UHF ARC-164 Airborne Radio

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Revision History

1.0.3 Page 5 updated
1.1.0 Pages 4, 11, 12 updated

Disclaimer

This document is for information only. It may not be accurate, nor free of errors. It has been created with the best of my knowledge, but no liability is assumed for any damage caused by using this document or the devices described herein.

Viperpits.org

A lot of information is also available on the viperpits.org forum. If you want to know about the history of this development read the thread
http://www.viperpits.org/smf/index.php?topic=5082.0
(free registration required)

Partlist

1x UHF Indication Board
1x UHF Control Board
1x UHF ARC-164 Panel
1x 5V/1A powersupply (an additional 5V/1.5A powersupply if using backlight!)
1x 10pol flat wire connector cable
1x 2pol wire cable (already mounted)
1x 7-Segment LED Board
1x Headphones or high ohm loudspeaker (not shown)

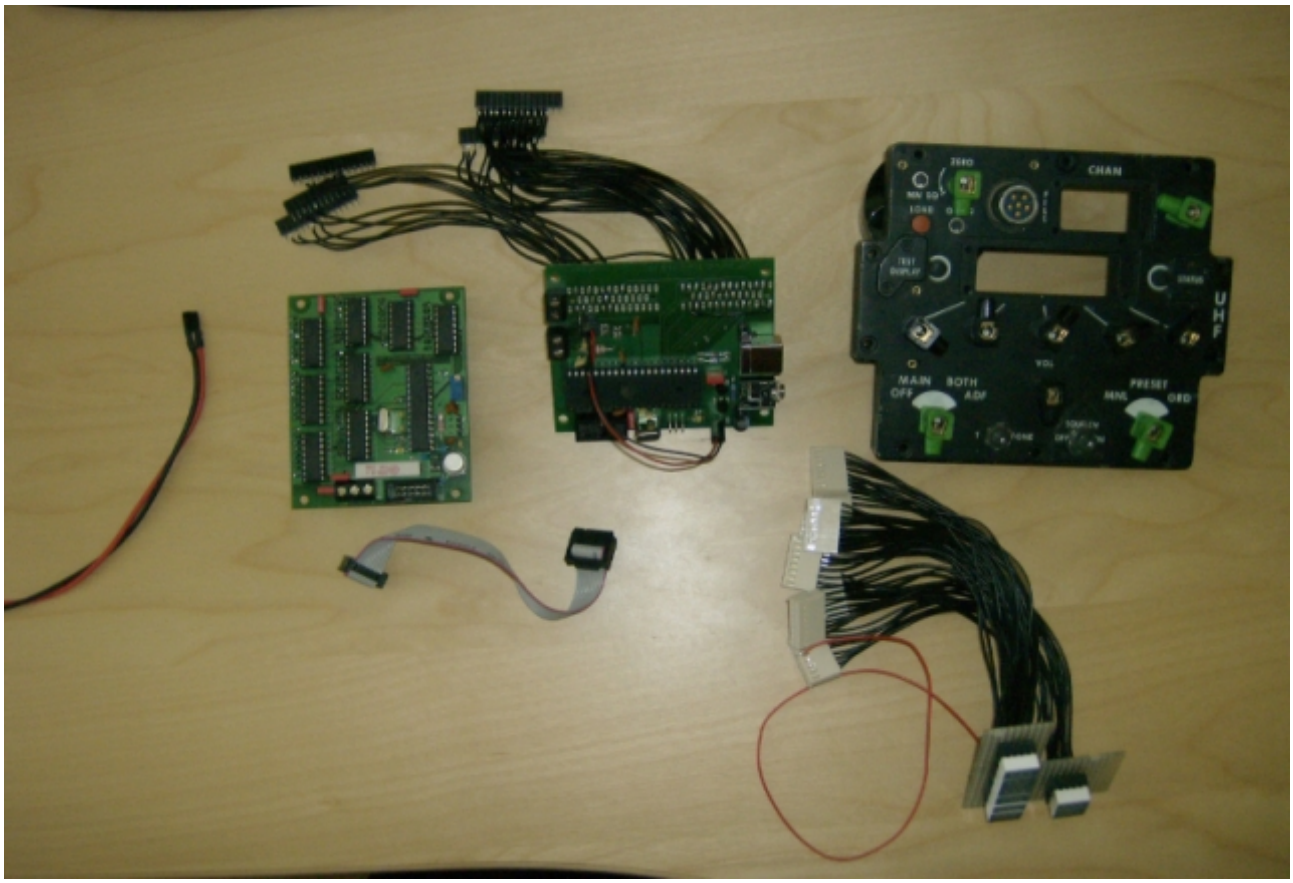

Figure 1: Parts

Components partlist

The eagle[1] .brd files can be used to generate gerber files if your local PCB manufacturer does not accept eagle files.

Note:
I do not endorse buying from mouser, the intention is only to give reference.

1 cadsoft.de

ATMega8	DIL-28	IC	1	556-ATMEGA8A-PU
Shift Register 595	DIL-16	IC	8	511-M74HC595
Quarz 16 Mhz	HC18U-V	Quarz	1	815-ABL-16-B2
IC-sockel (opt.)	16 pol	Sockel	8	517-4816-3000-CP
IC-sockel (opt.)	28 pol	Sockel	1	517-4828-3004-CP
LED yellow	1206	Led	1	696-SML-LX1206YC
2V7 Z-Diode 1,3W	DO-204AL	Diode	1	771-BZX79-C2V7133
BC141	TO-39	Transistor	1	511-BC141-16
SMCC 10uH		Inductivity	1	434-23-100
100nF	RM5	Capacitor	4	80-C320C104K5R5CA
10nF	RM2.5	Capacitor	2	80-C315C103K5R5CA
1nF	RM2.5	Capacitor	1	80-C315C102K5R5CA
100pF	RM2.5	Capacitor	2	80-C315C101K5R5CA
22pF	RM2.5	Capacitor	2	80-C315C220K5G5CA
150R	805	Resistor	9	652-CR0805FX-1500ELF
8k2	805	Resistor	1	652-CR0805FX-8201ELF
180R	1/4W	Resistor	1	291-180-RC
560R	1/4W	Resistor	1	291-560-RC
10R	5W	Resistor	1	284-ACS5SW-10
Powerplug	AK500/3	Connector	1	845-34.103
Pinheader 10pol	5x2	Connector	1	517-D2510-6002-AR
Pinheader 3pol	3 pol	Connector	1	855-M20-9730345
Pinheader 8pol	8 pol	Connector	8	855-M20-9730846
Poti 47k	RM2.54	Poti	1	652-3296Y-1-473LF

Table 1: UHF Indication Board

Note:

Instead of the Poti you could just as well mount a 3pol pinheader and connect any potentiometer with about the same resistor value.

Article	Value	Type	#	Mouser order number
22pF	RM2.5	Capacitor	2	80-C315C220K5G5CA
100pF	RM2.5	Capacitor	2	80-C315C101K5R5CA
10nF	RM2.5	Capacitor	2	80-C315C103K5R5CA
10nF	RM5	Capacitor	1	
100nF	RM5	Capacitor	2	80-C320C104K5R5CA
10uF El.Ca.	RM2.5	Capacitor	1	647-UST1H100MDD1TE
100uF El.Ca.	RM2.5	Capacitor	1	647-UVR1V101MED1TA
Audio Jack	3.5mm	Connector	1	502-35RAPC4BH3
Sockets 14pol	14pol	Connector	4	
Sockets 11pol	11pol	Connector	2	
Powerplug	A500/2	Connector	2	845-34.102
Pinheader 3pol	3 pol	Connector	2	855-M20-9730345
USB -B		Connector	1	649-61729-0010BLF
Pinheader 6pol	2x3	Connector	1	517-D2510-6002-AR
Pinheader 6pol	3 pol	Connector	2	855-M20-9730345
3,3V Z-Diode Fast 0,5W	DO35	Diode	2	78-BZX55B3V3
1N4148	MINIMELF	Diode	22	78-LL4148
74HC154	SO24W	IC	1	771-74HC4515D
ATMega16	DIL-40	IC	1	556-ATMEGA16A-PU
10uH	SMC	Inductivity	1	434-23-100
LED yellow	1206	Led	1	696-SML-LX1206YC
16Mhz	HC18U-V	Quarz	1	815-ABL-16-B2
2k2	805	Resistor	1	652-CR0805FX-2201ELF
220R	805	Resistor	1	652-CR0805FX-2200ELF
4k7	805	Resistor	1	652-CR0805FX-4701ELF
820R	1/4W	Resistor	1	291-820-RC
82R	805	Resistor	2	652-CR0805FX-82R0ELF
8k2	805	Resistor	1	652-CR0805FX-8201ELF
150R	805	Resistor	4	652-CR0805FX-1500ELF
IC-Sockel (opt.)	40pol	Sockel	1	517-4840-6000-CP
BC327	TO-92	Transistor	1	512-BC32740BU
BC337	TO-92	Transistor	1	512-BC33740BU

Table 2: UHF Control Board RP

Article	Value	Type	#	Mouse order number
Flat wire cable connector	AWG28	Wire	1	517-2M-BDBD-016-12
Jumper wire	2pol	Wire	1	
7-Segment LED Com. Anode	RM2.54	LED	8	630-HDSP-7801-JK000
Black wire 0.14mm²		Wire		
Socket 8pol	RM2.54	Connector	8	
Prototype Board 160x100	RM2.54	PCB	1	
Socket 5pol 5mm height	RM2.54	Connector	16	

Table 3: Additional components

Assembly

Wiring the 7-Segment LED `HDSP-7801-JK000`

In case you use the 7-Segment LED `Avago HDSP-7801-JK000`, you can use the following table to wire the devices.

UHF Indication Board Pin	Segment	HDSP-7801-JK000 Pin
1 (lilac)	a	10
2 (blue)	b	9
3 (green)	c	8
4 (yellow)	d	5
5 (orange)	e	4
6 (red)	f	2
7 (brown)	g	3
8 (black)	DP	7
Common Anode		6 & 1

Table 4: Wiring

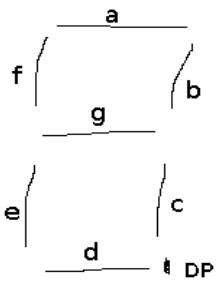

Figure 2: 7-Segment LEC layout

There are ready made connectors[2] available that use colored wires. These match the colors given for the UHF Indication Board Pin in Table 4.

Connect all Common Anode pins to a common (preferably red) wire.

The LEDs should be soldered to small prototype boards that fit into the tiny space of the UHF panel. Sockets do not provide reliable contact.

Mount the 7-Segment LED Board to the UHF ARC-164 Panel. M2.5 screws fit through the UHF panel holes.

2 http://www.reichelt.de/Platinen-Steckverbinder/PS-25-8G-WS/3//index.html?ACTION=3&GROUPID=5216&ARTICLE=14831&SHOW=1&START=0&OFFSET=500&

Assembly of UHF Control Board and UHF Indication Board

TODO

Note: The preferred way to mount the boards would be in a 90 degree angle to the UHF panel. This allows use of short wires for all connections. A casing, like the real panel could be build to mount the boards with spacers to the sidewalls.

Connections

If you have only the UHF Indication Board

1) Connect the UHF Indication Board with the 5V Powersupply. The polarity is printed on the PCB.

2) Connect the 7-Segment LED Board to the UHF Indication Board.

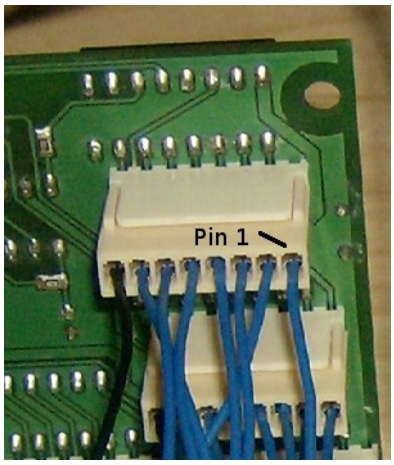

Figure 3: Pin 1

The UHF Indication Board Pin 1 is at the same position for all connectors.
The common anode wire is connected to the power plug labeled "PWM".

The 7-seg. LEDs are assigned as follows

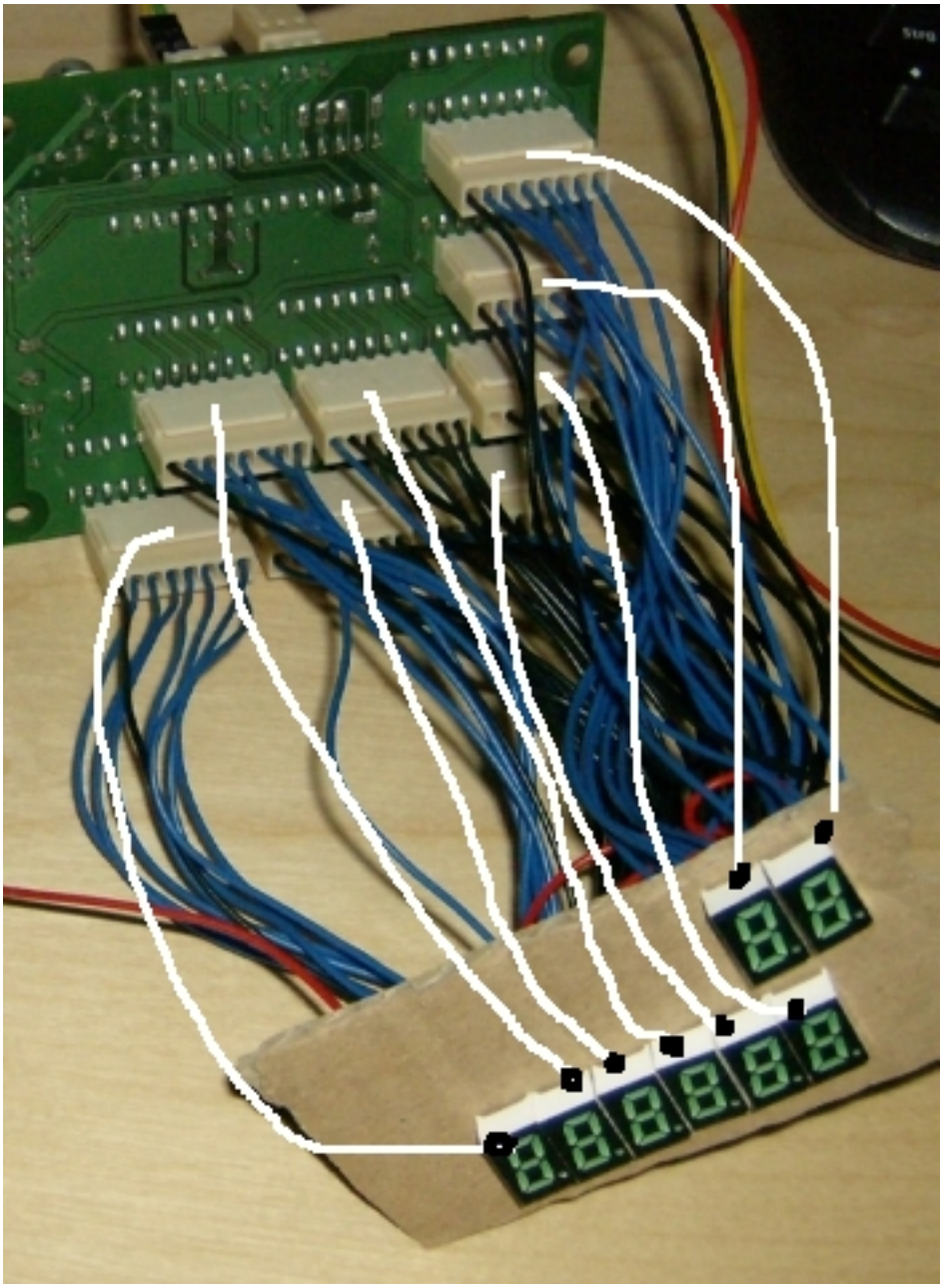

Figure 4: PCB to Display Connection

If you have both the UHF Indication Board and the UHF Control Board

1) Do the connections for the UHF Indication Board as instructed in the previous chapter.

2) Connect the Volume knob pinheader to a potentiometer with the 2pol wire cable.

Note: The UHF Control Board can use the Volume knob of the UHF ARC-164 Panel to adjust volume. Use the 2pol wire cable to connect the Volume knob pinheader to the audio volume pinheader of the UHF Control Board. (see Figure 5)

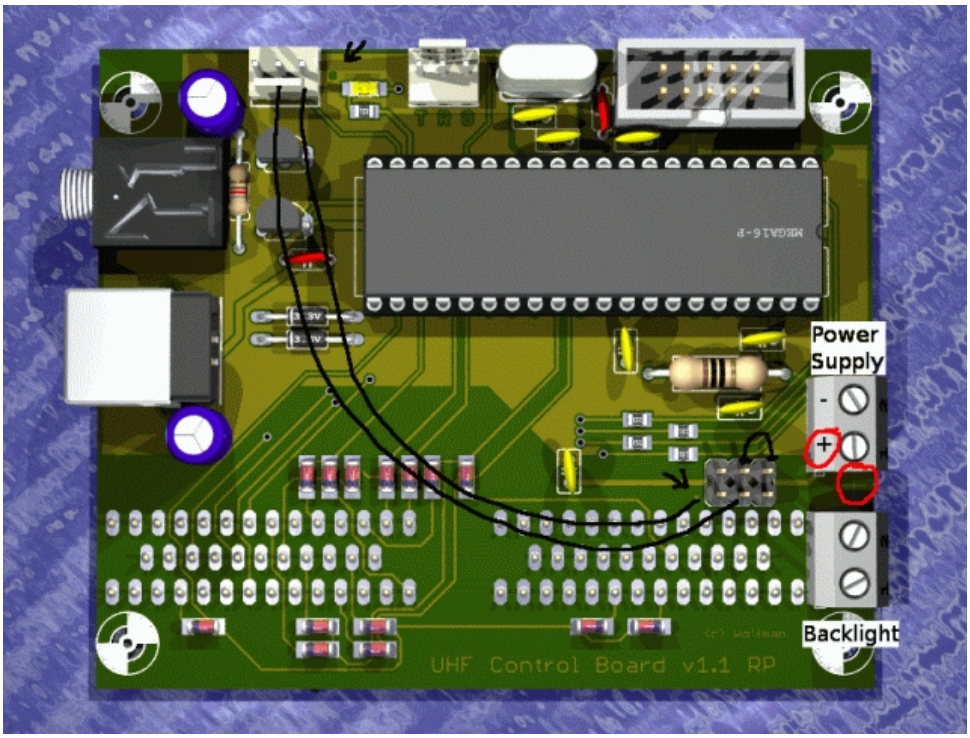

Figure 5: Volume Potentiometer Connection

3) Connect the UHF Control Board to the UHF ARC-164 Panel. The wiring is 1:1 when the board faces the panel (see also labeling J1 and J2 on both board and panel).

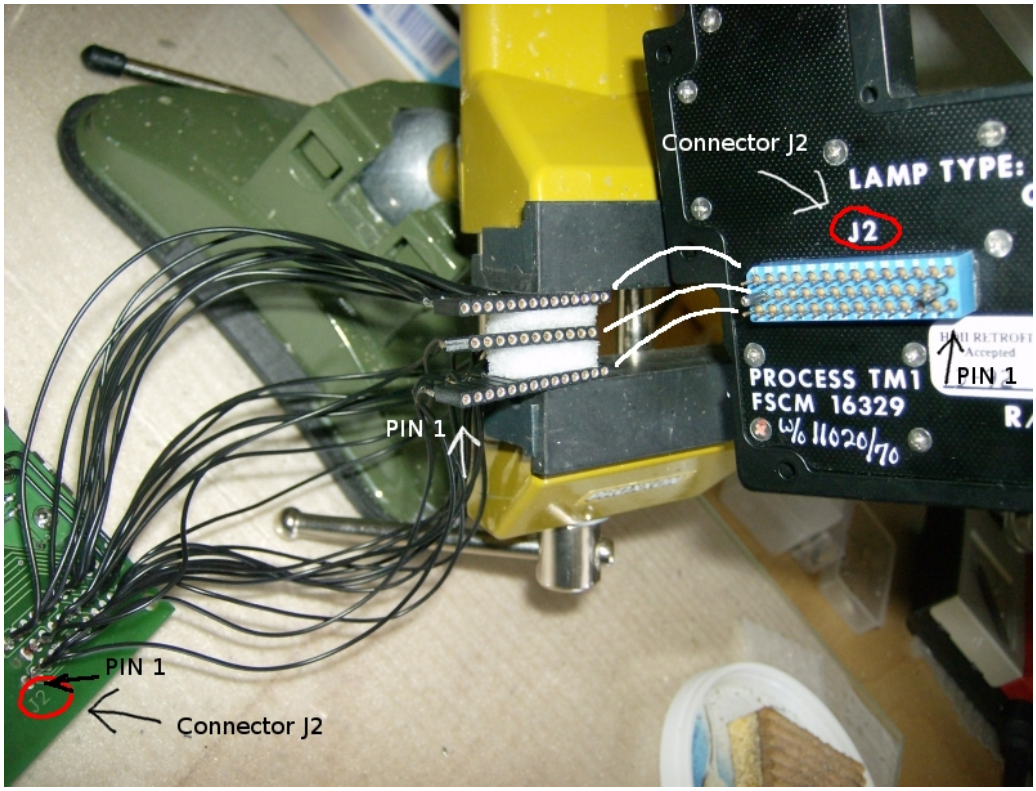

Figure 6: Control Board Connection

4) Connect the UHF Indication Board and the UHF Control Board with the 10pol flat wire cable.

5) Connect Headphones to the UHF Control Board.

6) UHF panel backlight power supply
The powersupply for the UHF Panel backlight is connected to the UHF Control Board (The Power Plug labelled "Backlight" in Figure 5).

7a) UHF Control Board power supply, USB not connected
The power plug "Power Supply" for the UHF Control Board (see Figure 5) should be left unconnected. The board receives its power through the UHF Indication Board.

WARNING:
Do NOT connect the UHF Control Board to the USB port for powersupply!
Always connect the UHF Indication Board with a powersupply!

7b) UHF Control Board power supply, USB connected
Connect a standard USB-B cable to the UHF Control Board.
The USB port provides power for the UHF Control Board, to avoid damaging your USB port, break the 1st wire of the 10pol flat wire cable. The power plug "Power supply" is for debugging purposes only.

If you have a TTL USART device

Both boards have a serial interface operating on TTL voltage. The transmit pin is labeled "T", The receive pin is labeled "R" and the ground pin is labeld "G". Connect a RS232-TTL or USB-TTL converter for accessing terminal operations.

Switch it on

The LEDs should display a test pattern for about a second, then show a channel number and a frequency.
The status LED on the UHF Indication Board should be briefly on.
The UHF Indication Board has a potentiometer to adjust brightness. Adjust as preferred.

USB Keyboard

The UHF Control Board operates as a USB keyboard. A prototype USB vendor and product ID are used, so use at your own risk!

The following switches send key strokes

Operator	Key
Mode Selector OFF	ALT SHF ENTER
Mode Selector MAIN	ALT CTRL ENTER
Mode Selector BOTH	ALT CTRL SHF ENTER
Mode Selector ADF	ALT CTRL SHF Z
MPG MNL	ALT CTRL SHF X
MPG PRESET	CTRL SHF C
MPG GRD	ALT SHF C
CHAN INC	ALT SHF CTRL F11
CHAN DEC	ALT SHF CTRL F12
FREQ 1 2	ALT SHF D
FREQ 1 3	ALT CTRL D
FREQ 1 A	CTRL SHF D
FREQ 2 0	ALT CTRL SHF D
FREQ 2 1	CTRL SHF F
FREQ 2 2	ALT SHF F
FREQ 2 3	ALT CTRL F
FREQ 2 4	ALT CTRL SHF F
FREQ 2 5	CTRL SHF G
FREQ 2 6	ALT SHF G
FREQ 2 7	ALT CTRL G
FREQ 2 8	ALT CTRL SHF G
FREQ 2 9	CTRL SHF H
FREQ 3 0	ALT SHF H

Operator	Key
FREQ 3 1	ALT CTRL H
FREQ 3 2	ALT CTRL SHF H
FREQ 3 3	CTRL SHF J
FREQ 3 4	ALT SHF J
FREQ 3 5	ALT CTRL J
FREQ 3 6	ALT CTRL SHF J
FREQ 3 7	CTRL SHF K
FREQ 3 8	ALT SHF K
FREQ 3 9	ALT CTRL K
FREQ 4 0	ALT CTRL SHF K
FREQ 4 1	CTRL SHF L
FREQ 4 2	ALT SHF L
FREQ 4 3	ALT CTRL L
FREQ 4 4	ALT CTRL SHF L
FREQ 4 5	CTRL SHF ;
FREQ 4 6	ALT SHF ;
FREQ 4 7	ALT CTRL ;
FREQ 4 8	ALT CTRL SHF ;
FREQ 4 9	CTRL SHF .
FREQ 5 00	ALT SHF .
FREQ 5 25	ALT CTRL .
FREQ 5 50	ALT CTRL SHF .
FREQ 5 75	CTRL SHF S

The Squelch switch in position ON suppresses sending keystrokes, so make sure it is in the correct position.

Operation

The operation of the UHF radio is documented in this PDF file.
http://mayprinting.com/TSB/data/comm/arc-164.pdf

The TSS/RSG frequency is 310.425. Use this frequency to get a Tone.

Additionally, the software version of the UHF Control Board can be displayed by switching to ADF and switching the T-Tone switch to T.

Connecting to Falcon 4.0 BMS 4.33 Shared Memory

With firmware version 23 (see chapter Operation on how to check the version), the UHF radio supports synchronising with the shared memory. A shared memory reader is required to establish the data transfer and is available at github[3].

To allow data transfer to a USB Keyboard (that is what the UHF radio basically is for a Windows OS), installation of a filter is required.

The software to do so is available at http://sourceforge.net/projects/libusb-win32/

Type `install-filter install –device=USBVid_16c0.Pid_27db.Rev_0100` on the commandline. Or use the `install-filter-gui.exe` to do the same. This must be done only a single time.

Start the commandline tool `uhfRadio.exe` and data will be sent, once the shared memory is available.

Note: Before ramp start, set the UHF radio to channel 6 and frequency 225.000

Note: During loading screen, the channel and frequency often show wierd numbers for a brief time.

Note: If channel or frequency is out of sync, use the squelch switch to suppress sending key strokes.

3 github.com/Wolfman-F16/uhfRadioUsbSharedMemReader

Firmware Update

The UHF Control Board supports firmware update via USB. Before being able to use the USB firmware update, the USB bootloader[4] has to be flashed onto the UHF Control Board microcontroller.

To put the UHF Control Board in USB bootloader mode,

1. disconnect the UHF radio from power (incl. USB)
2. switch to ADF
3. power up the UHF radio again.

Use the commandline tool `avrusbboot.exe`[5] to upload the new firmware.

When the firmware upload is complete, put the UHF radio in normal operating mode by

4. disconnect the UHF radio from power (incl. USB)
5. switch to UHF OFF
6. power up the UHF radio again.

Known Issues

TOD update and initiation of individual TOD not implemented, because there is no other radio that can be queried for a valid Tone signal (see also arc-164.pdf: 4-20 to 4-22).

The FMT CHG text is not displayed after 5 seconds of inactivity in FMT.CHG mode.

No interface to Falcon4.0, Falcon 4 Allied Force or OpenFalcon4.7 is implemented, because non of them support UHF ARC-164 radio operations.
However FalconBMS 4.32 provides limited support of UHF ARC-164 radio operations, extraction of display data is supported since BMS 4.33.

The UHF Indication Board, when operated stand alone, might always show the LED test. Connect 5V to the pin SS (6) to solve this.

If you think you found an error in this document or the software, please post at this forum thread
http://www.viperpits.org/smf/index.php?topic=5082.0
But remember the RTFM rule, so you might want to check the `arc164.pdf` file thoroughly first.

4 github.com/Wolfman-F16/usbBootloader
5 github.com/Wolfman-F16/usbBootloaderCommander