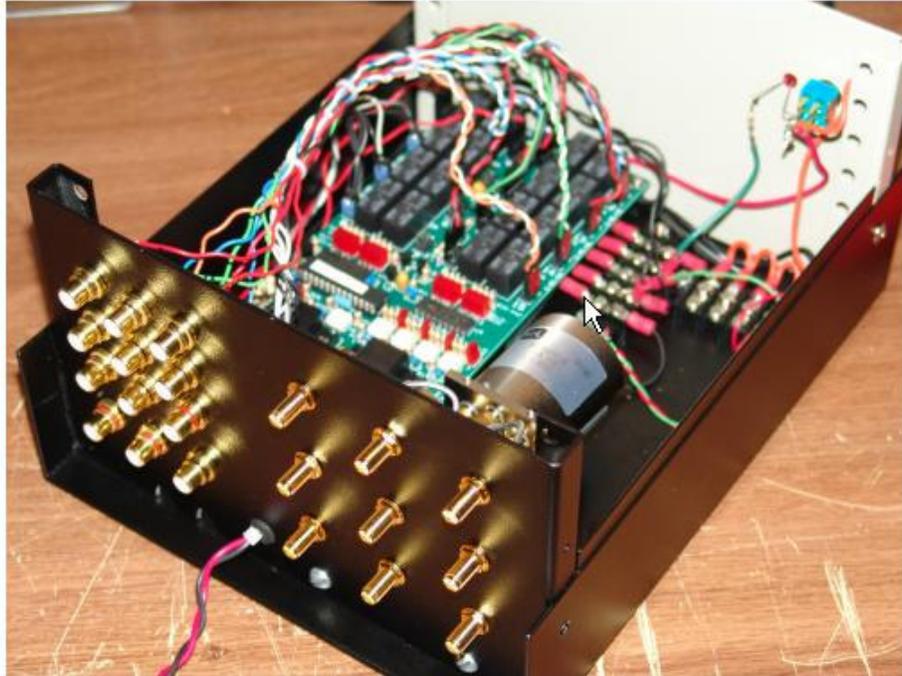


Rear Panel Showing PTT and Control RCA Jacks



Closeup of SMA Jumpers to Rear Panel Bulkheads





Rear Panel View

The photo above shows the completed controller module with all interface wiring installed. The single red and black wiring pair protruding from the grommet at the bottom center of the back panel is the DC power supply input. The final station installation may be seen in the following two photos. Note the neatness of the installation for coverage of all bands from 50MHz through 24GHz!



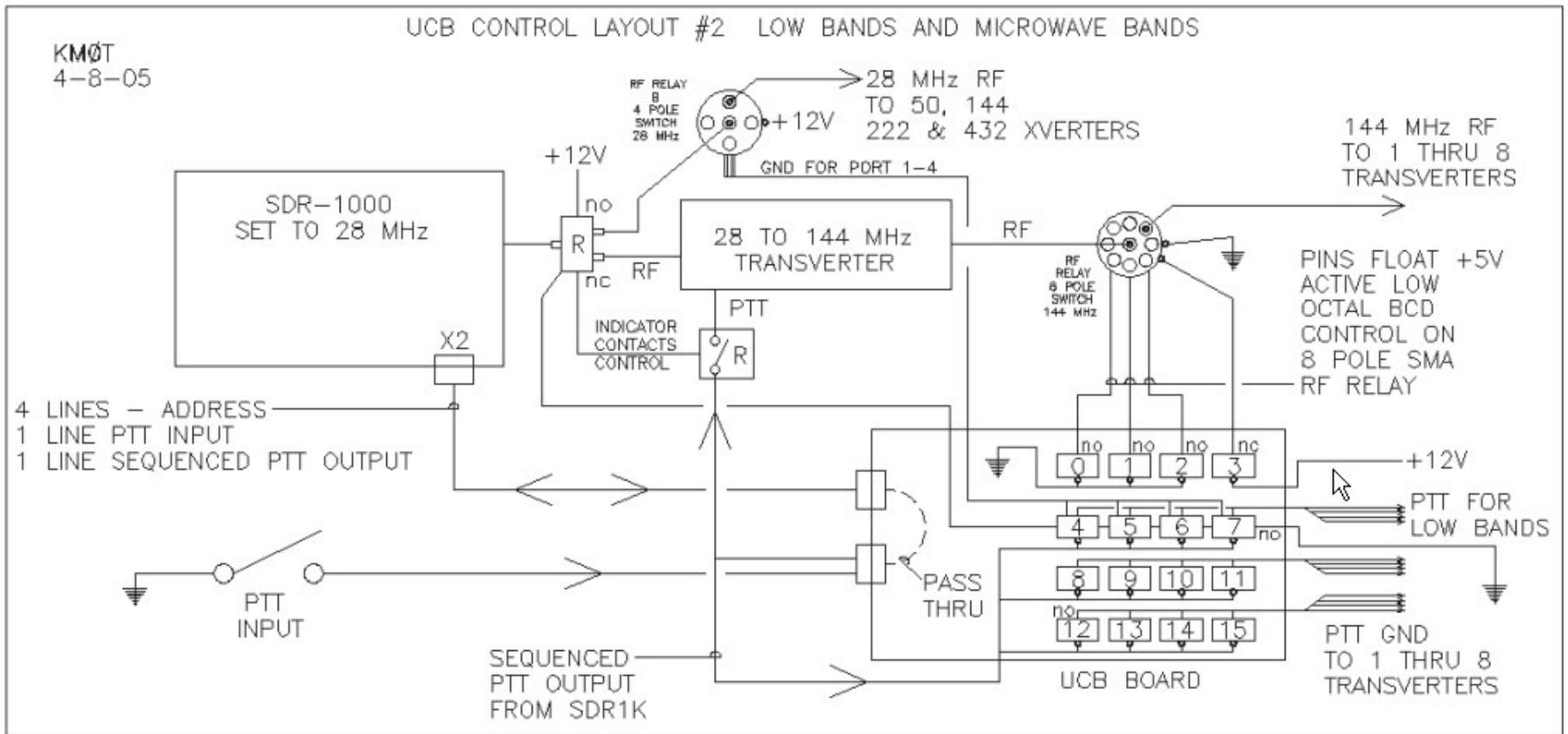


KM0T QTH

Integration of the SDR-1000 with UCB in the station requires a careful planning. The key steps are as follows:

1. Draw a wiring diagram of the station with all accessories to be controlled. Include all relays, PTT, power wiring, and other control logic required for the installation.
2. Create a spreadsheet matrix for the control logic by band and map each band to a UCB control register address.
3. Wire the station according to the schematic and control logic matrix.
4. Program the PowerSDR software by band according the control logic matrix.
5. Turn on the SDR-1000 and have fun.

The schematic on the next page provides the final wiring configuration at the KM0T location. Note the UCB at the bottom left of the drawing shows each relay and how it is connected to the other major components. The BCD control signals for the 8-position coax relay are clearly indicated. The SDR-1000 is used as a 28MHz IF for all bands. Note the two relays to the right and above the 28-144MHz transverter provide for low band selection. The SDR-1000 allows a sequenced PTT output with a user programmable delay time in milliseconds.



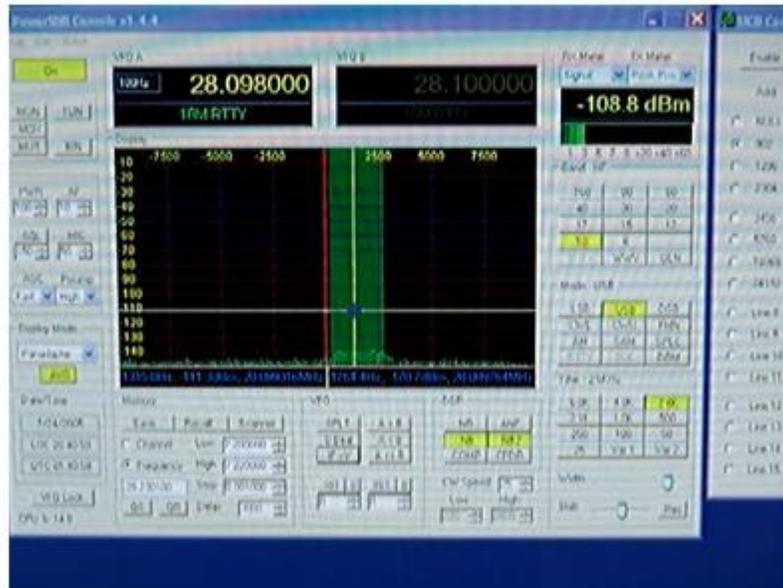
KM0T STATION WIRING DIAGRAM

UCB	SDR-1000	RELAY CNTRL BITS: 0 = OPEN RELAY 1 = CLOSE RELAY												RELAY	BIT OF 1 INDICATES			ASSOC	
REGISTER	ASSOCIATED	PTT RELAYS								PTT RELAYS - LOW BANDS				PWR	RELAY CLOSE TO GND			ASSOC	
ADDRESS	BAND BUTTON	BIT-15	BIT-14	BIT-13	BIT-12	BIT-11	BIT-10	BIT-9	BIT-8	BIT-7	BIT-6	BIT-5	BIT-4	ENABLE	RF RELAY ADDRESS			RELAY	
0	NULL BAND	0	0	0	0	0	0	0	0					1	0	0	0	N.O.	
1	902	0	0	0	0	0	0	0	1					0	1	1	1	1	
2	1296	0	0	0	0	0	0	1	0	RESTRICTED AREA			0	1	1	0	2		
3	2304	0	0	0	0	0	1	0	0	ALL ZEROS			0	1	0	1	3		
4	3456	0	0	0	0	1	0	0	0					0	1	0	0	4	
5	5760	0	0	0	1	0	0	0	0					0	0	1	1	5	
6	10368	0	0	1	0	0	0	0	0					0	0	1	0	6	
7	24192	0	1	0	0	0	0	0	0					0	0	0	1	7	
8	SPARE - 47 GHZ?	1	0	0	0	0	0	0	0					0	0	0	0	8	
9	50									1				1	X	X	X	1B	
10	144	RESTRICTED AREA									1			1	X	X	X	2B	
11	222	ALL ZEROS										1		1	X	X	X	3B	
12	432											1		1	X	X	X	4B	
13	NA	RESTRICTED AREA									RESTRICTED AREA								
14	NA	ALL ZEROS									ALL ZEROS								
15	NA																		
NOTE 1:	BIT-3 - RELAY POWER ENABLE - ON 1 - POWER BROKEN TO MICROWAVE RELAY - ADDRESS DOESNT MATTER - "X"																		
NOTE 2:	1 IN BIT 4, 5, 6 & 7 ROUTES PTT TO CORRECT LOW BAND XVERTER - AND SELECTS CORRECT LOW BAND 4 POLE RELAY PORT																		

KM0T CONTROL MATRIX TABLE

Now that setup is done, the moment of truth is to make contacts on all the microwave bands in just minutes with N0DQS. The presentation will include a video recording of the sequence of contacts from 902MHz through 24GHz!

The Moment of Truth – Running the Bands with N0DQS.



Coming Soon to a SDR-1000 Near You

PowerSDR software plans include instant band switching and direct frequency readout. Using the VHF+ button on the front console the band buttons will convert to VHF+ bands three band-stacking registers per band. The setup form will allow programming of offsets for each transverter so that direct frequency readout is possible that corrects for oscillator-offset error in each transverter. With the SDR-1000, UCB, and PowerSDR software, QSY to any of the VHF+ bands becomes as easy as switching HF bands. Now “DC to light” operation is possible from a single operating position.