The VK3ZAV synthesizer, Mk1.

This synthesizer is intended to control any radio that was designed to be crystal controlled for transmit and/or receive. It is capable of a much wider range of applications, but this description only covers this use in detail. It can be used with such sets as Philips 828, or even old valve models, if the bandwidth is not too broad.

OPERATION

The control interface was intended to be as simple to use as possible, so that mobile operation in a vehicle would require a minimum of attention, for this reason a key pad is not used, although this remains an option for DTMF tone selection. There are three switches and a 16 character two line LCD display.

A two-decade push wheel switch is used for channel number selection, and two centre stable toggle switches for control functions. One toggle switch is labeled “up” and “down”, and the other is labeled “DTMF” for the up position and “reverse” for the down position.

The decade switch allows the pre-setting of up to 89 channels, and current software can select operation on any of the FM allocations in the 10m, 6m, 2m, or 70cm bands. The numerals starting with "9" are not channel numbers, but are used as "control functions". to set channel frequencies, see below.

Once the channels are set, then switching from 01 to 89 will result in the radio tuning to the frequency shown on the display.
For example channel 05 might result in:

Rx147.125 << 05
Tx146.525

The “<” symbol indicates a received signal, one for had been, two for a signal now.
In this case, pressing the “reverse” switch down will (if a known repeater channel) reverse, or swap the transmit & receive frequencies
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Rx146.525 < 05
Tx147.125 swap
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and this allows very simple checking if a signal can be heard direct, not through the repeater, so you can QSY to a simplex channel
Non repeater channels do not have different frequencies displayed.

This is a toggle function, and a second operation restores the frequencies to normal.

Channel numbers can only be added in sequence, ie with only 5 channels set, you can't add channel 32, if you try, you get the next un-occupied channel, ie. (blank) channel 6. This prevents blank channels being left in a long list.

To reduce the number of switch operations, ie. only enter the changes, you can select an existing channel frequency, and press the “up” switch, this saves that frequency, so that becomes the starting point when you go to set another channel frequency.

To edit settings, the “90” range of numbers are used as "control functions", they are not channel numbers.

SET A CHANNEL FREQUENCY

These switch operations from 91 to 97 can be made in any sequence, but 98 must be last to store a new frequency.

set the decade switch to:

90, sets scanning mode, see later.

91, a Receive frequency will be displayed, and the “up” or “down” switch will allow stepping of the hundreds of Mhz.

maximum of 4, for 430Mhz band.

92, to allow stepping of the tens of Mhz. Note stepping through 0 does not roll over to the next decade.

93, to allow stepping of the units of Mhz, no rollover.

94, to allow stepping of the hundreds of Khz, , no rollover.

95, to allow stepping of the band normal channel spacing, for 2m 25Khz, but with rollover, so manual channel scanning can be done

96, to allow stepping of the tens of Khz, no rollover.

97, to allow stepping of the units of Khz, no rollover.

Each time you arrive at a new receive frequency, you will see also the corresponding Tx frequency on the display second line.

To set the transmit frequency separately, go to 99.

98, to allow storing of the new entry. Press the “up” or "down" switch, then select a channel number that you want to add the new frequency to.

The "down" switch simply selects that frequency to be set to the channel number selected next, but selecting the "up" switch also selects the setting if a CTCSS access tone of 91.5 Hz

The "down" switch display will show the present channel receive frequency and channel number on the first line, and the newly entered receive frequency on the second line, with the word “store” eg.

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| Rx146.975 05 |
| Rx146.375 store |
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Whereas the "up" switch display will also show the CTCSS in th top row:

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| Rx146.975 CTCSS05
| Rx146.375 store
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When adding channels, you have three choices. By pressing the “down” switch, you may over-write an existing channel frequency, or write a new frequency to the blank, in the above case 6, then the blank becomes 7. By pressing the “up” switch, the existing channel, and all above it are shifted up one place, and the new frequency is inserted into the selected channel number, again the blank becomes 7.

99, to over-ride or change the repeater offset frequency, this allows setting of the Transmit frequency separately from the Receive frequency.

ie. Set the transmit frequency only, press the “up” switch, then select the changes by 91 to 97 as above, only the transmit frequency is changed. This also allows setting of cross band operation. (not available yet)

SCANNING

There are two scanning modes, selected by channel "00", by pressing "up" or "down". For the first mode, all installed channels are scanned, and for the second mode, only a pre-selected set of frequencies are scanned. It pauses on the first occupied channel, where pressing the DTMF switch will freeze the scan, ans another press continues the scan.

Pressing "down" causes scanning of all channels.

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Rx146.525 < 05
Tx147.125 scan A
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Pressing "up" causes scanning of selected channels only.

Rx146.525 < 05

Tx147.125 scan S

To set the “special scan” frequencies, select channel “90”, then “up” switch, and the display 2nd line will show "set scan".

Next select those channels that you want on the restricted “special scan” list,

and "up" will select this channel for scanning, and “down” will de-select this channel. After setting the required channels, return to "90" and press "down" and the "set scan" mode & display will be removed. (beta version under test)

INSTALLATION

SETUP can be done from the panel controls, but more facilities can be had by using a PC, with the RS232 connection, for the IF frequency, crystal frequency being replaced, temperature and battery limits, calibration etc..

(RS232 controller & PC programs not yet operating)

CALIBRATION can be done by setting the signal frequency to 10 or 15 Mhz, for WWV, and listening to the beat in an HF receiver.

A PC is then connected to the serial port, and the PC program SetSynth1.exe is run. This allows incrementing and/or decrementing the master oscillator frequency by 10Hz or 1Hz steps, until zero beat is heard. (Not yet operating).

FEATURES

Planned as a bare PC board, or a working PC board, usually to be enclosed in a diecast box for shielding, then included inside or outside an existing radio, to feed into & replace crystal oscillators for transmit & receive.

When initially programmed, it has channels 1 to 4 set with a 10m, 6m, 2m, & 70cm frequency.

A band select output that can switch 12 volts at 60ma (for a small relay) via a 74LS145, means you can control up to 4 different radios from this one

synthesizer or build your own monitor receiver, with common IF and audio, and 4 front ends.

The PCB can be assembled with a 5v regulator if needed, and can accept nominal 12v input, or the regulator can be left out if a 5v supply is already available. The current model uses an AD9851 DDS chip, running at 5volts, the next model is planned to use an AD9859, and will need 1.8v, 3.3v, & 5v.

OPTIONAL EXTENSIONS

An amplifier can be added to raise the output level up to about 500mw, for transmit & receive

There is hardware provision for heatsink temperature measurement, to allow transmitter shutdown if too hot, code not written yet.

ATMEL Application note AN314 code is available for DTMF or CTCSS tone generation, for such applications as IRLP, hardware to select the codes is not included yet, but adding another four of the decade push wheel switches, or a key pad, or else a PC keyboard plug in is possible.

FM generation by using the Mega88 A/D converter, to feed into the DDS chip is possible, carefully written interrupt code will be needed.

An alternative to the RS232 serial port can be had by adding a USB converter chip FT232RL, costing $7.

Temperature compensation of crystal osc.

Extra board for audio processing, band decode, band output switching

Enlarged EEPROM so more data can be stored, such as repeater site names, cross band operation, PC program to allow setting up more readily, with cross band channels, repeater site names, heatsink temperature shutdown, power supply volts shutdown, CTCSS, etc.

An HF version of the software, to allow control of frequency increments down to 10Hz (or 1Hz) for CW & SSB. VFO type tuning by external plug in, maybe PC mouse, or using the mechanism out of a PC mouse.

If you want to tackle C code programing, and know something about the Atmel AtMega88 or 168, you can have the source code, and do anything you like. I used WinAVR, the free GCC compiler, and a DRAGON programmer/debugger.