

The VK3ZAV synthesizer, Mk1.

This synthesizer is intended to control any FM radio that was designed to be crystal controlled for transmit and/or receive. It is capable of a much wider range of applications than this, but the following description only covers use in FM mobiles, in detail, for 10m, 6m, 2m, and/or 70cm. It can be used with such sets as a Philips 828, or even an old (eg. AWA) valve model, although the receiver bandwidth may be too broad. (This can be corrected by adding a suitable filter)

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.

There are three controls and a 16 character two line (low cost) LCD display. The controls are two toggle switches and a two-decade push wheel switch. Both toggle switches are centre stable, momentary (spring loaded). The first is labeled "up" and "down", and the second is labeled, IRLP 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, and scanning. More details to follow.

Software is also used to generate IRLP calling tones, and CTCSS access tones, an addition of four more push wheel switches can be added to select the DTMF tones for IRLP operation.

If more channels are required, a HEX switch can be used, allowing a total of 239 channels, with some minor software changes.

Its possible for four different radios to be controlled from the one synthesizer board, one for each band, and the interface could be set up for virtually any make or model. The scan function allows band selection, so scanning can pick up which bands are open.

INSIDE

The heart of the project is an Atmel microcontroller, either an ATmega88 or ATmega168, which controls an AD9851 or AD9859 DDS (Direct Digital Synthesizer) chip. Controlling software is written in C, compiled with the free WinAvr compiler, and I use a Dragon programmer/debugger.

The software is an on-going project, and is available to anyone who wants to contribute some ideas and effort, but their work must be made available to others, free of charge.

Provision is made for using the A/D converter to process audio, and to add this to the frequency data to give an all digital FM modulator. Also the A/D can monitor the TX heat sink temperature, reducing power if too hot, and to monitor the battery volts, shutting down when low. Calibration and temperature compensation of the crystal time base will be done from a PC. The synthesizer needs careful shielding and filtering to keep the spurious signals under control.

Currently the first prototype of the Mk1 (AD9851) version is operating, with channel setting, and channel scanning, but future versions will have more memory to allow repeater site names, cross band operation, and VFO tuning to allow SSB or CW operation, using the mechanism out of a PC mouse. The PC program, written in TCL has been started, to allow more comprehensive setup, but needs more work.

Specifications:

Mk1

- Power source, nominal 12, (automotive)
- Master oscillator, 20Mhz (low cost) crystal
- Frequency range 10Khz to 60Mhz
- Power output +12dbm (option +27dbm, 1/2watt)
- Output impedance 50ohms
- Display, 16 characters by two lines LCD, back lit.
- Controls, two decade push wheel switch, and two toggle switches.
- Power consumption, approx 100ma without light, 140ma with back light
- Frequency accuracy, calibrated against WWV or other standard.
- Chips used, AD9851, AtMega88 or AtMega168
- Spurious signals, -65dbc worst case, -75dbc nominal
- Phase noise, -138 Dbc/Hz @ 25Khz (adjacent channel)
- Serial interface, RS232 (convertible to USB)
- generates CTCSS tones

Mk2 (provisional)

- Power source, nominal 12, (automotive)
- Master oscillator, 100Mhz or 133.333333Mhz (low cost) crystal
- Frequency range 1Khz to 170Mhz
- Power output +12dbm (option +27dbm, 1/2watt)
- Output impedance 50ohms
- Display, 16 characters by two lines LCD, back lit.
- Controls, two decade push wheel switch, and two toggle switches.
- Power consumption, approx 120ma without light, 160ma with back light (linear P/S) or with SMPS, 12v @ 20ma without light, 35ma with back light
- Frequency accuracy, calibrated against WWV or other standard.
- Chips used, AD9859, AtMega168, 25LC640-I/P
- Spurious signals, -75dbc worst case, -90dbc nominal
- Phase noise, -143 dbc/Hz @ 25Khz (adjacent channel)
- Serial interface, RS232 (convertible to USB with DS232BQ18)
- generates CTCSS and DTMF tones
- temperature compensation of master crystal oscillator.
- digital FM modulation

Peter Ward, VK3ZAV (since 1955)