This version (SYNTH v2.10) fixed a bug that caused the LCD to briefly
display LOCKED when the PLL was unlocked. (display would show UNLOCK
then briefly LOCKED then UNLOCK etc)
It also fixed a bug that caused the minimum user selected Step Size
not to work correctly when used with press buttons.
(it worked ok with the rotary encoder)
This version is for the UNIPLL2 EME 124,
(it can also be used with the UNIPLL EME77 but it does require some minor
changes to the PCB, see the note at the bottom of this file)
it provides the following features,

1) This version is only for the PIC 16F628.
2) It can be used with the SP5055 or TSA5511 PLL chip.
3) The software can use press buttons or a mechanical rotary encoder to
   modify the frequency.
4) The software now allows 2 modes of operation,
   a) VFO (variable frequency oscillator) mode, where the press buttons/
      encoder is used to adjust the frequency, is the default mode. This is
      the only mode that was available in versions 1.XX of Synth.
      While in this mode, VFO is displayed on the top line of the LCD.
   b) MEM (memory) mode, where the press buttons/encoder is used to select
      a previously saved frequency, has been added in versions 2.xx .
      While in this mode, Mxx is displayed on the top line of the LCD.
      Where xx is the memory number in use.
5) The software now allows upto 5 bands to be used, each band has its own
   set of display frequency limits, VCO offsets, etc.
6) New setup screens have been added.
   1) For selecting the PLL chip type/reference frequency,
   2) Use of the Shift button,
   3) TX RX modes, (for disabling the use of TX or RX)
   4) Number of bands in use,
   5) User selectable PLL step size.

7) For the SP5055,
   1) PLL frequency range of 100MHz to 2.8GHz for RX & TX.
   2) Frequency Steps of 125Khz with a reference of 4.0MHz or
      100 KHz with a reference of 3.2MHz.
   3) RX & TX frequency display range. 0 to 6.0GHz.
   4) RX & TX Display to VCO offset 0 to +/-3.2GHz.
   5) Display multiplier. 1 to 20.
      (Multiplies all frequency displays on the LCD)

   For the TSA5511,
   1) PLL frequency range of 50MHz to 1.4GHz for RX & TX.
   2) Frequency Steps of 50Khz with a reference of 3.2MHz.
   3) RX & TX frequency display range. 0 to 3.0GHz.
   4) RX & TX Display to VCO offset 0 to +/-1.6GHz.
   5) Display multiplier. 1 to 20.
      (Multiplies all frequency displays on the LCD)

8) The time between PLL status checks has been reduced from 1 sec to 160mS so
   a small amount of unlock filtering can now be included.
   That is, the PLL has to be unlocked for the filter time (.8 sec) before it
   is considered unlocked, but it is considered locked as soon as the PLL
   status bit says its locked.

9) The software is designed to use a 16x2 LCD with or without a R/W pin.
   (it uses delays rather than busy checks)
   If the LCD has a R/W pin it can be tied to the boards R/W pin or GND pin.

This package should include the following files.

Readme.txt   This file.
Synth.asm   The program source file.
Synth.hex   Hex file for programming a PIC 16F628.
Ver_2.gif   Circuit diagram if the button/encoder/band switch wiring.

** New:- Using a rotary encoder. **

With this version of SYNTH, you have the option of replacing the Up & Down
buttons (Freq +, Freq -) with a mechanical rotary encoder.
ALPS EC16B series or similar. See Ver_2.gif
To enable the use of the encoder you have to connect PIC RA5 to ground.
(on the rear of the PCB, solder a link between pins 4 and 5 of the 16F628)

** New:- TX Enable O/P location. **

Port P7 of the SP5055, is now used as the TX_EN O/P. (Pin 6 of the SP5055)
It is still active low, (TX enabled when TX_EN is low) but it is an open
collector O/P, it can sink 10 mA but it cannot source any current.
So you may need to add a pull-up resistor if you require TX_EN to source
current to drive a transistor, etc.
It is advisable to bypass the P7 output with a 1nF capacitor to ground
close to the IC. (there is provision on the PCB for a surface mount cap)

** New:- Band switch input. **

The software now allows upto 5 bands to be used, each band has its own
set of Display multiplier, PLL step size, RX/TX display frequency limits
and RX/TX VCO offsets.
Use option setup screen 4 to select how many bands you want to use. (1 to 5)
The PIC determines the band switch position by reading the voltage on port P6
of the SP5055 chip. (pin 7 of the PLL chip) See Ver_2.gif
a voltage of 0.00V to 0.75V selects band 1.
a voltage of 0.75V to 1.50V selects band 2.
a voltage of 1.50V to 2.25V selects band 3.
a voltage of 2.25V to 3.00V selects band 4.
a voltage of 3.00V to 5.00V selects band 5.

It is advisable to bypass the P6 input with a 1nF capacitor to ground
close to the IC. (there is provision on the PCB for a surface mount cap)

If you use a 2 or 3 pole band switch, 1 pole can be used to feed the selection
voltage to the PIC, the other poles could be used to drive transistors for
VCO switching etc.
If you elect to use only 1 band, It doesn't matter what voltage is on P6, band
1 will always be enabled, and the band number display on the LCD is removed.

** New:- Program version display. **

The meaning of the last digit of the version number, displayed at power up
allows you to verify that the software has correctly identified whether you
are using Up & Down buttons or a rotary encoder.

   ver 2.x0   Up & Down press buttons.
   ver 2.x1   Mechanical rotary encoder.

** General info. **

When first turned on, the software name and version number is displayed.

After 1 second the VFO screen is displayed.
The frequency displayed is the same as the frequency displayed on the
currently selected band's VFO screen, before the power was turned off.
If the PTT button is pressed "TX" is displayed, and the PLL is set to
produce the TX frequency.
PLL freq = (TX DISPLAY FREQUENCY + TX VCO OFFSET)/ DISP MULT.
Otherwise RX is displayed, and the PLL is set to produce the RX frequency.
PLL freq = (RX DISPLAY FREQUENCY + RX VCO OFFSET)/ DISP MULT.

If using the Up & Down buttons, (FREQ+ or FREQ-) a single brief press of the
button will change the PLL frequency by one step. (minimum step size or user
defined step size, depending upon the state of the shift button) (See the
SHIFT FUNCTION option setup screen, and the STEP SIZE setup screen)
Holding a button down for a while will allow you to tune across the
frequency range, after a few seconds the tuning rate increases.

If using the rotary encoder, slow movement changes the PLL frequency by one
step for each click of the encoder. Again you can switch between the minimum
step size and the user defined step size, by pressing the shift button.
There is also a small amount of variable rate tuning. (the faster the encoder
is rotated, the greater the step size)
Due to 4mS software debouncing, if the encoder is rotated to fast, no change
in frequency will occur.

Any changes to the frequency are saved to EEPROM 2 seconds after leaving the
Up & Down buttons/rotary encoder idle. If you change the state of the PTT
lead or band switch while adjusting the frequency, the buttons/encoder must
be left idle for 1 second before the frequency can be modified again.
(ie, prevents changing TX freq inadvertently if the PTT lead is operated
while setting the RX frequency)

To minimise disturbance of the PLL, the divider info that sets the PLL, is
sent by the PIC to the PLL only if the frequency needs to be changed.
(ie operation of the PTT lead or during manual frequency changes)
When the PLL frequency is changed, it is assumed that the PLL is unlocked,
'UNLOCK' will be displayed on the LCD.
The PIC checks the PLL status continuously until the PLL locks. Once locked,
'LOCKED' is displayed on the LCD, and status checks are made every 160mS.
If the PLL goes out of lock, continuous checks are started again.

If an attempt is made to set the PLL below 100MHz, (50MHz for the TSA5511)
'UNLOCK' will be displayed on the LCD. and the PLL will be set to 100MHz.
(ie, if RX display = 500MHz and the RX VCO offset is -500MHz)

If an attempt is made to set the PLL above 2.8GHz, (1.4GHz for the TSA5511)
'UNLOCK' will be displayed on the LCD. and the PLL will be set to 2.8GHz.
(ie, if TX display = 2000MHz and the TX VCO offset is +1000MHz)

The PIC continuously checks the band switch to see if it has been changed,
if it has, it saves the current TX & RX frequencies, then loads the TX & RX
frequencies, and the band setup screen info, for the newly selected band,
from EEPROM. The current band in use is displayed on the bottom right hand
corner of the LCD display. (ie, B3 = band 3)

If the MEM button is pressed briefly, the MEM function is activated.
If the MEM button is pressed for 1 second, the MEM SAVE function is activated.

If the SHIFT & MEM buttons are pressed for 1 second, the setup screens for the
current band are displayed. See band setup screens below.

          ** New:- Memory function. **

A memory function has been added to save and recall frequencies to EEPROM.
The number of memories that can be used depends upon the number of bands
in use, and whether you are using BOTH TX AND RX, or TX ONLY, or RX ONLY.

The table below shows the number of memories available in the various
setup configurations.

Bands in use	Memories with BOTH TX AND RX	Memories with TX ONLY, or RX ONLY
1	22	39

2	18	36
3	15	33
4	11	30
5	8	27

1 BAND, BOTH TX AND RX, is the default, but it can be changed in the option
setup screens. See **The option setup screens** below.

** New:- Saving to the memories **

To SAVE the current band's VFO RX & TX frequency, hold down the MEM button
for 1 second, use the UP & DOWN buttons/rotary encoder to select the memory
number you want to save to.
As an aid to selecting a memory location that is no longer wanted, the
bottom line of the LCD displays the RX/TX frequency of the selected
memory and the band number that it was used with.
(You can use the PTT lead to view the TX frequency)
Then press the MEM button again for 1 second to complete the SAVE.
A message, "SAVING" will be displayed briefly, before returning you to the VFO
display.
If you decide that you want to return to the VFO display without proceeding
with the SAVE, briefly press the MEM button, or wait for the 10 second timeout.

It is advisable to make sure that all the option setting screens have been set
correctly before using the SAVE function.

** New:- Using the saved memories **

To switch from the default VFO (variable frequency oscillator) mode,
(where the UP & DOWN buttons/rotary encoder are used to adjust the frequency)
to the MEM mode, where they are used to select a previously saved frequency,
briefly press the MEM button.
"MO1" will be displayed on the top line of the LCD, you can use the UP &
DOWN buttons/rotary encoder to select the memory number you want to use.
Only memories that were saved in the currently selected band will be available
for use. If there are no memories for this band, MOO will be displayed, and
the band's VFO frequencies, will be displayed.
You can use the band switch to change bands, the PIC will attempt to find a
valid memory for this new band, if there are none MOO will be displayed.
While in the MEM mode the PTT lead functions normally, but you can't use the
UP & DOWN buttons/rotary encoder to adjust the frequency.
While in the MEM mode, you cannot use the setup screens or the memory
save function.
There are two ways to exit the MEM mode, and go back to the VFO mode,
1) Briefly pressing the MEM button, ignores the memory you were using and
   returns the VFO frequencies you were using prior to entering the MEM mode.
2) Pressing the MEM button for 1 second, copies the memory you were using into
   the VFO TX & RX frequencies, so it is available in the VFO mode.

** New:- The option setup screens **

There are 4 option setup screens that effect the basic operation of the
software.
   1) PLL & REF FREQ.
   2) SHIFT FUNCTION.
   3) TX RX MODES.
   4) BANDS IN USE.

It may be advisable to make a written copy of all your memories and band
setups before making changes to these screens!

To enter the option setup screens, press the SHIFT & MEM button, while turning
on the power. After the version number is displayed,
the 1st option setup screen, PLL & REF FREQ will be displayed.
      The options available are:-
      1) TSA5511 3.2MHz
      2) SP5055 3.2MHz
      3) SP5055 4.0MHz

Use the UP & DOWN buttons/rotary encoder to make a selection, then briefly
press the SHIFT button.

The 2nd option setup screen, SHIFT FUNCTION will be displayed.
      The options available are:-
      1) Min step size.
      2) User step size.

Selecting Min step size, means that when the shift button is pressed, the
frequency can be changed by the minimum step size available for the PLL &
REF FREQ selected above,
      ie, TSA5511 3.2MHz = 50 KHz steps,
          SP5055 3.2MHz = 100 KHz steps,
          SP5055 4.0MHz = 125 KHz steps.
With the shift button released, the user selected step size is used.
(see the STEP SIZE setup screen below)

Selecting User step size, swaps the functions, so when the shift button
is pressed, the user selected step size is used.
With the shift button released, the minimum step size is used.

Again use the UP & DOWN buttons/rotary encoder to make a selection, then
briefly press the SHIFT button.

The 3rd option setup screen, TX RX MODE is displayed next.
      The options available are:-
      1) TX ONLY.
      2) RX ONLY.
      3) BOTH TX & RX.

If you were using the UNIPLL board in a transmitter, you would select TX only.
If used in a transceiver, select BOTH TX & RX, etc.
In the TX ONLY and RX ONLY modes, only 1 frequency is saved in the memories,
and there are less setup screens for the band limits, so there is more room
for extra memories in these modes.

The 4th option setup screen, BANDS IN USE is displayed next.
      You can elect to use from 1 to 5 bands.

After exiting the 4th setup screen, any changes made are saved to EEPROM.
A message, "SAVING" will be displayed before returning to the VFO display.
As an extra safety measure, if you make any changes to the TX RX MODE or
BANDS IN USE screens, you will be prompted to confirm your selection.
This is a **WARNING** that some of the current memories or band information
may be lost.
If you are sure you want to change modes, use the UP & DOWN buttons/rotary
encoder to select YES, then press the MEM button briefly.
If you select NO, all changes made will be ignored.

If you change the PLL & REF FREQ screen, you will find that all frequencies
will be changed because of the different PLL step size. (channel spacing)

On all setup screens, if the buttons/rotary encoder are left idle for 10
seconds, any changes made in any of the screens will be ignored and you will
be returned to the VFO display.

        ** The band setup screens **

There are 8 band setup screens, (5 if using the TX ONLY or RX ONLY mode)

1) DISP MULT.
2) STEP SIZE.
3) MIN RX DISPLAY.
4) MAX RX DISPLAY.
5) RX VCO OFFSET.
6) MIN TX DISPLAY.
7) MAX TX DISPLAY.
8) TX VCO OFFSET.

You can enter the setup screens for the currently selected band by holding down the SHIFT & MEM buttons for 1 second,
The 1st band setup screen, DISP MULT will be displayed.
     The range available is 1 to 20.

You would normally use a display multiplier of 1, but if you have an extra frequency divider between the VCO and PLL chip, or a multiplier after the VCO, etc, you can use the DISP MULT to get the correct frequency display on the LCD.

Use the UP & DOWN buttons/rotary encoder to make a selection, then briefly press the SHIFT button.

The 2nd band setup screen, STEP SIZE will be displayed next.
This screen allows you to select a larger PLL step size.
(See also the SHIFT FUNCTION option setup screen above)
The table below shows the range of step sizes available with each of the PLL & REF FREQ options.

TSA5511 3.2 MHz	SP5055 3.2 MHz	SP5055 4.0 MHz
50 KHz	100 KHz	125 KHz
100 KHz	200 KHz	250 KHz
200 KHz	400 KHz	500 KHz
250 KHz	500 MHz	1.00 MHz
400 KHz	800 MHz	1.25 MHz
500 MHz	1.0 MHz	2.00 MHz
1.00 MHz	2.0 MHz	2.50 MHz
1.25 MHz	2.5 MHz	4.00 MHz

The 3rd and 4th band setup screen are used to limit the range of the RX display frequency, to prevent out of band operation.

The 5th band setup screen is used if there is a frequency offset between the display frequency and the VCO frequency.
PLL VCO freq = (RX DISPLAY FREQUENCY + RX VCO OFFSET)/ DISP MULT.

The 6th 7th and 8th band setup screen, are for the TX range and VCO offset.

After exiting the last setup screen, any changes made are saved to EEPROM.
A message, "SAVING" will be displayed before returning to the VFO display.

On all setup screens, if the buttons/rotary encoder are left idle for 10 seconds, any changes made in any of the screens will be ignored and you will be returned to the VFO display.

        ** Using SYNTH Ver 2.x with the UNIPLL EME77. **

To use this version of software with the UNIPLL EME77, 3 hardware changes have to be made.
1) Replace the 16F84 or 16F628, with a 16F628, programmed with Ver 2.x
    The 22pF & 5.6K connected to pin 16 of the PIC are no not required with
    the 16F628, it makes no difference if they are fitted or removed.
2) The TX_EN O/P has been shifted to the TSA5511 O/P port P7. (Pin 6 of the
    TSA5511) It is still active low, (TX enabled when TX_EN is low)

but it is an open collector O/P, it can sink 10 mA but it cannot source
any current. So you may need to add a pull-up resistor if you require
TX_EN to source current to drive a transistor, etc.
It is advisable to bypass the P7 output with a 1nF capacitor to ground
close to the IC.
3) Add a 10K pull-up resistor on RA3, to +5V. (pin 2 of the 16F628)
This allows the original TX_EN O/P to be used for the new MEM button I/P.

Make sure you select TSA5511 3.2MHz in the first option setup screen.

If you want to use more than 1 band, connect the band switch to TSA5511 I/P
port P6. (Pin 7 of the TSA5511) See Ver_2.gif
It is advisable to bypass the P6 input with a 1nF capacitor to ground
close to the IC.

If you want to replace the Up & Down buttons with a mechanical rotary encoder,
solder a link on the rear of the PCB between pins 4 and 5 of the 16F628.