

# Using an SDR as a Microwave IF

W5HN

Martlesham Roundtable

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• Elecraft K3

• The Future?

North Texas NTMS Microwave Society

## **Basic Software Defined RX**





# Softrock 5



- My 1<sup>st</sup> introduction to SDR
- Sold as a kit by KB9YIG around \$20
- Single band. I built 40m version
- Oscillator at signal frequency
- Didn't work on 10m



# Softrock 7



- Development of Softrock 5 for 10m RX
- Only covered 10m

- Oscillator at signal frequency
- Used for monitoring beacons



# Softrock 6.2 10m TX/RX



- 1W 10m TX/RX
- Osc at 4 times signal frequency (112.36MHz xtal gives 28.090 c.f.)



•Can be set for good image rejection, but LO leakage -33dBC



## Softrock 6.2 10m RX/TX



- XTALL board made available which uses SI570 chip and PIC to generate 16 freqs selectable by DIL switches
- Unfortunately only 3 frequencies on 10m, (28.046, 28.092, 28.346) in standard xtall PIC



# Softrock 6.2 10m TX/RX



- XTALL PIC reprogrammed to give 16 frequencies on 10m
- 28.03, 28.07, 28.11, 28.15, 28.19, 28.23, 28.27, 28.31, 28.35, 28.39, 28.43, 28.47, 28.51, 28.55, 28.59, 29.6MHz
- Another PIC used to step through the 16 bands and to count oscillator frequency.



# KGKSDR 1296MHz W5HN

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#### Transmit: All modes

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# Rocky 1296MHz W5HN



🐻 Rocky 3	.6										
File View 1	rools Help										
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140.dB											
120 d8											
100 dB											
80 dB											
60 dB											
40 dB											
20 dB											
0 dB	No distanti anda di a	of the state of th	Lawrence & Love	der weiteren der		41				an a sull taken t	
28280	28290	28300	28310	28320	28330	28340	28350	28360	<b>1</b> 8370	28380	28390
CW	Step 12 I	-12	Peak	L: -53 dBES	Peak R: -54 dBF	5 Noise: -71 dBE	5				1

Transmit: CW only

# Softrock 8.3 Multiband RX



- Covers 1.8 to 30MHz
- Has 4 **plug in** filter boards (160, 80/40, 30/20/17, 15/10m)
- Frequencies, set by onboard SI570/PIC and 4 DIL switches
- Supplied for: 1.846, 1.892, 3.546, 3.846, 7.046, 7.221, 10.146, 14.046, 14.271, 18.114, 21.046, 21.321, 24.936, 28.046, 28.092, 28.346 c.f.
- Latest version has Frequency control by USB control of SI570





- •1.8 to 50MHz Transceiver. 1W or 100W with optional internal Amplifier
- •Has provision for internal DEMI 144MHz transverter for use as microwave IF.
- •Optional K3TUF UCB allows control of IF switching between multiple bands under software control
- •Direct Transverter frequency readout in PowerSDR
- •Needs soundcard. Recommend: Delta D44 (Internal) or Edirol FA66 (external)
- Controlled through PowerSdr software

## PowerSDR

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🗱 FlexRadio Systems PowerSDR v1.12.0 WW2R							
Setup Memory Wave Equalizer XVTRs CWX							
Start     VFO A     VFO Lock     Tune     10Hz     1296.104 028       MDN     TUN     1.2 GHz Weak Signal     1296.100000     Save     Restore     1.2 GHz Weak Signal	RX Meter TX Meter Signal Fixed Pwr - -108.2 dBm						
MUX     X2TR     Caspiay       Rec     Play     088     1296.090     1296.094     1296.096     1296.100     1296.102     1296.104     1296.106     1296       -20	1 3 5 7 9 +20 +40 +60 Band VHF+						
AF: 50	1296     2304     2320       3400     3456     5760       10368     7     8       9     10     11       HE     12     13						
Drive:     100       J     -90       J     -100       AGC     Preamp       Mt20     Mt20       Med     High       -130     -140	Mode - CWU LSB USB DSB CWL CWU FMN AM SAM SPEC						
SQL     104 ÷     -3400.9Hz     -63.8dBm     1296.094     775 MHz     718.5Hz     -109.3dBm     1296.098     894 MHz	DIGL DIGU DRM Filter - 250 1.0k 800 750						
BCI Rejection VFO DSP Display Mode Mode Specific Controls - CW   SPLT A > B NR ANF Panadapter CW Speed: 25 ÷ Pitch Freq (Hz): 600 ÷ VAC   IF->V A <> B SR BIN AVG Peak If If If	600     500     400       250     100     50       25     Var 1     Var 2       Low 475     +     High 725     +						
Date/Time     XIT     0     RIT     0       11/4/2008     0     1     -	Width: . J Shift: J Res						
Preamp     AGC-T:     90 ±     NR     ANF     Display Mode     RX2 Mode     RX2 Filter       Preamp     V     V     V     NR     ANF     NR     ANF     SQL     SQL     150 ±     SR     BIN     AVG     Peak     AM     SAM     250     Var1     Var2       10m     ✓     Mute     ✓     AGC:     Med     ✓     DIGL     DIGU     DRM     Low 0     ±     High 5000 ±	BX2 Meter Signal ▼ 0 dBm						

## SDR1000 EXTERNAL REFERENCE



• Supplied with Internal 200MHz Can oscillator

- All you need is a 14 pin DIL header, a length of coaxial cable and change 2 links to allow use of external 10MHz reference
- Problem: SDR1000 no longer stand alone
- So installed an onboard 10MHz TCXO under board stack (from Qualcomm synth)

## SDR1000 EXTERNAL REFERENCE





# SDR1000 XVERTER INTERFACE



When I got SDR1000 three people told me DON'T use the xverter interface  $\boxtimes \mathbb{K}$ 

Xverter port is before preamp and bandpass filtering, lots of L.O. comes out on RX which you don't want to apply to rx mixer



Due to preamp and filtering on RFE PCB (not used during XVERTER operation) LO < -55dBm at the 1w antenna port. Need to divert drive from input to PA and split RX and TX paths Also wanted Transmit LED indication and circuitry to be isolated from SDR1000 circuitry

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## SDR1000 XVERTER INTERFACE





# SDR1000 XVERTER INTERFACE











Allows control of 16 external relays by the X2 connector of the SDR1000. Used to switch transverters between microwave bands.





# SDR1000 UCB: Application

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		RELAY	CNTRL	BITS: 0	) = OPE	N RELA	(Y 1=)	CLOSE	RELAY					RELAY	BIT OF	1 INDIC/	ATES	
UCB	SDR-1000													PWR	RELAY	CLOSE	TO GND	ASSOC
REGISTER	ASSOCIATED				PTT RE	LAYS				UNA	JSED RE	LAYS		ENABLE	RF REI	LAY ADI	DRESS	RELAY
ADDRE SS	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	BIT-3	BIT-2	BIT-1	BIT-0	PORT
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		IN THIS	AREA		0	1	1	0	2
3	2304	0	0	0	0	0	1	0	0		UN-USE	ED REL/	AYS	0	1	0	1	3
4	3456	0	0	0	0	1	0	0	0		CAN BE	E USED	FOR	0	1	0	0	4
5	5760	0	0	0	1	0	0	0	0		OTHER	CNTRL	ITE MS	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> 15		RESTR	ICTE D A	REA						RESTR	ICTE D A	REA		1	RESTR	ICTED A	<b>REA</b>	N.O.
		ALL ZE	ROS							ALL ZE	ROS				ALL ZE!	ROS		
NOTE 1:	BIT-3 - RELAY POV	VER EN	ABLE -	ACTIVE	LOW - /	A 1 CON	<b>IDITION</b>	ACTIVA	TESRE	LAY 3 -	BRE AK:	S POWE	RTOR	ELAY - S		ORTS	OPEN	
NOTE 2:	TE 2: RE RELAY BCD CONTROL IS ACTIVE LOW - SO 1 - 1 - 1 FOR ADDRESS 1 CLOSES THE THREE RELAYS TO GROUND - GIMING 0 - 0 - THUS PORT 1																	

### Transverter configuration Screen



🗱 XVTR S	etup														
Enabled	Band Button	UCB Address	Button Text	LO Offset (MHz)		LO Error (kHz)	Begin Freq (MH	łz)	End Freq (MH	z)	RX G (dB)	ain	RX Only	Power	XVTR RF TX
<b>v</b>	0	0 🕂	1296	1152.0	-	0.000 🕂	1296.000000	-	1297.000000	-	0.0	-	Γ	100÷	•
<b>v</b>	1	1 🕂	2304	2160.0	-	0.000 🕂	2304.000000	-	2305.400000	-	29.0	-	Γ	100 ÷	1
<b>v</b>	2	2 📫	2320	2176.0	-	0.000 🕂	2320.000000	-	2320.400000	-	0.0	-	•	100÷	5
<b>v</b>	3	3 📫	3400	3256.0	-	0.000 🕂	3400.000000	-	3401.000000	-	0.0	-	Г	100 ÷	•
<b>v</b>	4	4 🕂	3456	3312.0	-	0.000 🕂	3456.000000	-	3456.200000	-	0.0	-	Γ	100	5
<b>v</b>	5	5 📫	5760	5616.0	-	0.000 🛨	5760.000000	-	5760.200000	-	0.0	-	Γ	100 ÷	•
<b>v</b>	6	6 📫	10368	10224.0	-	0.000 🛨	10368.000000	-	10369.000000	-	0.0	-	Γ	100	Γ
Γ	7	7 🚊	7	0.0		0.000 🕂	0.000000	-	0.000000	-	0.0	-		100-	Γ
Г	8	8 🛨	8	0.0	-	0.000 -	0.000000	-	0.000000	-	0.0	-	Г	100-	
Г	9	9	9	0.0	-	0.000 🕂	0.000000	-	0.000000	-	0.0	-		100-	
Г	10	10 🛨	10	0.0		0.000 🕂	0.000000	-	0.000000	-	0.0	-	Г	100-	Γ
Г	11	11 +	11	0.0	-	0.000 🕂	0.000000	-	0.000000	-	0.0	-		100-	
Г	12	12 🕂	12	0.0		0.000 🕂	0.000000	-	0.000000	-	0.0	-		100-	Γ
Г	13	13	13	0.0	-	0.000 🕂	0.000000	-	0.000000	-	0.0	-		100-	Γ
Г		14		0.0		0.000 -	0.000000	-	0.000000	-	0.0	-		100-	
Г		15		0.0	-	0.000 🕂	0.000000	÷	0.000000	+	0.0	-	Γ	100-	Γ
	🔽 Use XV	TR PWR for Tur	)e												



### **UCB** Configuration screen

Setup	XVTRs	Enable	Relays	elay: 80ms 👱	Set	
		Disa	ble D	isable and Clear	Matrix	
Addr			F	elays		Write All
Line	12 0 r= r	234	5678	9 10 11 12		Write
Line	1 _		FFFF	FFFF	FFFF	Write
Line	2		гггг	FFFF	гггг	Write
Line	з гг		гггг	гггг	FFFF	Write
Line	4		FFFF		FFFF	Write
Line	5		гггг	FFFF	гггг	Write
Line	6		гггг	гггг	FFFF	Write
Line	7 ГГ		гггг	гггг	гггг	Write
Line	8		FFFF	FFFF	FFFF	Write
Line	9 r r		гггг	гггг	FFFF	Write
Line	10 -		гггг	гггг	FFFF	Write
Line	11 ГГ		гггг	гггг	гггг	Write
Line	12 _		FFFF	FFFF	FFFF	Write
Line	13 ГГ		гггг	гггг	гггг	Write
Line	14 r r		гггг	гггг	FFFF	Write
Line	15 _		FFFF	FFFF	FFFF	Write

#### Access from <ctrl><alt><U>

Try finding that in the documentation!

### Virtual COM Ports: N8VB Vcom



Allows COM ports to be virtually connected together between applications (no physical cables)



# Virtual Audio Cable (VAC)



Allows digital audio streams to be connected together virtually

Eg; sending output of sdr1000 to WSJT/MMTTY/MMSSTV

2	🕿 Virtual Audio Cable Control Panel 📃 🗖 🔀													
	Driver ( Cables Resta	oarameters Set rt	Cable SR Max in Conr Mic	parameters	96000	Form BPS	at range 8 🛨 16 eam fmt Cabl	NC Ie range 💌	1 😳	., 2 ne contr	ol 「	]		
	Cable	Max instances	MS per int	SR range	BPS range	NC range	Stream fmt limit	Volume ctl	SR	BPS	NC	Rc stms	Pb stms	
	1	20	10	1102596000	816	12	Cable range	Disabled		2000 - 1996 - 1996 - 1996 - 1996 - 1996 - 1996 - 1996 - 1996 - 1996 - 1996 - 1996 - 1996 - 1996 - 1996 - 1996 -	2 - 18 - 18 - 18 - 18 - 18 - 18 - 18 - 1		ee	
	2	20	10	1102596000	816	12	Cable range	Disabled						
										Abou	t	Help		Exit

## **SDR-IQ**



500Hz to 30MHz receiver

Maximum display bandwidth of 196 KHz at 0.75 HZ RBW. I/Q bits sent out on USB, doesn't need soundcard Data can be recorded to file and played back later







#### Spectravue software: 1296MHz ARRL EME contest



# SDR-IQ Continuum mode



The continuum display mode displays the total power over the entire  $\not$  frequency span versus time. Data can be saved as a dbm .CSV file for later processing



# **SDR-IQ** Antenna Plots



Sun moves at approximately 0.25 degrees per minute depending on declination

Therefore point dish at a location on the suns path and let it drift through the beamwidth



# HPSDR



• Atlas Backplane

- Ozy interface provides I/Q data via USB
- Janus A/D and D/A ("soundcard" 196kHz)
- Mercury 0.1MHz to 55MHz receiver (11/08)
- Penelope 1 W Transmitter
- Alex LPF/BPF Filter Unit (01/09)
- A series of plugin boards on Ozy back plane
- Modules available through TAPR
- Controlled by PowerSDR software



## **HPSDR**





L to R: OZY, Janus, Penelope, Mercury, Alex (external unit)







1.8 to 50MHz. 10/100W. Optional Transverter interface

Has transverter band data to switch transverters between bands





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Basically an SDR: Connects to IF output of K3 to give panoramic display

LP Bridge/ Power SDR-IF allows clicking on signal which retunes the K3 to the right frequency for QSO







# K3: LP-BRIDGE

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Allows multiple applications to share the K3's ONE com port  $\swarrow$ 

🖣 LP_Bridge_v0.9.	78			
File Setup Help				
		PowerSDR	K3 Status	
01		App #1	MODE	LSB
6 (S 1272) (S 1		App #2	FREQ	3846000
K3 Com Port	- K3 Ethernet Port	OPP #0	VFO_A	3846000
COM4 💌	Remote IP / Host Na	ame TCP Port	VFO_B	3946750
38400 💌	XXX. XXX. XXX. XXX	: 12345	PREAMP	0
Disconnect			TX/RX	Off
Disconnect	Password xxxxxxx		K3 IF FREQ	-1400
Auto Connect			K3 IF BW	2200
Virtual Com Port #1	Virtual Com Port #2	Virtual Com Port #3	MCU rev	02.58
COM5 -	СОМ7 –	СОМ9 –	DSP rev	01.94
Connect	Connect	Connect	K3 Rovd Text	C Show
T Auto Connect	F Auto Connect	🖵 Auto Connect	E13600:	
T Al1 T Al2	T AI1 T AI2			
Pgm power sdr	Pgm wsjt	Pgm mmsstv		

### K3 902MHz W5HN



#### WU2X PowerSdr IF stage

🗱 WU2X PowerSDR/K3 IF Stage v0.92							
Setup Memory Wave	e Equalizer XVTRs CWX Help						
On	VF0 A VF0 B VF0 Lock Tune - 250Hz + 7.033 201	RX Meter TX Meter Signal 💌 Fwd Pwr 💌					
MON TUN	10M SSB 7.000000 Save Restore 40M CW	-71.0 dBm					
MUT X2TR	Display 28,370 28,372 28,374 28,376 28,378 28,380 28,382 28,384 28,386 28,388 28	1 3 5 7 9 20 00 00 Band - HF					
AF: 30 🛨							
		40 30 20 17 15 12					
		VHF+ WWV GEN					
Drive: [100 🛨		Mode - USB					
AGC Preamp	Linkear paranting date in the same the second date in the second	LSB USB DSB CWL CWU FMN					
SQL 114-	-140 2218.2Hz -76.4dBm 28.379 968 MHz	DIGL DIGU DRM					
	Pan:	Filter - 2.7k 5.0k   4.4k   3.8k					
BCI Rejection	VF0 DSP Display Mode Mode Specific Controls - Phone Transmit Brofile	3.3k 2.9k 2.7k					
Date/Time	SPLT A > B NR ANF Panadapter Mic Gain: 35 ± Conventional   0 Beat B > A NB NB2 AVG Panadapter COMP 35 ± Conventional	2.4k 2.1k 1.8k 1.0k Var1 Var2					
10/24/2008	IF-2V A K2 B Show TX Filter   Show TX Filter 3 - 5 0 Display	Low   150 한 High   2850 한					
LOC 17:06:31	$\begin{bmatrix} 0 & \Rightarrow & 0 & \Rightarrow & & & \\ \hline & & & & & \\ \hline & & & & & \\ \hline & & & &$	Shift:					
SI S 10. E0.0							



- Softrock 2m
- WB6DHW QSE board (to go with his 56MHz QSD/9954 DDS below)



•WB6DHW 700MHz SDR RX/TX (Beta boards available, KY1K kitting)



## What next: Commercial



### Flex 1500:-

- 160m to 6m coverage 1W output
- A/D and D/A converters operating at a sampling rate of 48 KHz
- USB interface
- External Connector for connecting an external clock source
- External connectors for band data, PTT, external keying line, headphones, key and microphone.
- 4" x 6" x 1.5".
- \$499. Orders now being taken. Available April 09.



# More information



- Softrocks: <u>http://groups.yahoo.com/group</u>
- K0AWU: <u>http://www.geocities.com/en37ham/10mRxTx.html</u>
- KGKSDR: <u>http://www.m0kgk.co.uk/sdr/index.php</u>
- ROCKY: http://www.dxatlas.com/Rocky/
- SDR-IQ: <u>http://www.rfspace.com/SDR-IQ.html</u>
- Spectravue: <u>www.moetronix.com</u>
- SDR1XXX: <u>www.flex-radio.com</u>
- SDR1000 Interfacing: <u>http://www.km0t.com/pages/sdr.htm</u>
- VAC: <u>http://software.muzychenko.net/eng/vac.html</u>
- VCOM: <u>http://www.philcovington.com/SDR.html</u>
- Elecraft: www.elecraft.com
- LP PAN: <u>http://www.telepostinc.com/LP-PAN.html</u>
- Power SDR-IF: <u>http://www.wu2x.com/sdr.html#powersdr</u>
- HPSDR: www.hpsdr.org
- WB6DHW: <u>www.wb6dhw.com</u>