WSPR Audio Signal Source v2.0

A stand-alone WSPR signal source that generates audio WSPR tones to drive a SSB transmitter or transceiver.

Features:

- **Internal timing or NMEA GPS timing for UTC synchronization of WSPR transmissions.**
- **On chip generation of WSPR message.**
- **'On-the-fly' GPS generation of grid square location for portable operation.**
- **Line or microphone output.**
- **Symbol data output available to modulate a VXCO**
- **Low power consumption allowing battery operation**

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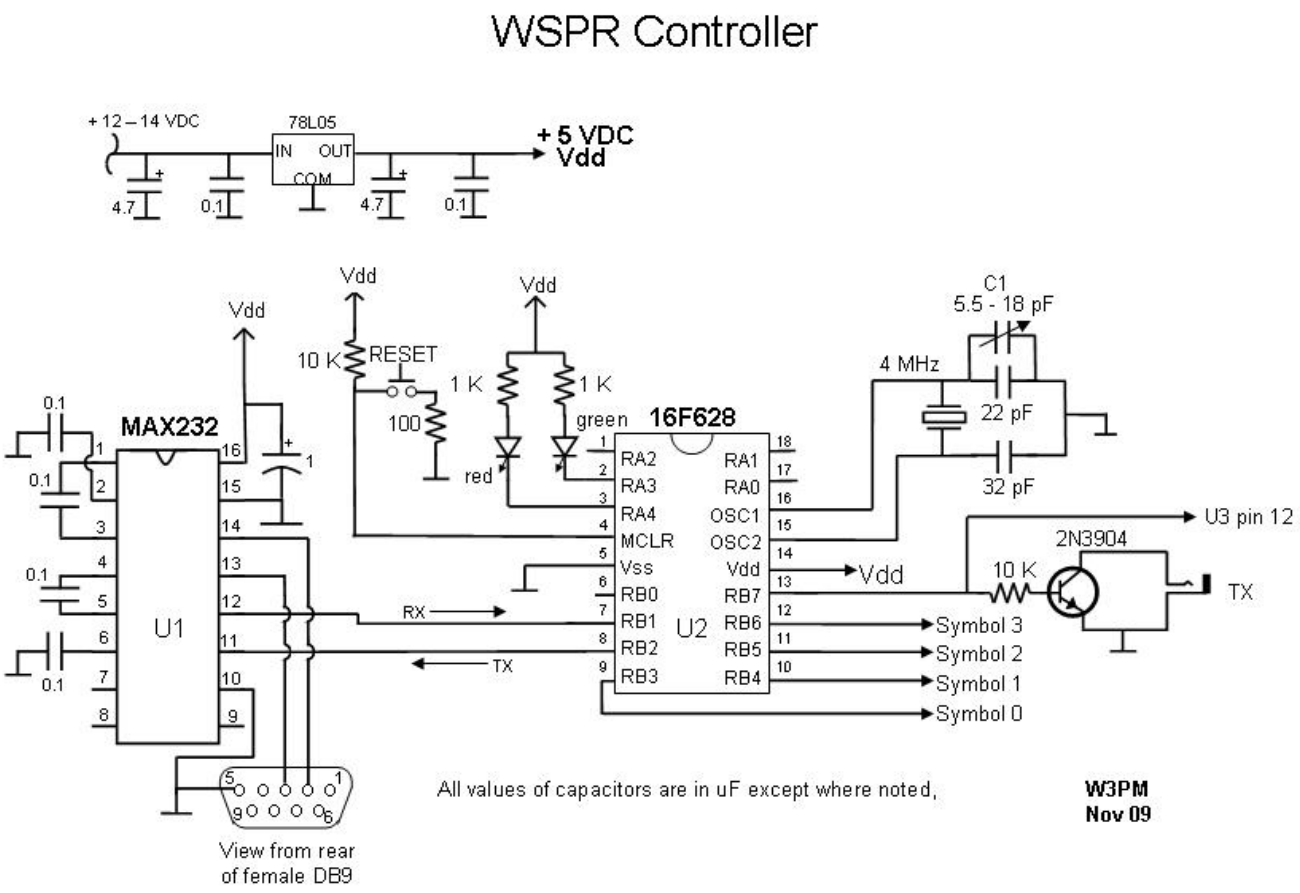

Fig. 1 WSPR Controller

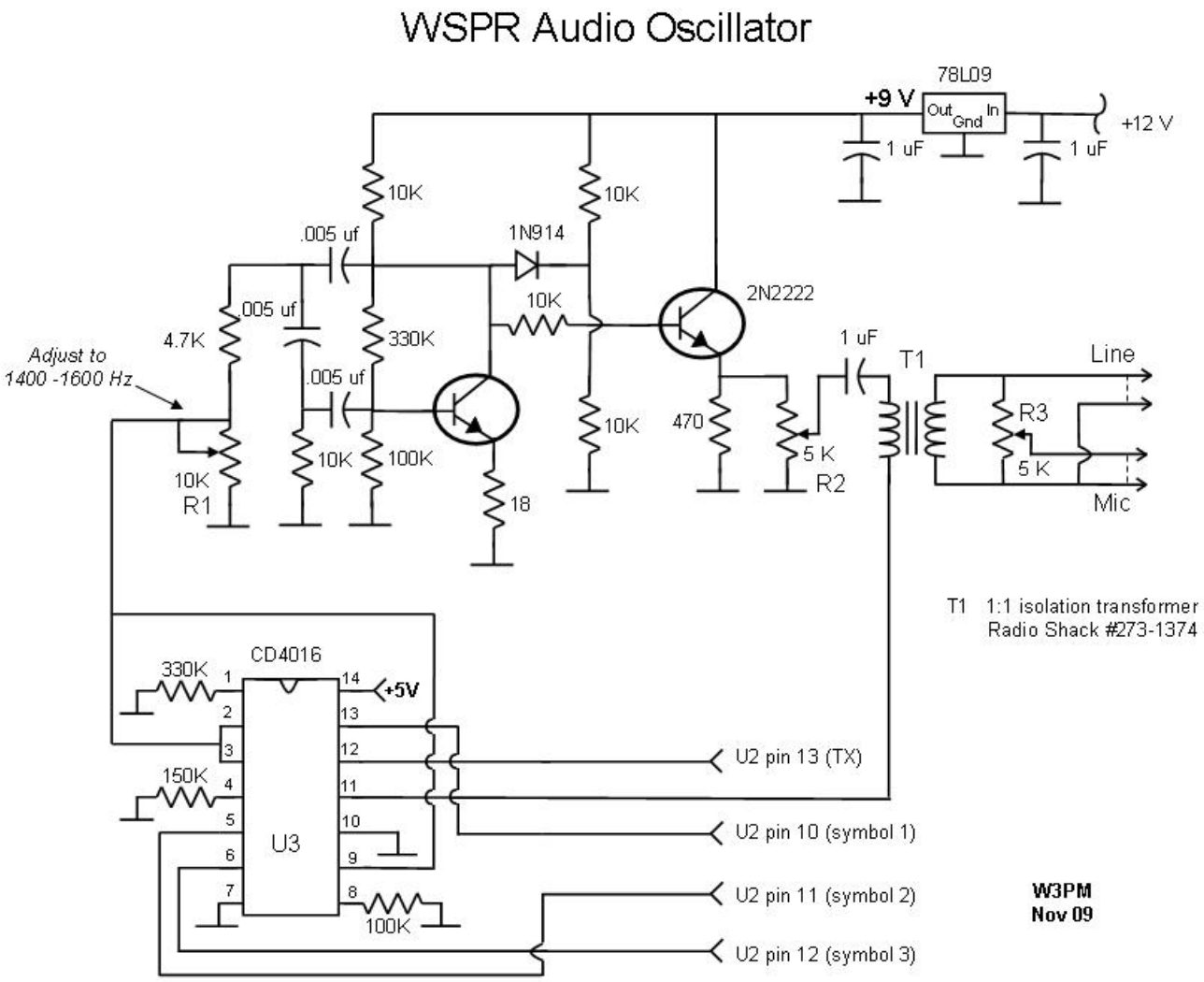

Fig. 2 Audio Oscillator

Introduction

This is a project that allows an operator to unshackle their portable SSB QRP transceiver from their computer to transmit WSPR beacons from a portable location, or to use a home station as a PC-less beacon.

The purpose of this paper is to describe a simple audio oscillator controlled by a Microchip 16F628 PIC. This paper is not written as a construction article. Circuit information is included to easily reproduce this project and to put it on the air using a minimum amount of test equipment.

WSPR Controller

The WSPR controller provides the synchronized outputs necessary to modulate an oscillator with the station specific WSPR message.

Synchronization of WSPR transmissions is derived from either an internal timer, or via a 4800 baud RS232 NMEA GPS data stream. Connecting the unit to a 4800 baud RS232 GPS NMEA data source will override the internal oscillator and allow the unit to default to GPS timing.

The short and long term accuracy of the internal timer is dependant upon the uncertainty and stability of the microprocessor's 4 MHz crystal reference. The prototype unit uses a 5.5–18 pF variable capacitor to adjust the clock to 4MHz. The builder may have to use other capacitor combinations depending upon the 4MHz crystal used.

The controller provides four keyed outputs, each corresponding to the four channel symbols used in the WSPR protocol. The outputs are used to drive the CD4016 quad bilateral switch in the audio oscillator circuit. Alternately, the symbol outputs can also be used to drive a variable crystal controlled oscillator (VCXO) modulator.

Transmitter control is provided by a keyed NPN transistor switch for PTT operation. The transmitter keyed output is also used to switch the audio output to allow for VOX operation.

The unique WSPR message containing the station's callsign, power level, and gridsquare is stored in the PIC's EEPRPOM in a compressed format. The WSPR message may be changed at any time by loading a text file containing the message via the 4800 baud RS-232 input line.

Audio Oscillator

This simple phase-shifted oscillator provides excellent distortion and stability characteristics.

The builder may wish to experiment and increase the value of the 18 ohm emitter resistor to lower oscillator distortion. Minimum distortion occurs just below the point where the oscillation stops.

Two potentiometers provide adjustable line level and microphone outputs.
The oscillator is allowed to run continuously to aid stability. The audio output is switched on during transmission times using one of the four bilateral switches in U3, thus allowing VOX operation.

Symbol 1-3 outputs are used to drive the remaining three U3 bilateral switches. The switches are used to alternately switch three different resistor values to ground corresponding to the WSPR message. The resistors change the RC time constant of the audio oscillator setting up the required frequency deviation of 1.43 Hz for each symbol. Symbol 0 is at the baseline frequency, therefore, no resistor is required to be switched to ground. Standard resistor values of 100K, 150K, and 330K resulted in deviation values very close to nominal. The builder may chose to replace the fixed value resistors with potentiometers to allow adjustment to nominal values.

Initial Set Up

WSPR Message

The station callsign, grid location, and decibel power must first be loaded into the PIC controller to generate a unique WSPR symbol table consisting of 162 channel symbols. The symbols consist of four digits ranging from 0 to 3.

The communication format to load this data is plain ASCII, 4800 baud, 8 data bits, no parity, 1 stop bit, no echo. Flow control is not used. Perform the following to load the message:

- Depress the RESET pushbutton
- Enter four consecutive + characters “++++” within a six second window
- Station data entered after the following prompts:
  CALL?
  GRID?
  POWER?
  The callsign and grid square data are not case sensitive, but decibel power must be entered as two characters i.e. ‘07’ for 5 mW.
- Upon successful transfer, the channel symbol data will appear on your screen for verification
- Depress the RESET pushbutton to start

The message file is now stored into EEPROM. It will only require reload upon change of station callsign, location, or power.

If GPS NMEA timing used, the system will automatically update the grid square data. This will allow portable operation without requiring manual updating. The data stored in EEPROM is NOT changed. The system will revert to the original grid square data loaded into EEPROM if internal timing is used.

Calibration

Calibration consists of adjusting the PIC clock to 4 MHz, and setting the audio oscillator's frequency and line level output.

A small pickup loop or short length of wire connected to a modern HF receiver via a length of coaxial cable is used to set the PIC's clock. Place the loop near U2 and adjust the variable capacitor for 4 MHz. Although this is not a precise method of adjusting the PIC oscillator, it is sufficient for operation with internal timing over a period of two or three days without the need for time re-synchronization.

Connect the line level audio output to a frequency counter. The output of the oscillator will turn on for a 152 second period ten minutes after the reset pushbutton is depressed. During this period adjust the oscillator's frequency control R1 for any frequency between 1400 and 1600 Hz. This 200 Hz window corresponds to the WSPR operating window on each band.

Connect an RMS voltmeter to the line level output. During the 152 second transmit period adjust the line level potentiometer R2 for 0.316 Vrms. Alternately, replace the voltmeter with an oscilloscope and adjust for 0.9 Vp-p.

The microphone level is adjusted for normal output when transmitting. Start with the minimum MIC level output as to not overload the microphone input circuitry of the transmitter.

Operation

After the controller is first turned on, initial synchronization begins by depressing the reset pushbutton at the beginning of an even minute. The unit will begin a WSPR transmission ten minutes after the reset pushbutton is depressed and will repeat the transmission every 10 minutes.

If GPS NMEA timing is required, simply connect a 4800 baud RS-232 GPS NMEA output to the DB-9 connector. The GPS NMEA timing will override the internal oscillator and allow the unit to default to GPS timing. If GPS timing is disconnected, depress reset pushbutton at the beginning of an even minute to resume operation with internal timing.

Two LED indicators are used to monitor proper operation. The red LED is lit during transmitting periods. The green LED will flash at a one second rate to indicate internal timing. If GPS timing is used, the LED will flash at a two second rate.

Testing

With the line level output connected to the soundcard input, use the WSPR program to verify correct operation.

Acknowledgements

The on chip generation of the WSPR message algorithm would not have been possible without the help of Andy Talbot, G4JNT. His excellent paper 'The WSPR Coding Process' provided a simple description of the encoding protocol.

Portions of this project were influenced by MJB, the stand alone PC-less MEPT_JT beacon controller by Johan Bodin, SM6LKM. The basis for the audio oscillator was found at techlib.com.

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