

<b>Specifications:</b>	VCO Frequency Coverage	100MHz to 2.8GHz
	Display Multiplier	x1 to x20
	Frequency Steps x1 Mult	125KHz \ 500KHz \ 1MHz / 10MHz ( <b>4MHz Ref</b> )
	RX / TX VCO Offsets	-3.2 to +3.2GHz ( 125KHz Steps ) ( <b>4MHz Ref</b> )
	Microcontroller	PIC 16F628/20P
	PLL Synthesizer	SP5055 ( 4MHz Reference ) 3.2MHz Optional
	Software	<b>Version 2.1 Synth.ASM S Jones 29/3/2006</b>
	Power	12volts 85mA ( <b>No LCD Module Connected</b> )

**DESCRIPTION:** The EME124 UNIPLL2 Kit is a design upgrade to the popular EME77B UNIPLL Kit. The EME77B was designed around the TSA5511 PLL IC that has now become difficult to source, so it was decided to redesign the Kit & use a more easily obtainable SP5055 PLL chip. The SP5055 is usable to 2.8GHz & is commonly used in Satellite Tuner modules, & 2.4GHz video sender units. The Kit uses a preprogrammed PIC16F628 Microcontroller to control the PLL, & a standard 2 Line x16 character LCD display module. The UNIPLL2 has primarily been designed to be used in conjunction with the EME79 1250MHz video transmitter. It is also suitable for connecting to various VCO modules like the Mini-Circuits POS & JTOS types, or your own VCO design. The SYNTH software has been completely rewritten to suit the UNIPLL2 Kit, but is also backward compatible, & with minor modifications to the EME77B board, a new programmed 16F628 can simply be plugged into the older UNIPLL Kit. With the larger memory space available in the 16F628 chip, It was decided to add some new features to the software. Software additions now allow for a number of memory channels, & the option of using a Rotary Encoder for tuning, & external bandswitching which allows up to 5 Bands to be programmed. The software supplied with the Kit can easily be changed without having to reprogram a new chip. The software displays menu setup screens to allow all settings to be easily programmed into memory. All new settings are automatically memorized into the PICs Eeprom, & remain when powered down. The UNIPLL2 is suitable for using on a wideband transceiver where the RX frequency may be offset 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 UNIPLL2 has a PTT control input to switch between RX & TX mode, & a TX low enable output which can be used to disable the transmitter if the PLL is out of lock, to prevent out of band operation.

**MICROCONTROLLER:** The PIC16F628 with pre-programmed SYNTH software, controls the whole operation of the PLL. RB0 & RB1 Input/Outputs send I2C bus data to & from the SP5055 PLL to control & receive status information back from the PLL. The RA0 to RA5 inputs are connected to +5volts by 10kohm pullup resistors, & are pulled low to 0volts with 1kohm resistors using push buttons to control the PLL functions. RB1 to RB7 outputs 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. The internal clock inside the 16F628 is used so no external clock components are required on pins 15 & 16.

**SP5055 PLL:** The reference frequency for the SP5055 is 4.0MHz, which provides a standard frequency step of 125Khz. Optionally the software menu can be changed, & a 3.2MHz crystal used for 100KHz steps. 3.2MHz crystals are not a standard low cost computer type crystal so have not been used in this kit due to cost. The SP5055 is controlled & sends status information back to the 16F628 through its I2C bus connection on pins 4 & 5. DC control output to drive a VCO is from pins 1 & 16 & 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. As the PLL has primarily been designed to be used in conjunction with the EME79 transmitter, only one 10nF Loop Filter component has been fitted on the output of the PLL. Loop filter components on the EME79 transmitter board, consists of a 1nF & 4k7 on the input of the BB405B varicap diode. Refer to the SP5055 design guidelines application note AN168 for loop filter design for other applications. The SP5055 is not designed for narrow band FM voice applications as it produces high phase noise, which would produce background noise on the FM Audio. Surface mount decoupling capacitors & plated through holes are used around the SP5055 to improve phase noise. A 50ohm loop through splitter is used to couple a small amount of RF to the internal prescaler input pin 13 on the SP5055. The splitter has around 5dB through loss which drops the +17dBm from the EME79 board to around +12dBm. The TX Enable output on pin 6 is normally 0 volts locked, & goes to 5

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volts when the PLL is unlocked. This output can be used to drive a transistor to disable the transmitters output when the PLL is out of lock preventing accidental out of band operation. Pin 7 on the SP5055 is a 5 level A-D input that can be programmed to convert analogue input signals to digital. It is used for the optional band switching by reading voltages from an external rotary switch & resistor voltage divider network. Data from the A-D is fed back to the 16F628 on the I2C bus to select the band. Refer to the EME124 circuit diagram.

**SOFTWARE:** All user information including Menu Programming information can be found in the readme.txt & synth.asm files in the synth\_v2.zip software package available on the Mini-Kits web site. The following examples use the synth.hex software Pre-programmed into the PIC supplied with the EME124 KIT. The 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.

**EXAMPLE 1.** The UNIPLL2 is used to control the EME79 video transmitter for use as a single band transmitter. There are 2 menu screens available in the software.

Set the sub menu settings to display the following. To get into the sub menu, press both the shift & memory buttons down & then power up the UNIPLL2, & when the menu screen comes up, let go of both buttons. The shift button is now used to step through menu settings. The up/down buttons are used to change the settings. The Menu screens will default back to the normal display in 10 seconds if no buttons are pressed. The settings will not be saved unless you step through all the menus & save on exit.

PLL & REF FREQ	SP5055 4MHz
SHIFT FUNCTION	USER STEP SIZE
TX RX MODES	TX ONLY
BANDS IN USE	1

**Press the shift button at the end to Save to settings**

Set the Main Menu to display the following. To get into the main menu, press both the shift & memory buttons down with the UNIPLL2 already powered up. The shift button is now used to step through menu settings. The up/down buttons are used to change the settings. The Menu screens will default back to the normal display in 10 seconds if no buttons are pressed. The settings will not be saved unless you step through all the menus & save on exit.

DISPLAY MULT	01
STEP SIZE	125Khz
MIN TX DISPLAY	1240MHz
MAX TX DISPLAY	1300MHz
TX VCO OFFSET	0.000MHz

**Press the shift button at the end to Save to settings**

**EXAMPLE 2.** The UNIPLL2 is used with an EME79 video transmitter as a multiband ATV transmitter covering 1200, 2400, 3300, 5800, & 10,300MHz. Please note that an Optional 5 Position rotary switch & resistor network needs to be connected to pin 7 of the SP5055 PLL for band switching. The Bands in use setting tells the PIC that you have connected a 5 position band switch to the A-D converter input of the SP5055. The switch with resistors forms a voltage divider & the A-D input measures the voltage & tells the PIC what band is selected.

Sub Menu	PLL & REF FREQ	SP5055 4MHz
	SHIFT FUNCTION	USER STEP SIZE
	TX RX MODES	TX ONLY
	BANDS IN USE	5

**Press the shift button at the end to Save to settings**

The Main Menu settings need to be set for each band. B1 to B5 are displayed on the LCD to indicated the band selected. Start by switching to band 1 & enter the main menu & enter the following settings.

Main Menu	DISPLAY MULT	01
	STEP SIZE	125Khz
	MIN TX DISPLAY	1240MHz
	MAX TX DISPLAY	1300MHz
	TX VCO OFFSET	0.000MHz

**Press the shift button at the end to Save to settings**

Then switch to band 2 & enter the main menu & enter the following settings.

Main Menu	DISPLAY MULT	02
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STEP SIZE	250Khz
MIN TX DISPLAY	2400MHz
MAX TX DISPLAY	2450MHz
TX VCO OFFSET	0.000MHz

**Press the shift button at the end to Save to settings**

Do this until you have set up all your bands.

## CONSTRUCTION:

1. The PC Board supplied is a plated through hole board, which makes it easier to construct the Kit. The board component spacings, & drilled hole sizes, were designed around the components that are used in the Kit, so no drilling or modifications should be required. The single earth pad connections on the bottom of the board are plated through holes & only have to be soldered on the bottom track side of the board.
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 some SMD components along with the SP5055 which are mounted on the bottom trackside of the board.
3. **Start with the SMD component first.** Solder in the SP5055 IC using a pair of tweezers to hold it in place when soldering. Pin 1 is indicated on the PC board by a small arrow next to the track. Solder in the remaining chip components using a pair of tweezers to hold them in place, soldering one side first then the other side.
4. Next fit all conventional sized components to the board. **An 18 pin IC socket is supplied for the PIC16F628 to make it easier for software upgrades.**
5. When mounting the 7805T regulator, use the supplied M3 hardware to mount it to the board. A heatsink is not required as the current drain of the PLL board & LCD display module including backlight is normally only around 150mA. When using an LCD with a backlight, you will need to calculate a suitable dropping resistor to drop 5volts down to the voltage & current required by the backlight LEDs. Some LCD's have inbuilt LED backlight dropping resistors, & are designed for 5volt operation. The LCD1 display sold by Mini-Kits requires a 22ohm 1/4 watt resistor on the anode of the LCD module to 5volts. The Cathode side is connected to ground.

**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.

**CONNECTION TO THE 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 is required on the EME124 board. Any extra connections available on the LCD e.g. ( d0-d3 etc ) should be ignored. VDD is 5volts, VSS is ground, VL is Vo, K is Cathode, & A is Anode. The E is the ( Enable ) connection, & is sometimes confused with the earth or ( Gnd ) connection. Some LCD's don't have a RW ( Read Write ) pin, & have onboard LCD backlight circuitry that doesn't require the Vo ( contrast connection ), or 10k Trimpot.

**CONNECTION TO A TRANSMITTER:** The comments refer to connecting the UNIPLL2 Kit to the EME79 1250MHz Video transmitter, but is also applicable to most other transmitters or VCO modules. When connecting to an ATV transmitter or VCO module, use mini 50ohm Teflon coax for the RF connections to the board. The Connections should be direct to the board using good UHF practices without using PCB pins or long pigtail connections. The PCB has a small hole drilled through the board at the ends of each stripline for the cable connections. Pass the center core of the cable through the hole & solder the earth braid to the top groundplane of the board for a good 50ohm termination. Alternatively flange or PCB mount SMA female sockets can be soldered to the edge of the Board for connection.

1. Connect the RF output connection from EME79 to the RF IN connection on the UNIPLL2 board.
2. Connect the RF OUT connection on the UNIPLL2 board to the power amplifier or 50ohm load.
3. Connect the DC tune output on the UNIPLL2, to the PLL input connection on the EME79 1250MHz ATV transmitter board. Use a short length of miniature shielded cable to stop radiation from the PLL into the video circuitry. 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 UNIPLL2 board to Gnd. This enables the TX display & VCO programmed settings.

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**INITIAL TESTING:** Before applying power to the UNIPLL2, disconnect the +5volts to the LCD display & remove the PIC16F628 from the board. Apply +12volts power & check that there is +5volts from the output of the 7805T regulator. If this is ok then install the PIC16F628 & reapply power & check that the UNIPLL2 draws around 85mA. If this is ok then re-connect the LCD modules +5volt connection. **Reapply power & check the full operation of the function buttons & LCD readout. Refer to the notes on settings for the menus & set the menus up for 1240 to 1300MHz operation.**

**UNIPLL ALIGNMENT:** The only alignment on the UNIPLL2 board is the adjustment of the 4MHz crystal oscillator. The oscillator can either be adjusted by connecting a frequency counter to pin 2 or 3 of the SP5055, & adjust the trimmer for a frequency of 4.0000MHz, or alternatively more accurately by checking the VCO output frequency of the transmitter. Further adjustment may be required when used with multipliers on the higher microwave bands.

**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 UNIPLL2 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 UNIPLL2 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 5dB loss. This means that when using an EME79 1250MHz transmitter with 10mW into the UNIPLL2 board, there is around 3.2mW left to feed a M67715 Poweramplifier to produce around 1Watt output. By bypassing the 7dB pad on the EME79 board, around 50mW is available to feed into the UNIPLL2 board which produces 10-16mW output **Recent measurements have shown up to +16dBm ( 40mW ) available after the UNIPLL2 attenuator. This seems to vary slightly depending on construction, & cable connections. This is enough to drive a M68719 power-module to +42dBm ( 16Watts ) .**

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 4MHz oscillator on the PLL radiating into the video circuitry, which can be seen with an Oscilloscope on the DC Tune Output connection. A 10nF filter capacitor has been fitted on the output of the DC tune connection to effectively stop this. A similar problem can also be radiation from the cable connecting the UNIPLL2 board to the LCD module. Extra shielding, or rerouting the cable usually fixes the problem.

## OPTIONS:

1. For Multiband operation, locate pin7 on the SP5055 & follow the PCB track until you get to the square SMD pad which goes to the band switch connection on CON3. A thin track bridges the pad to ground & needs to be cut with a knife & then a 1nF SMD capacitor soldered into position. Refer to the circuit diagram & construct the band switch circuit using a suitable 2 pole 5 position switch & 1/4 watt resistors. Connect the band switch assembly to CON3 on the UNIPLL2 board using the +5v, Ground, & Band switch connections. The second pole of the switch can be used to switch power to multiplier boards, or relays etc.

2. For optional rotary tuning control, fit an EC16B rotary encoder as shown on the circuit diagram. The frequency +/- switches need to be removed as they will not work with the encoder in circuit. **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)**

3. To avoid out of band operation the TX enable option can be used to turn the transmitters drive or power amplifier off if the PLL goes out of lock. A suitable transistor buffer will be required as the SP5055 outputs can only sink low current. Pin 6 is 0volts when the PLL is locked & +5volts when it is unlocked. To use the TX enable option, locate pin 6 on the SP5055 & follow the track until you get to the square SMD pad which goes to the TX enable connection on CON3. Cut the track shorting the SMD pad to ground & fit a 1nF SMD capacitor.

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## PARTS LIST:

### RESISTORS

3 x 18R	1206 SMD Resistor
1 x 51R	1206 SMD Resistor
2 x 330R	1/4 Watt Resistor
6 x 1k	1/4 Watt Resistor
1 x 3k3	1/4 Watt Resistor
6 x 10k	1/4 Watt Resistor
2 x 22k	1/4 Watt Resistor

### TRIMPOTS

1 x 10k	TPV 5mm Trimpot Resistor
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### CAPACITORS

1 x 22pF	0805 Chip Capacitor
1 x 100pF	0805 Chip Capacitor
3 x 1nF	0805 Chip Capacitor
1 x 0.1uF	0805 Chip Capacitor
1 x 10pF	Ceramic Capacitor
1 x 39pF	Ceramic Capacitor
2 x 100pF	Ceramic Capacitor
1 x 10nF	Ceramic Capacitor
4 x 0.1uF	Monolithic Capacitor

1 x Software ( synth.zip file supplied on WEB Site )

**For Product support, visit the Mini-kits WEB site  
[www.minikits.com.au](http://www.minikits.com.au)**

1 x 33nF	Monolithic/MKT Capacitor
1 x 220nF	Monolithic/MKT Capacitor
2 x 100uF	Electrolytic Capacitor
1 x 10pF	Yellow Trimmer Capacitor

### SEMICONDUCTORS

1 x 7805T	5v 1A Regulator
1 x BC547/8	NPN GP Transistor
1 x SP5055	PLL IC
1 x PIC16F628	Microprocessor ( <b>Pre-Programmed</b> )

### MISCELLANEOUS

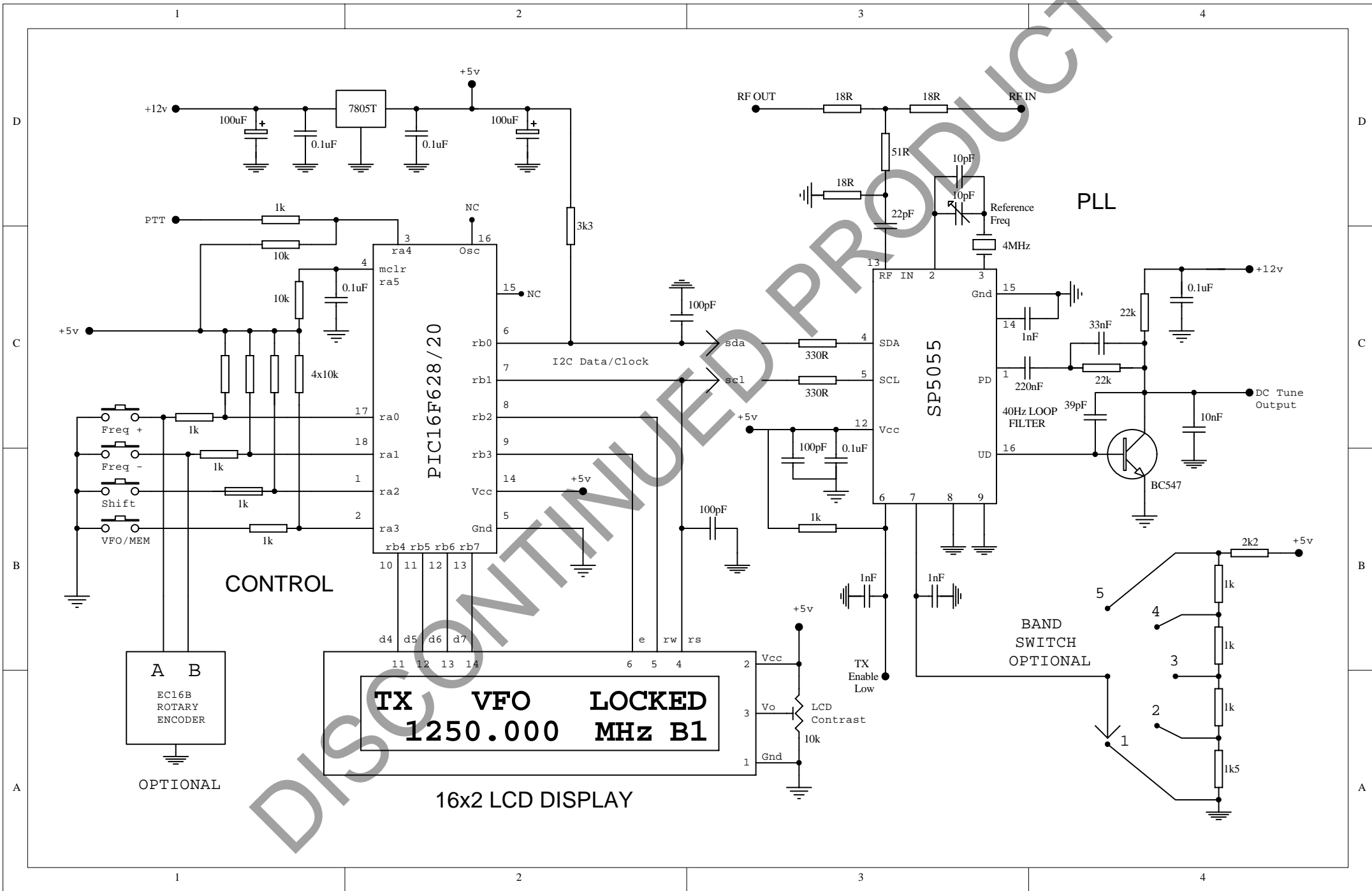
1 x PC Board	EME124B
1 x Instructions	EME124B
1 x 4MHz	Crystal
1 x 18 Pin	IC Socket
1 x 40 Pin	Inline Header
1 x M3 Nut	
1 x M3 Washer	
1 x M3 Bolt	

### REQUIRED COMPONENTS NOT SUPPLIED

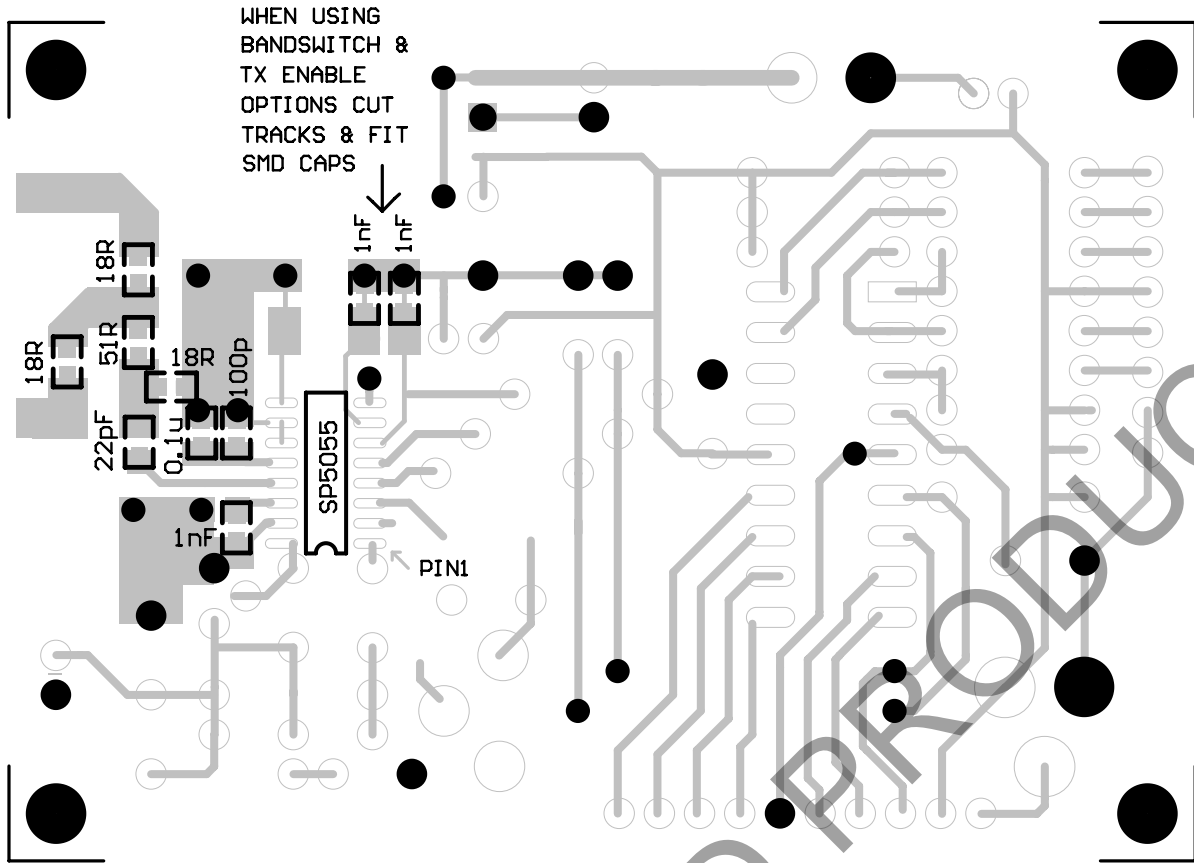
1 x 16 x 2 LCD Display Module Hitachi HD44780
4 x Push Button Switches ( Momentary on )

### OPTION COMPONENTS

1 x 2 Pole 5 Position switch ( For Band Switch Option )
1 x EC16B Rotary Encoder ( For rotary tuning Option )



# BOTTOM SMD COMPONENT OVERLAY



# TOP PCB OVERLAY

