The JT4G Transmission on GB3SCX

RF Source

The frequency generation hardware for GB3SCX makes use of a 'Reverse DDS' [1,2]. A voltage controlled crystal oscillator is multiplied up to the final RF output, and also clocks an AD9851 (32 bit) Direct Digital Synthesizer. This is programmed to deliver 10MHz output when clocked at the wanted frequency :

The 10MHz generated by the DDS is compared in a Phase Locked Loop with a GPS derived reference and fed back to control the VCO. The 32 bit DDS has sufficient resolution to ensure the programmed final RF can be set within 13Hz of any desired value.
The value to be sent to the DDS is derived from:

$N * / 2^{32} * F_{RF} / RF_{MULT} = 10MHz$ Or $N = 2^{32} * 10MHz * RF_{MULT} / F_{RF}$

For 10368.905MHz $RF_{MULT} = 96$,
N = 397647447 or Hex 0x17B39E57

By reprogramming the value of N, the RF output can be changed in real time to give FSK modulation, provided the PLL loop bandwidth is fast enough to track the changes. The DDS module already in use on GB3SCX was designed to accept a two bit binary code to select one of four frequencies stored in EEPROM in the controller PIC. These frequencies can be programmed, on-site, using ASCII Text commands via an RS232 serial interface.

JT4 Message

The JT4 message is stored as a series of 207 two-bit symbols in a 16F627 PIC microcontroller. The symbols are generated off-line using a utility '*GENJT4.EXE*' [3] and stored in the PIC in compressed form at four symbols per byte. A Jupiter-T GPS receiver (already in use with the frequency reference hardware) delivers serial time coded data and a one pulse-per-second signal to the PIC. At the appropriate interval (every even minute) the JT4 message is replayed with each symbol is sent via two data lines to control the DDS frequency generation.

Timing for the JT4 message, at 4.375Hz, is derived asynchronously from dividing-down the PIC clock and leads to no more than 4ms timing error over the 48 second transmit interval – insignificant when compared with the symbol interval of 229ms.

During the Odd Minute, the controller is used to generate the CW ident. The sequence is :

Odd minute + 0s, '**GB3SCX IO80UU**' sent at 20WPM
Odd minute + 30s, callsign at 12WPM
Odd minute + 50s, callsign at 12WPM

Plain carrier is transmitted between these and from the end of the JT4G signalling at the Even minute + 48s

In keeping with other beacons forming part of the GB3SC# complex, the CW is sent by on-off keying. A separate output pin from the PIC is used to switch the RF via the multiplier chain. If

FSK were to be adopted in place of on-off keying, the CW could switch between two of the four pre-stored frequencies.

Frequencies

The JT4 modulation consists of four tones separated by 315Hz. As the DDS frequency controller only allows for four pre-stored frequencies, these all have to be allocated to the JT4G message. The four tones are :

Tone No	Freq MHz	N	N (Hex)	Error Hz
0	10368.905000	397647447	0x17B39E57	6.85
1	10368.905315	397647435	0x17B39E4B	4.76
2	10368.905630	397647423	0x17B39E3F	2.67
3	10368.905945	397647411	0x17B39E33	0.57

Tone Zero is the nominally allocated beacon frequency, and the CW and plain carrier are generated with this code sent to the DDS controller.

[1] http://www.scrbg.org/gpslock.html
[2] http://www.g4jnt.com/SCC_Locking.htm
[3] http://www.g4jnt.com/JT4_BCN.ZIP