PIC Based DDS Source

Andy Talbot G4JNT August 2011

This frequency source implements a simple DDS designed around a low cost 16F628A PIC. Two logic level input lines select one of four pre-stored frequencies stored in the PIC's NV-EEPROM. The DDS runs at a clock rate equal to the device oscillator / 192, or the internal clock divided by 48. The maximum specified frequency for this device is 20MHz, so with a crystal of this value, the DDS clock runs at 104.167kHz

The DDS word is based on a 24 bit register, so the resolution of around 6mHz at this clock. An 8 bit D/A converter is implemented by a discrete 2-2R ladder

There is no provision for updating the stored frequencies without using a PIC programmer to change the values stored in EE.

Figure 1 shows the circuit diagram,
Figure 2 shows the PCB layout and a mirror imaged copper track pattern at 1:1 scale in Figure 3.

Calculating and storing Frequencies

1) Choose a suitable clock oscillator / crystal frequency, F_{osc}
2) Determine the DDS clock, $F_{clock} = F_{osc} / 192$
3) For each of the four desired frequencies, F_N calculate the value N from $N = F_N / F_{clock} * 2^{24}$.
4) Convert to Hex notation and store in the PIC assembly file in the format shown below
5) Repeat for each of the other three frequencies.

Example : Tone frequency 24997.8Hz (WSPR Tone zero on a 25kHz centre) with a 20MHz crystal

Fclock = 20MHz / 192 = 104166.7Hz
N = 24997.8 / 104166.7 * 2^{24} = 4026178
Convert to Hex = 0x3D6F42
Store as three bytes (with a dummy 4th one)

de 0x3D, 0x6F, 0x42, 0

Assemble the code, using, for example the *MPASM* assembler
Programme the chip

Part of "*4FREQSOURCE.ASM*"

```
  org   0x2100
FREQ            ;4th dummy byte included for boundary of 4
        de      0x3D, 0x6F, 0x42, 0   ;'0'  freq   25kHz CF WSPR tones. Based on 20MHz Fosc / 192
        de      0x3D, 0x70, 0x2E, 0   ;'1'  freq
        de      0x3D, 0x71, 0x1A, 0   ;'2'  freq
        de      0x3D, 0x72, 0x06, 0   ;'3'  freq
```

(the ' de*' before each line defines the four numbers as EE data. Anything after a semi-colon is a comment for reference purposes only. The '*FREQ*' label must be on the extreme left hand side, immediately preceding the data itself. The '* org 0x2100 *' must be immediately before the label)*

PIC Code , as a .ASM source file can be found in File 4freqsource.zip, with an assembled .HEX version for initial testing. This contins the frequency values shown below, for 25kHz centre frequency set of WSPR tones.

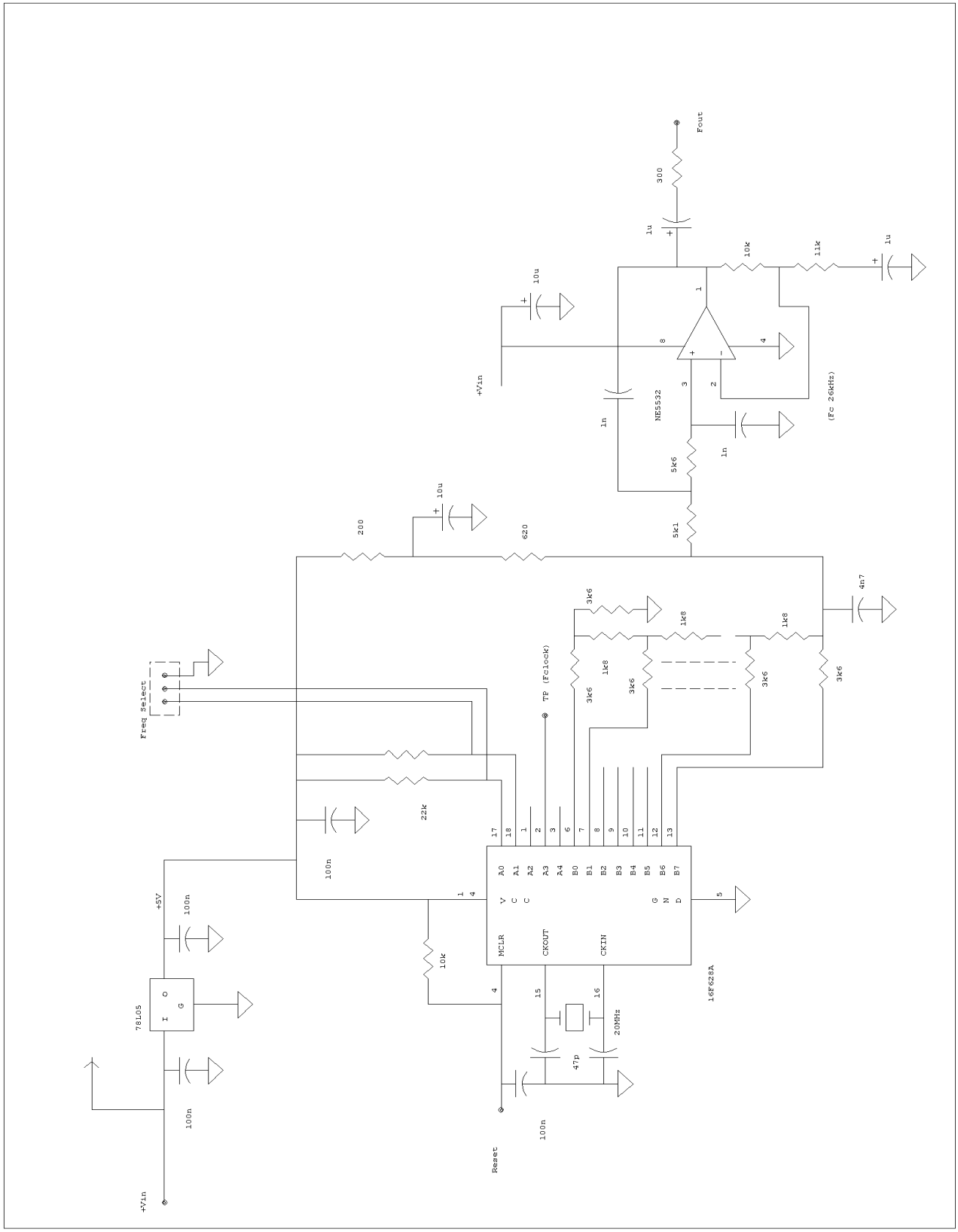
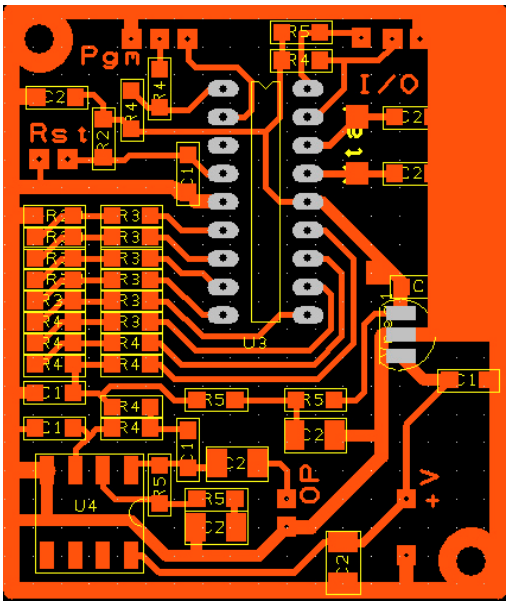


Figure 1 4-Frequency DDS Source Circuit Diagram



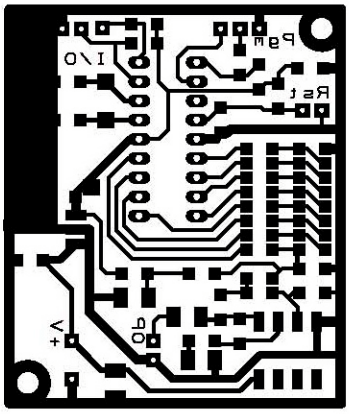


Figure 3 Mirrored 1:1

3

Figure 2 PCB layout

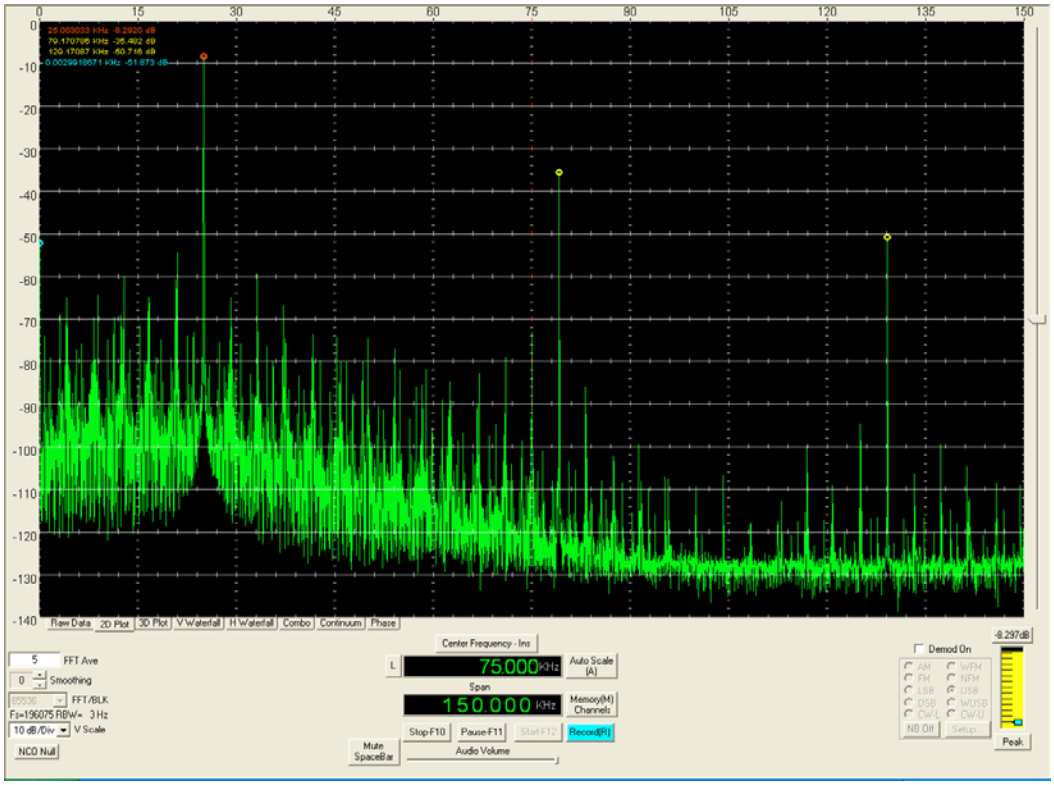


Figure 4 Output Spectrum at 25kHz