Specifications:	VCO Frequency Coverage	50 to 1400MHz
	Display Multiplier	x1 to x20
	Frequency Steps x1 Mult	50KHz \ 100KHz \ 1MHz / 10MHz
	RX / TX VCO Offsets	-500 to 500MHz
	Microcontroller	PIC 16F84/04P
	PLL Synthesizer	TSA5511
	Software	**Version 1.1 Synth.ASM S Jones 5/2/2000**
	Power	8 – 14volts 150mA

DESCRIPTION: The circuit uses a preprogrammed PIC16F84 Microcontroller to control a TSA5511 PLL & a standard Hitachi 2 Line x16 character LCD display module. The UNIPLL is suitable for connecting to various VCO modules like the Mini-Circuits POS & JTOS types, & can be connected to the EME79 1250MHz ATV transmitter without modification. The standard software supplied with the Kit is preprogrammed to cover 1240 – 1300MHz band. To cover another frequency range, the display can be put into program menu mode to set the display frequency range, VCO frequency range, & frequency offset options for RX & TX. All menu settings & frequency settings are automatically memorized into the PICs Eeprom, & remain when the PLL is powered down. The UNIPLL is suitable for using on a transceiver where the RX frequency may be offset by e.g. 21.4MHz compared with the TX frequency. With the new software, the RX & TX VCO frequencies will track the frequency readout on the display when changing frequency. The UNIPLL provides a PTT input line to control the 16F84 to change over from RX to TX mode. The UNIPLL also provides a TX low enable output which will go high if the PLL is out of lock preventing out of band operation.

MICROCONTROLLER: The software allows the 16F84 to output I2C bus data on pins 6 & 7 to control the TSA5511 PLL IC, along with driving a standard LCD display, monitoring inputs from function buttons, & providing inputs & outputs for TX & RX control. Inputs on pins 1, 3, 17, & 18 are normally pulled high to 5 volts via resistors, & are pulled low 0v to control the 16F84. The TX-en output on pin 2 is normally 0 volts, & goes to 5 volts when the PLL goes out of lock. This output can be used to disable the transmitters amplifier when the PLL is out of lock preventing accidental out of band operation. Outputs on pins 7 to 13 are used to drive a standard Hitachi 2 line x 16 character LCD display module. Many different types of displays should work ok with this software. The software even allows displays without a R/W (Read/Write) connection to be used. **If you are Programming your own PIC16F84, then remember to have the settings.dat file in the same directory as the synth.asm file when using an assembler, eg MPASM to generate a HEX file.**

TSA5511 PLL: The reference frequency for the TSA5511 is 3.2MHz which provides a standard channel spacing of 50KHz. A 6.4MHz crystal is used in a simple colpitts oscillator & is divided by 2 in a CD4040 binary counter, & is input to pin 2 of the TSA5511. A 3.2MHz crystal could have been used but they are not an off the shelf item. The TSA5511 is controlled by the 16F84 through its I2C bus inputs on pins 4 & 5. DC control output to drive a VCO is from pins 1 & 18 & consists of a loop filter with a cut off frequency of 40Hz which suits TV, & Data applications to a bit rate of 38k4. The PLL & loop filter is slow in lockup which is good for Video modulation (50Hz to 7MHz), so the PLL doesn't react to the modulation, thinking that it is frequency drift. This can cause Low Frequency tilt, ramping or distorted syncs. The TSA5511 is not designed for FM voice applications as it produces high phase noise, resulting in background noise on the FM Audio. The PCB features a 50ohm splitter which allows the UNIPLL to be connected inline with the TX VCO & transmitter buffer stages to sample a small level of RF, & feed it to pin 15 of the TSA5511 to its internal prescaler.

EXAMPLES OF APPLICATIONS: The following examples use the synth.asm software Pre-programmed into the PIC. This software is basically a text file & can be read using Microsoft ® Notepad, or a text file editing program like PFE (Program File Editor). By double clicking & opening this file, the default program will usually be Notepad that will open up for the text to be read. All user information including Menu Programming information can be found in the synth.asm file. To get into the Menu settings, hold the Shift button down while powering up the UNIPLL. Then release the button, & quickly hit the button 2 times. You should now see the Menu screen. The Menu screen will default back to the normal display in 10 seconds if no buttons are pressed. For all Menu Programming & options read the synth.asm files text.

EXAMPLE 1. The UNIPLL is used to control a Mini-Circuits POS800W VCO module to be used as a signal generator in the 400 - 500MHz range. Therefore we don't require any VCO offset to the displayed frequency, nor do we require the RX & TX functions. I don't intend on explaining the complete details of programming the user settings as all the information is supplied in the synth.asm file. Power down the UNIPLL & then hold the shift button down. Power up the UNIPLL & release the shift button. Then double click the shift button, you are now in the Menu Program mode. Holding down the shift button while pushing the frequency up or down buttons allows the display to be changed at a fast rate. Set the menu settings to display the following. Although I have not tried this application it should work, but I would expect that phase noise generated by the PLL would not make it suitable for local oscillator for FM narrowband applications. The TSA5511 was designed to control Television Tuners, & Data is only available for a slow lockup 40Hz loop filter design.

DISPLAY MULT	01
MIN RX DISPLAY	400MHz
MAX RX DISPLAY	500MHz
RX VCO OFFSET	0.00MHz
MIN TX DISPLAY	400MHz
MAX TX DISPLAY	500MHz
TX VCO OFFSET	0.00MHz

EXAMPLE 2. The UNIPLL is used as a synthesizer on a homebrew 1240 – 1300MHz FM Transceiver. The first RX I/F is 21.4MHz. Therefore the display needs to read the same frequency for both RX & TX, but the RX VCO needs to be offset +21.4MHz higher than the frequency display. Set the menu settings to display the following.

DISPLAY MULT	01
MIN RX DISPLAY	1240MHz
MAX RX DISPLAY	1300MHz
RX VCO OFFSET	21.40MHz
MIN TX DISPLAY	1240MHz
MAX TX DISPLAY	1300MHz
TX VCO OFFSET	0.00MHz

EXAMPLE 3. The UNIPLL is used to control an EME79 video transmitter along with a X5 multiplier for use on the 6cm Amateur Band. For a 5800MHz output the EME79s oscillator is 1160MHz. Even though the oscillator is being locked by the TSA5511 PLL at a lower frequency, the frequency readout can be programmed to readout a frequency 5 times higher & tracking the VCO when changing frequency. One thing to bare in mind, is that the frequency steps when changing frequency are now X5, eg 50KHz steps are now 250KHz. Set the menu settings to display the following.

DISPLAY MULT	05
MIN RX DISPLAY	N/A
MAX RX DISPLAY	N/A
RX VCO OFFSET	N/A
MIN TX DISPLAY	5650MHz
MAX TX DISPLAY	5850MHz
TX VCO OFFSET	0.00MHz

CONSTRUCTION:

1. The PC Board supplied is not a plated through hole board, so component leads that pass through holes on the groundplane side of the board that are not recessed, must be soldered on both sides of the board for earthing. These holes are shown as dark colored pads on the PCB overlay diagram.

2. Follow the PCB overlay & circuit diagrams carefully, by checking the components and placing them onto the board. All components are mounted on the top groundplane side of the board, except the SMD components that are used for the 50ohm splitter, which are mounted on the bottom trackside of the board.

3. A 18 pin IC socket is mounted on the board for the PIC16F84 to make it easier for reprogramming. For good RF practices, a socket **should not** be used on the TSA5511 due to the input frequency to the prescaler being as high as 1300MHz in some applications. **Be careful when mounting the IC's to the board, as their pins can short out on the top groundplane of the board.** Leave a slight gap under each IC before soldering them into place. Some pins on the 4040 & TSA5511 IC's must be soldered to the top groundplane of the board for earthing.

4. When mounting the 78L05 regulator on the board, make sure that you solder the center leg to the top groundplane of the board for earthing. The 78LO5 regulator is only able to supply enough current for the UNIPLL board & control circuitry on the LCD display module. It is not designed to power the LCD's LED backlight. When using an LCD with a backlight, then it is best to calculate a suitable dropping resistor to drop 12volts down to the voltage & current required by the backlight LEDs. Some LCD's like the LCD3 modules supplied by Mini-Kits, have inbuilt LED backlight dropping resistors, & will require the 78L05 regulator to be upgraded to a 7805T.

5. Solder in the chip capacitor & resistors using a pair of tweezers to hold them in place, soldering one side first then the other side.

TESTING: Before connecting the PLL to the LCD Display & other circuitry, the 5V regulator must be checked. Take the PIC16F84 out of its socket, & apply +12v to the PLL board. Check that the regulator supplies +5v on its output connection. **If you measure more than +5v, then you may not have soldered the center leg of the regulator to the top groundplane. Failure to check this can cause damage to the PIC16F84, TSA5511, & LCD Display module by overvoltage.**

BOARD CONNECTIONS: Basic header sockets are supplied for soldering the wire connections along the edge of the board. Alternatively, 2.54mm header Plugs & Sockets can be used on the board for easier connection of the keypad, LCD display, & power etc. When connecting a transmitter or VCO module e.g. an ATV transmitter or POS535, use mini 50ohm Teflon coax for the RF connections to the board. Connections should be direct to the board using good UHF practices without using PCB pins or long pigtail connections. Alternatively miniature PCB mount SMA female sockets can also be fitted onto the top of the PC Board for easier connection. If external modulation is required to drive a VCO module e.g. POS525, refer to the main circuit diagram for an example.

CONNECTION TO A LCD: Refer to the circuit & overlay diagrams for the various connections to the PC Board. LCD Displays are supplied with a Data sheet showing the pin connections. Some LCD's have more connections than what the EME77B board has, so any extra connections available on the LCD e.g. (d0-d3 etc) should be ignored. Some LCD's like the LCD3 don't have a RW (Read Write) pin, & have onboard LCD backlight circuitry that doesn't require the Vo (contrast connection), or 10k Trimpot. The E is the (Enable) connection, & is sometimes confused with the earth or (Gnd) connection.

CONNECTION TO A TRANSMITTER: The comments refer to connecting a EME79 1250MHz Video transmitter to the UNIPLL Kit, but is also applicable to most other transmitters or VCO modules.

1. Connect the RF output connection from your ATV transmitter to the RF IN connection on the UNIPLL board.

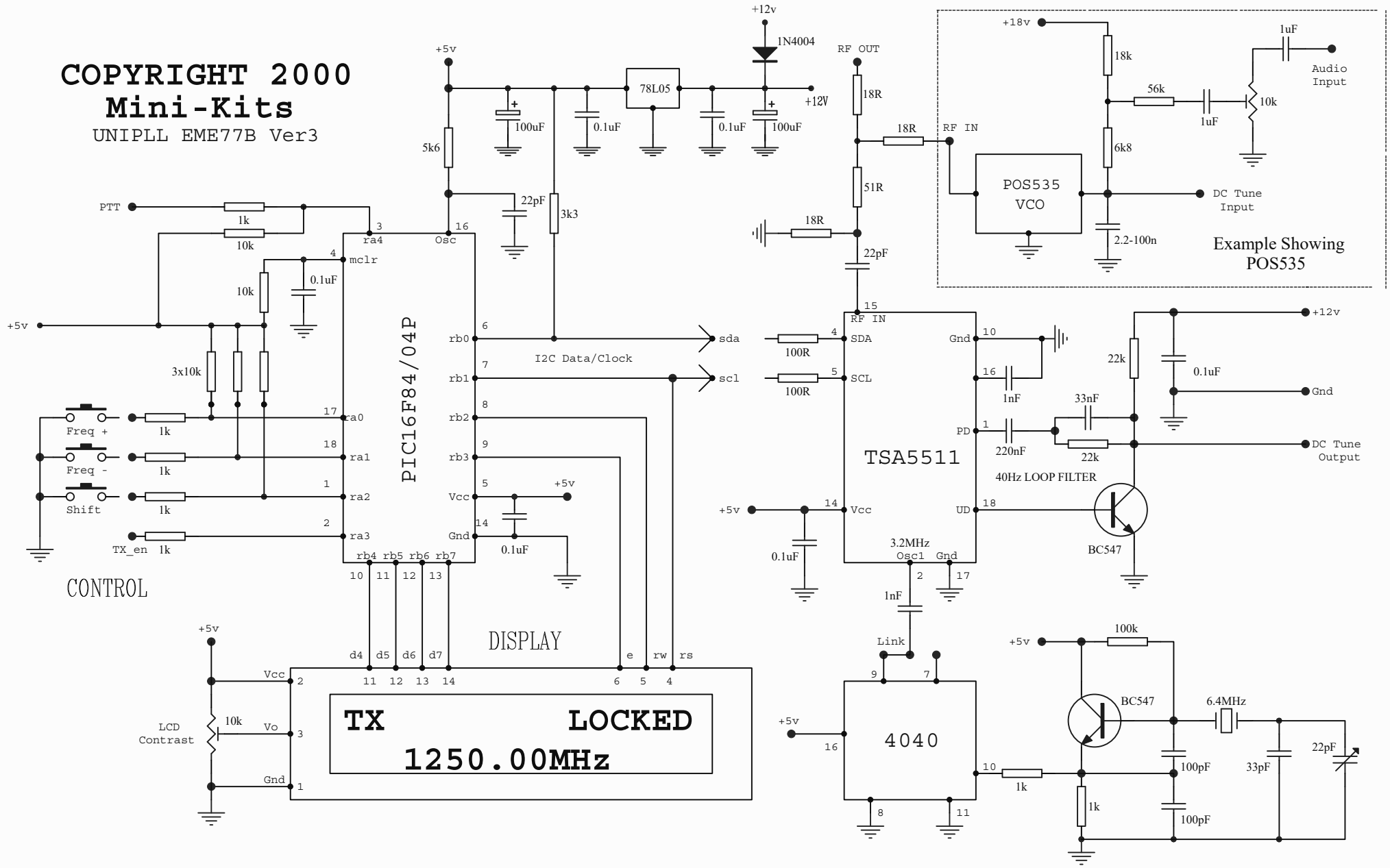
2. Connect the RF OUT connection on the UNIPLL board to the power amplifier or 50ohm load.

3. Connect the DC tune output on the UNIPLL, to the PLL input connection on the EME79 1250MHz ATV transmitter board. In most cases shielded cable is not required here, but can be used. Don't forget to unsolder the 5kohm Tune trimpot on the EME79 board as it is not required, & will load the PLL if left in circuit.

4. As the RX display & VCO settings are not required for TX only operation, hardwire the PTT connection on the UNIPLL board to Gnd. This enables the TX display & VCO programmed settings.

5. If you are going to use the UNIPLL on older 1250MHz transmitter designs, e.g. EME36, then refer to the WEB site for modification notes & circuits.

UNIPLL ALIGNMENT: The only alignment on the UNIPLL board is the adjustment of the 6.4MHz crystal oscillator. The best way to adjust the oscillator is to connect a frequency counter to pin 2 of the TSA5511 & adjust the trimmer for a frequency of 3.2000MHz.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Mini-Kits
UNIPLL EME77B Ver3
PIC16F84/04P
TSA5511
4040
CONTROL
DISPLAY
TX LOCKED
1250.00MHz
I2C Data/Clock
40Hz LOOP FILTER
Example Showing
POS535
POS535
VCO
Audio
Input
DC Tune
Input
DC Tune
Output
RF OUT
RF IN
Freq +
Freq -
Shift
TX_en
LCD
Contrast
Link
BC547
78L05
1N4004
3.2MHz

VCO ADJUSTMENT 1250MHz TX: On the EME79 1250MHz TX, the wire shorting link is adjusted until the DC Tune voltage is around 1 volts at 1240MHz & 7volts at 1300MHz. POS & JTOS VCO's are accurately made & are not adjustable, so just check that the tuning voltage is within range, & the PLL is locked.

ADDITIONAL NOTES:

1. If you find that the display sometimes flicks between Locked & Unlocked when using the UNIPLL on a transmitter, this might be due to the transmitter producing spurious output, or the oscillators tuning voltage being at the end of its range to keep the PLL in lock. To check whether the PLL is locked, measure the DC control voltage with a multimeter. A varying voltage when tuning across the band of between 0.1 & 10volts is usually a good indication that the frequency is locked. Erratic jumping of the DC control voltage across the band indicates instability that is usually due to poor RF connections from transmitter to the UNIPLL board. Most problems can be cured by careful connection & shielding of RF circuitry when mounting everything in a box.

2. The onboard RF splitter has around 10dB loss. This means that when using an EME79 1250MHz transmitter with 10mW into the UNIPLL board, there is only around 1mW left to feed to a Poweramplifier. By bypassing the 7dB pad on the EME79 board, around 50mW is available to feed into the UNIPLL board which produces 5-10mW output suitable to drive a M67715 power amplifier module. **Recent measurements have shown up to +16dBm (40mW) still available after the PLL attenuator. This seems to vary depending on construction, & cable connections.**

3. On some Transmitted signals, faint vertical lines have been seen traveling slowly across the picture. The lines vary depending on the video source used, & its time base frequency. The problem seems to be the PLL oscillating, as it can be seen with an Oscilloscope on the DC Tune Output connection. Try a 10pF ceramic capacitor from the DC tune Output connection to Ground. A similar problem can also be radiation from the cable from the PLL board to the LCD module. Extra shielding, or rerouting the cable usually fixes the problem.

PARTS LIST:

RESISTORS

3 x 18R	1206 SMD Resistor
1 x 51R	1206 SMD Resistor
2 x 100R	1/4 Watt Resistor
7 x 1k	1/4 Watt Resistor
1 x 3k3	1/4 Watt Resistor
1 x 5k6	1/4 Watt Resistor
5 x 10k	1/4 Watt Resistor
2 x 22k	1/4 Watt Resistor
1 x 100k	1/4 Watt resistor

TRIMPOTS

1 x 10k	TPV 5mm Trimpot Resistor

CAPACITORS

1 x 22pF	0805 Chip Capacitor
1 x 22pF	Ceramic Capacitor
1 x 33pF	Ceramic Capacitor
2 x 100pF	Ceramic Capacitor
2 x 1nF	Ceramic Capacitor
5 x 0.1uF	Monolythic Capacitor
1 x 33nF	Monolythic/MKT Capacitor
1 x 220nF	Monolythic/MKT Capacitor
2 x 100uF	Electrolytic Capacitor
1 x 22pF	Green Trimmer Capacitor

SEMICONDUCTORS

1 x 1N4004/7	Diode
1 x 78L05	5v Regulator
2 x BC547/8	NPN GP Transistor
1 x CD4040	IC CMOS Divider
1 x TSA5511	PLL IC
1 x PIC16F84	Microprocessor **(Pre-Programmed)**

MISCELLANEOUS

1 x PC Board	EME77B
1 x Instructions	EME77B
1 x 6.4MHz	Crystal
1 x 18 Pin	IC Socket
1 x Plug Link	2 Pin Suit Header
1 x 3 Pin	2.54mm Header Socket
1 x 4 Pin	2.54mm Header Socket
1 x 8 Pin	2.54mm Header Socket
1 x 10 Pin	2.54mm Header Socket

OPTIONAL NOT INCLUDED

1 x 16 x 2 LCD Display Module Hitachi HD44780
1 x Software (synth.zip file supplied on WEB Site)