CONSTRUCTION PLANS

FM EXCITER FME500-3

The FME-500 is a highly stable DIRECT FM exciter with an RF output up to 500 milliwatts. A Phase-Locked-Loop (PLL) circuit controls the mean frequency of the oscillator. Stability exceeds that of broadcast service standards of + or - 2 kHz for both long and short term drift. Typical drift is less than 200 Hz.

A buffer amplifier follows the direct FM oscillator. This provides isolation for the oscillator as well as increasing the power output. It operates in a class A/B mode rather than class C which greatly reduces any harmonic content. The power output can be adjusted from near zero to over 500 milliwatts. Reduced power output is obtained by decreasing coupling or by changing some part values.

The Phase-Locked-Loop may be programmed for any frequency between 87 MHz and 109 MHz in 50 kHz increments. A precision crystal oscillator is used for the PLL reference. Capacitor trimming of the crystal frequency allows setting of the carrier frequency to +/- zero deviation.

Two audio inputs are provided. One includes the U.S. standard 75 microsecond pre-emphasis which is for mono audio inputs. The second is a broadband input for composite stereo and/or SCA type audio. The required input level to achieve 100% modulation is .3 volts rms. The input is a broadcast standard of - 10 dBm and a 600 ohm input impedance.

Power requirement is 12 volts at 300 milliamperes. The supply should be well regulated for optimum performance.

We recommend you read this entire set of plans before attempting assembly or operation of this circuit

CAUTION::::::::: This unit has not been type-accepted by the FCC for use by licensed radio stations. It may legally be used in closed systems such as cable FM stations. Other uses may require specific FCC approval and/or licensing. Operation of this unit with an antenna will give coverage from 1 to 5 miles. This is not permitted under Part 15 of the FCC Rules. The responsibility for this unit's ultimate use rests solely with the builder and/or operator. If you have any questions as to the legal use of this kit you should read Part 15 of the FCC Rules. Part 15 and other applicable information may be obtained from you local FCC field office.

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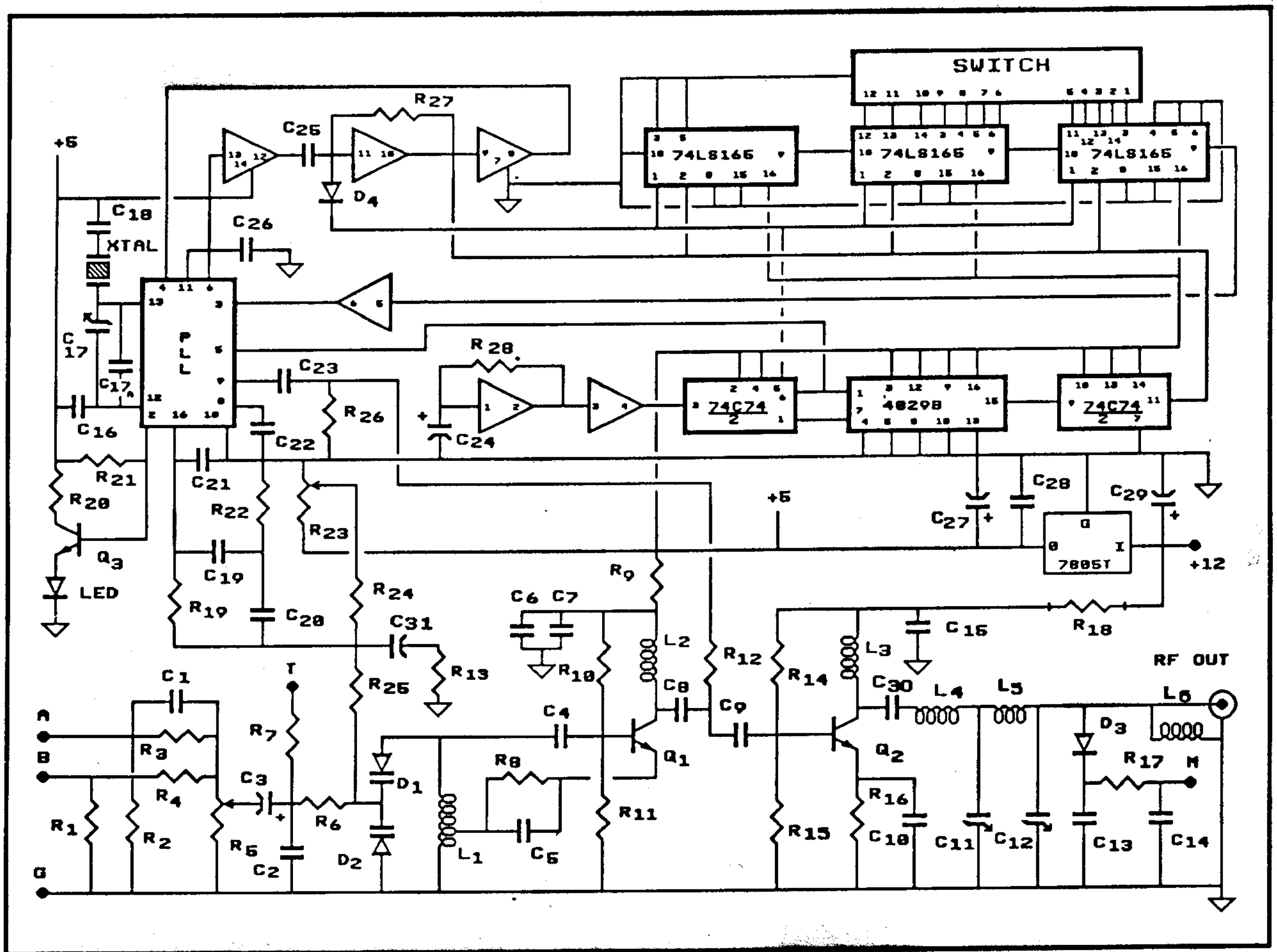

Figure 1 - Schematic

THEORY OF OPERATION

THE DIRECT FM OSCILLATOR, BUFFER, AND AUDIO CIRCUITS

We'll examine the easy part first. Transistor Q1 is connected as a Hartley oscillator. Current changes through the transistor must flow from the circuit common (ground) up through the bottom two turns of L1, through R8/C5, the transistor, RF choke L2, isolation resistor R9, and to the + 5 volt supply. The current introduced into L1 produces a voltage at the top of L1 which is coupled to Q1's base by C4. Resistors R10 and 11 establish the operating bias for Q1. The action of L1 provides a positive feed-back so the circuit will sustain oscillations. Capacitors C6 and C7 and resistor R9 help reduce undesirable feed-back through the power supply lines.

The frequency of oscillation is determined by the inductive value of L1 and the capacity across it. The capacity is provided by voltage variable diodes D1 and D2. Any change of voltage at their junction point changes their internal capacitance which in turn changes the frequency of oscillation. The "mean" frequency bias is provided by the PLL IC through R19 and R25 to R6 (the diode's junction point). The value of the bias voltage may be measured at test point "T".

An audio signal introduced at point "B" and ground (G) is coupled to the bias point through R4, C3 and R6. This is the wideband input and is used for stereo or for SCA inputs. It only takes about 5 millivolts to change the oscillator frequency 75 KHz either side of the mean frequency. This represents 100 % modulation. The ratio of R4 to R5 reduces the input signal level to the proper amount for 100% modulation. The value of R5 is variable from 0 to 500 Ohms permitting fine adjustment of the modulation level for a variety of input levels. One-quarter turn is about right for a -10 dBm (.3 volt rms) input.

An audio input at point "A" passes through the pre-emphasis circuit of R3 and C1. The "time constant" of this circuit is the standard 75-microsecond curve used in U.S. broadcasting. With a 1 KHz audio input the signal level reaching the modulator diode's biaspoint is simply the ratio of R3 to R5. As the audio frequency increases the "reactance" of C1 becomes less and creates a "bypass" across R3 which increases the level.

The result is an increasing signal level at the bias point as a function of increased frequency. With the 75-microsecond pre-emphasis curve this works out to a 17 dB increase in signal level at 15 kHz. FM receivers have a de- emphasis circuit to restore the original audio level. All of this is done to to help mask higher frequency noise (hiss) during transmission and reception.

The European pre-emphasis is set at 50-microseconds. To change the FME-500 to accommodate the European standard simply change R3 to 10K Ohms instead of 15K Ohms. R4 should be changed to 10K also to keep both input level requirements the same.

The oscillator operates at its programmed frequency (87 MHz to 107 MHz) developing an RF (radio frequency) signal across inductor L2. That signal is coupled to the buffer amplifier through C8 and C9. The proper operating bias for the buffer (Q2) is set by R14 and R15. The emitter resistor R16 and capacitor C10 help stabilize the bias and set the gain of the amplifier. C15 and R18 help decouple the circuit from the power supply.

The amplified RF signal is developed across L3. It's then fed to a double "L" section filter consisting of L4, C11 and L5, C12. C11 "tunes" the filter while C12 permits matching of the filter to a load such as a cable system or antenna. The filter reduces the signal level of any harmonics (multiples of the operating frequency), and/or spurious frequencies above the desired frequency, which might otherwise reach the output jack. The 12 volt dc present at L3 is blocked from the filter by C30.

Diode D3 samples the RF voltage at the antenna connector and feeds it to C13, R17 and C14 for filtering. L6 provides a dc return path for the D3. The result is a dc output voltage at test point "M" which may be used to measure relative output power. A high resistance (20,000 Ohms/volt) or digital voltmeter should be used for measurements. The positive terminal of the voltmeter is connected to the test point, the negative terminal is connected to circuit common (ground). With a suitable "dummy" load (50 to 75 Ohms) connected to the output jack, adjust C12 and C11 for a maximum reading on the meter.

THE PLL (PHASE-LOCKED-LOOP) CIRCUIT

The PLL combines a low frequency oscillator (4 MHz), a very high frequency (80 MHz - 120 MHz) divider, and a phase comparator. The PLL is "programmed" to divide its input frequency by some number. That number is determined by the setting of a combination of DIP (dual-inline-package) switches. The code presented by the switches is transferred to the PLL as a string of "pulses". The PLL stores the code in its memory.

Integrated circuits 74LS165, 74C74, 4029, and Hex inverter 74C14 (triangles in the schematic) provide the proper coding, timing and resetting of the PLL's memory.

A 4 MHz crystal (XTAL) oscillator is incorporated in the PLL circuitry to provide a stable reference frequency. The reference frequency can be fine-tuned by means of trimmer capacitor C17. This in turn permits adjustment of the exciter's output to within a few Hz of the desired frequency. The 4 MHz signal is divided down within the PLL to a frequency of 25 kHz.

The oscillator frequency is sampled at the junction of C8/C9, reduced to the proper level by R12 and R26 and fed to pin 9 of the PLL. Within the PLL it's divided down to a frequency of 25 kHz.

The divided reference frequency and the divided sample of the carrier frequency are then compared within the PLL. Even the slightest difference between the two produces an "error" output voltage. The value of the error voltage is determined by the amount of "phase error" that may exist.

This error voltage becomes the mean frequency bias for the modulating diodes D1 and D2.- If the frequency tends to drift up, the error voltage decreases, the capacitance of the diodes increase, and the frequency is lowered. All of this, of course, is instantaneous so the frequency remains where it should be.

There is usually some residual 25 khz "ripple" on the error voltage which can cause a problem with stereo modulation. The stereo audio signal includes a 19 KHz pilot frequency. That mixed with the 25 kHz reference frequency can produce a difference frequency of 6 kHz which would be audible as a "whistle" at the receiver. To eliminate this problem a "notch" filter, consisting of R19, C19, C28, and R22, is included as part of the PLL's "loop filter". The remainder of the loop filter, used to suppress fast changes in the error voltage, consists of C21, C31, R25, R6, C2, and R5.

THE FUNCTIONS OF R23

(1) it aids in the initial set-up of the oscillator. With the PLL removed R23 should adjust the oscillator to slightly below and above the FM band. At mid-position the carrier oscillator should be at about 100 MHz. If it's not you should adjust the oscillator coil (L1) by squeezing the coil turns together to lower the frequency or spreading them apart to raise it. Only a slight amount of movement is required it at all.

If you experience a problem with the PLL not locking while in operation you may still have to squeeze or spread the turns of L1 slightly.

(2) if there is any remaining 25 kHz ripple on the PLL's error voltage you may still hear a very small background 6 kHz "whistle" when modulating with a stereo signal. Slight adjustment of R23 will "trim out" the bias which in turns lowers any 25 kHz ripple produced by the PLL's phase comparator. In most cases the notch and loop filters completely remove the 6 kHz whistle problem.

PROGRAM CODE GENERATION AND AUTO-RESET

Capacitor C24 charges slowly through R28. R28 is connected to the output of an inverting amplifier (pin 2). When power is first turned-on there's about 5 volts at pin 2. As C24 charges toward 5 volts a point is reached where the voltage on pin 1 causes the amplifier to suddenly switch "on". When this happens pin 2 drops to 0 volts. C24 must then discharge back through R28. When the voltage at pin 1 drops below a certain value the amplifier switches "off" and pin 2 again changes to 5 volts. This continues to repeat at intervals determined by the time constant of C24 and R28 (about 5 seconds or so). The output is a square wave about 10 seconds long. This is your "reset clock".

Each time the reset clock goes through a cycle it causes 1/2 of the dual flip-flop (74C74) to change from "off" to "on". One of the flip-flop's outputs prepares the PLL (pin 6 to pin 5) to accept a new command. The other flip-flop output (pin 5) prepares the shift registers (74LS165's) to accept information. The "programming clock" is also switched "on" by unclamping diode D4.

The auto-reset function assures that:

(1) The PLL is sent the proper code each time the power is turned-on.

(2) If your electrical power is cut-off, even for a moment, the PLL would lose it's memory. When electrical power returns the auto-reset assures the PLL will again be sent the proper code.

(3) If you decide to change the operating frequency all you need to do is set the proper DIP switches. There is no need to switch off and on the power to activate the new frequency - the auto-reset circuit does it for you within 5 seconds.

The programming clock works the same way as the reset clock except faster. Here we have C25 being charged through R27 from pin 10. The voltage present across C25 is at pin 11 and determines if that amplifier is on or off...it cycles just like the reset clock.

The output from the programming clock is fed to pin 2 of each shift register. An opposite phase version of the clock is fed to the PLL at pin 4. The clock signal is also fed to pin 11 of the other half of the dual flip-flop (74C74). This second half divides the clock frequency by 2 and then feeds it to a divide- by-10 counter (4029). After 2 x 10 pulses (20) have been counted a pulse from the output of the 4029 switches "off" the first flip-flop in the 74C74. Everything stops and waits for the next reset clock pulse to start it all over again.

During the programming "run" data pulses were being fed from the last shift register (74LS165) through an amplifier (pins 5,6 of the 74C14), to the PLL data input (pin 3). The number of data pulses, and their relative positions in time, are determined by which of the 12 switches are on or off. The selection of switches therefore determines the PLL divide code which in turn determines carrier frequency.

Resistors R20 and R21 along with transistor Q3 and an LED are used to test if the programming circuits are working. If a code has been received by the PLL properly, the LED will glow. To double check if the reset feature is working the power supply should be switched off and on several times to scramble the coding. When this is done the LED will go dark....but will glow again in a few seconds - this shows the reset is working. The LED will glow continuously when the PLL is out of its socket.

THE REST OF THE CIRCUITS

The 7805 IC is a 5 volt regulator. It assures the PLL and digital circuits are given the proper supply voltage. The oscillator is also supplied from this regulated 5 volts to assure low noise operation. The buffer amplifier operates from 12 volts with a series resistor, R18.

By changing the value of R18 you can control the amount of current drawn and therefore the voltage available, for Q2 - the buffer. R18 should not be less than 10 ohms nor more than 220 ohms If you desire to have a variable poer output you may remove R18 from the printed circuit board and place it in sereies with a 250 Ohm, 2-watt potentiometer. The potentiometer should be wired as a rheostat. The "pot" can then be installed on the front or rear of your enclosure for easy access. The "pot" is then your power output control.

Remember... Do not install R18 if your FME will be used with the ENC-1 enclosure. R18 will instead be located on the ENC-1's connection strip.

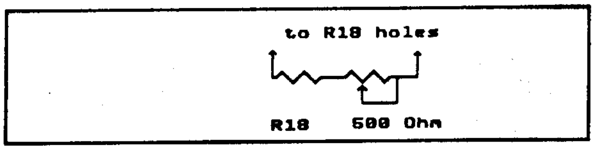

Figure 2 - External Power Control

The maximum output level is set by the location of R9. When connected to the +5 volt bus your output power is limited to about 250 mW. When connected to the +12 volt bus output is raised to 500 mW. See assembly drawings.

BEFORE STARTING ASSEMBLY

Check out all your parts. Place them in neat piles in front of you where they are easy to reach and identify. If you purchased a kit, make sure all the parts are there...if any are missing report it immediately.

Study the assembly drawing carefully. It's drawn to scale so you should be able to identify which holes are for which parts. Hold your PC board up to the light to see the "traces and pads". This will help you locate the proper holes.

Have all of your tools handy. You'll need small wire cutters, long nose pliers, and a small screw driver. Use only 60/40 or 63/37 rosin-core solder...and no larger than a 40 watt pencil type soldering iron (if you're an accomplished solderer) or a 25 watt iron if you're not so sure.

Work slowly and carefully. Don't jump ahead of the instructions - this almost always gets the builder into trouble.

Although not apparent, the leads of diodes, transistors and crystals can serve as heatsinks during soldering. Further, if crystal or diode leads are cut before they are made secure the vibrations from the cut can damage the unit. For these reasons we recommend that diode, transistor and crystal leads be soldered first and THEN cut off any excess lead lengths.

PARTS LIST

	Qty	Value	Part#	Description	ID Code
RESISTORS	3	620	R1, 2, 12	1/4 w Resistor	BL/RD/BR
	2	15K	R3, 4	"	BR/GN/OR
	1	500	R5	3/8" Trimpot	
	4	330	R6, 20, 25, 26	1/4 w Resistor	OR/OR/BR
	2	24K	R7, 17	"	RD/YL/OR
	4	22	R8, 9, 16,18	"	RD/RD/BK
	2	4.7K	R10, 14	"	YL/VI/RD
	2	1.0K	R11, 15	"	BR/BK/RD
	1	120	R13	"	BR/RD/BR
	1	150	R19	"	BR/GN/BR
	2	47K	R21, 24	"	YL/VI/OR
	1	27.0	R22	"	RD/VI/BK
	1	5K	R23	3/8" Trimpot	
	1	5.1K	R27	1/4 w Resistor	GN/BR/RD
	1	220K	R28	"	RD/RD/YL
CAPACITORS	1	.005 uF	C1	Ceramic disc or	502
	2	.001 uF	C2, 25	Polycarbonate	102
	1	2.2 uF	C3	10 v Radial Elec. or Tantalum	2.2 uF
	5	47 pF	C4, 8, 9, 13, 16	NPO Ceramic disc	47
	3	220 pF	C5, 10, 23	Ceramic disc	221 or 220
	10	.1 uF	C6, 7, 14, 15, 18, 19, 20, 21, 26, 28	12 v Mini Ceramic disc	104 104
	3	9-50 pF	C11, C12, 17	5 mm Trimmer	Green
	1	12 pF	C17a	NPO Ceramic disc	12
	1	.01 uF	C22	Ceramic or Poly	103
	2	10 uF	C24, 27	16 v Radial Electrolytic	10 uF
	1	470 uF	C29	16 v Radial Electrolytic	470 uF
	1	470 pF	C30	Ceramic disc	471 or 470
	1	47 uF	C31	10 v Radial Elec. or Tantalum	47 uF
SEMICONDUCTORS	3	74LS165		Shift Register 16 PIN IC	
	1	74C14 (40106)		Hex Inert Amp 14 PIN IC	
	1	CD4029B		Divider 16 PIN IC	
	1	74C74		Dual Flip Flop 14 PIN IC	
	1	PLL		Panaxis # CR7806 20 PIN IC	
	1	7805T		5 V Regulator	
	2	MV2113	D1, 2	Varactor Diode	
	2	1N4148	D3, 4	Silicon Signal Diode	
	1	LED		20 MA Mini LED Indicator	
	2	2N4427	Q1, 2	TO 39 VHF Transistor (NPN)	
	1	2N3904	Q3	General Purpose NPN Transistor	
INDUCTORS	3	3.3 uH	L2, L3, L6	Molded RF choke (Grey body) (may be green with 2 orange stripes)	336

	Qty	Item	ALSO ....
MISCELLANEOUS	1	12 pos. DIP switch	Insulated hook-up wire (Rd, Wh, Bk, Gn, Yl)
	2	14 pin IC socket	L1-Osc coil 5 t. 1/8" i.d. #22 wire spaced
	4	16 pin IC socket	L4-Output coil 7 t. 1/4" i.d. #20 wire close
	1	20 pin IC socketl	L5-Output coil 5 t 1/4" i.d. #20 wire close
	2	TO39 Heatsinks	
	1	4.0 MHz HC18U crystal	5 each 4-40 x 3/4 screws with nuts
	1	FME Printed Circuit Board	5 each 1/4" aluminum spacers

ASSEMBLY INSTRUCTIONS

Begin by installing all of the resistors, diode D3, and RF chokes L2 and L3 and the insulated wire jumpers. Place a check mark next to each part's number after it has been installed. Use the parts list's color codes to identify each resistor. The diode is a bit smaller than a resistor, is made of glass, and has a black band at one end. *Be sure the banded end is in the same direction as that shown in the assembly drawing.* **CUT DIODE LEADS ONLY AFTER SOLDERING.**

The RF chokes look like resistors but are larger and usually have a green or grey body color. The resistors and chokes may be installed in either direction.

Prepare each jumper from #24 insulated wire which is 1/2" longer than the distance between the holes. Strip 1/4" of insulation from each end. Bend the wire ends and install.

(Cut and solder)

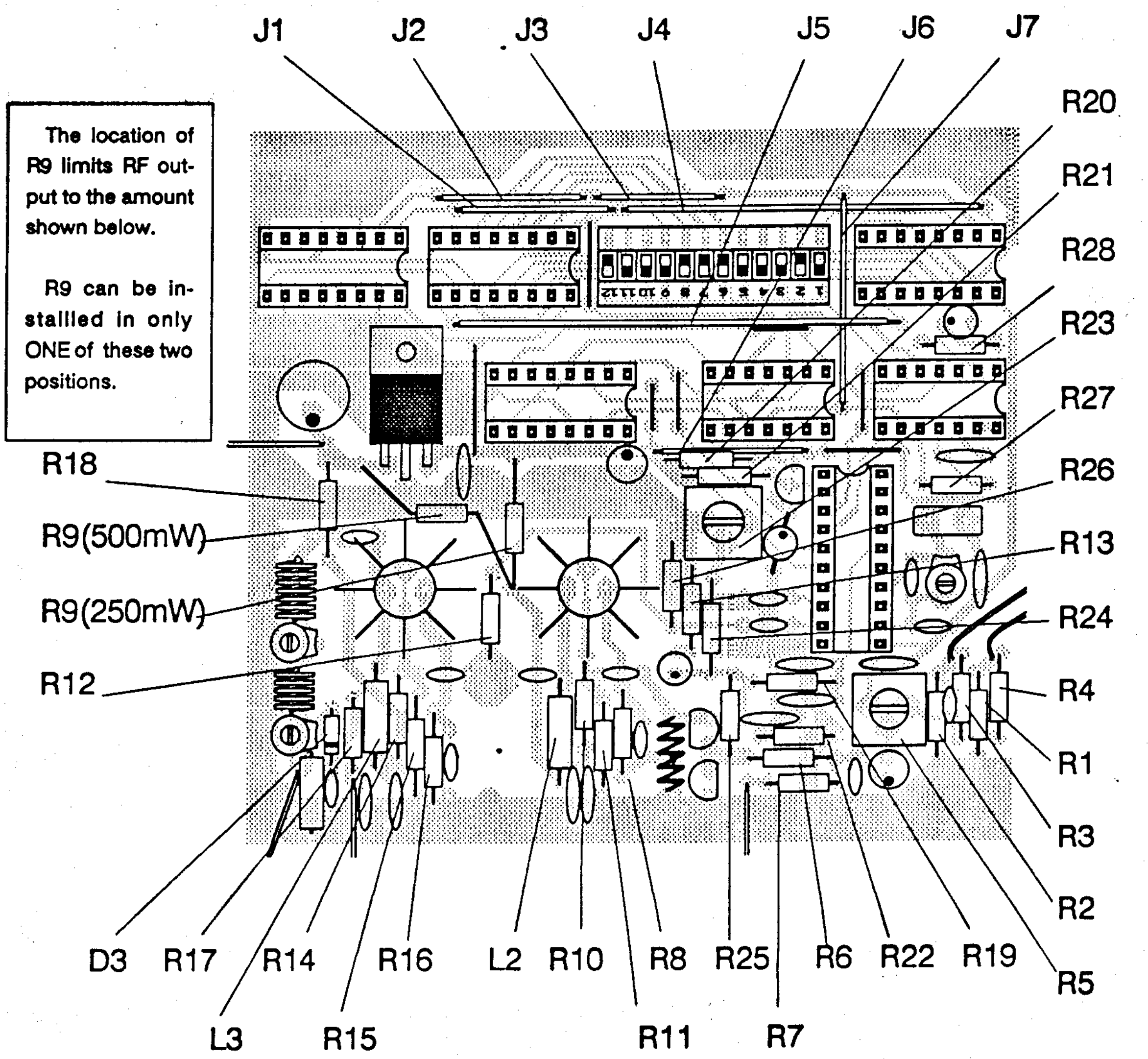

Figure 3 - Assembly Drawing

Now install the capacitors. The electrolytic capacitors (C2, C24, C27, C29) are of the "radial" type - both wires come out the same end. The longer of the two wires is the " + " wire. Be very careful that the " + " wire is installed in the proper hole as shown in the assembly drawing. The positive wire is identified in the drawing as a black dot.

The trimmer capacitors C11, C12, C17 are round on one side and flat on the other. For best performance they should be installed as shown in the drawing. The remainder of the capacitors may be either ceramic discs or miniature poly carbonate types. They may be installed in either direction.

Install trimpots R5 and R23 by holding them firmly against the board. Bend over their leads on the other side of the board to hold them in place. Cut and solder.

See Figure 5 on page 9: Grip 2 leads of Q1 with long nose pliers close to the case. Force a heatsink onto the cap. Do the same to Q2. The three mounting holes in the board should be obvious - they form a "triangle" pattern. Install Q1 and Q2 flat against the board, bend over the leads on the other side... SOLDER QUICKLY, let cool, THEN cut off excess lead length. Carefully rotate the heatsinks so their fins are clear of all other component leads.

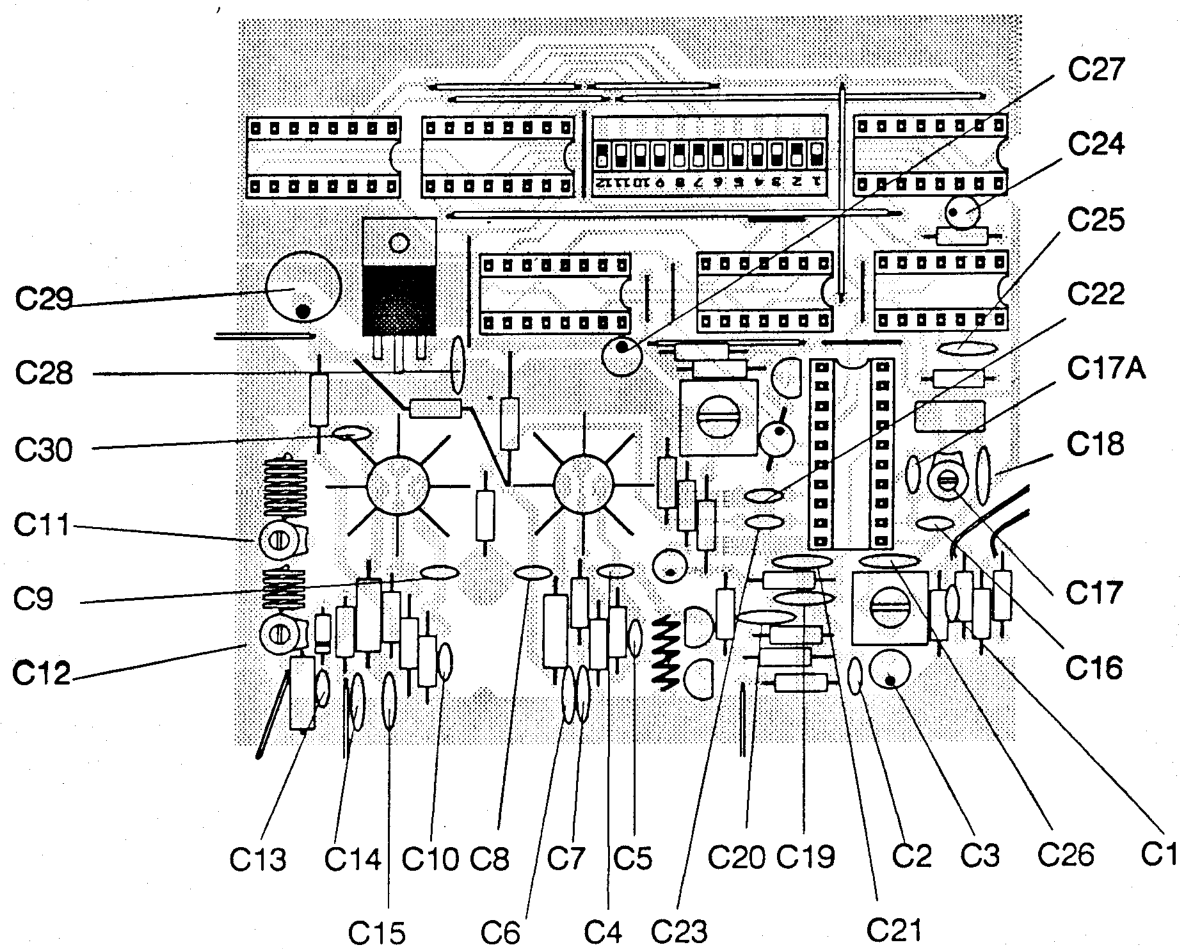

Figure 4 - Assembly Drawing

DS 8907N
PLL CHIP

Install Q3 and the LED. The flat side of Q3 faces away from R23. It should be installed so its bottom is about 1/8th inch above the board. Its emitter pad has two holes - one for its emitter lead, the other for the LED. Very carefully bend the LED leads out to the sides. Install the LONG led wire in the extra hole at Q3's emitter. The shorter LED lead installs in a "ground" hole.

Install D1 and D2 as shown and as close to the board as possible (1/16").

Place the 3 leads of the 7805T in the proper holes then gently bend it's IC body down until it's flat against the board. Align its hole with the hole in the board.

Install the 7 #24 bare wire jumpers.

Solder, THEN remove excess wire.

Now comes some fun stuff. Coil winding and installation. Don't panic, its easy. L1 & L7 are each 5 full turns of #22 bare wire wound on an 1/8th inch drill bit shank. Another piece of the same size wire is placed between the turns at one end and then wound between each of the turns. The wire used for spacing is then unwound leaving each coil with its turns spaced one-diameter apart.

Slip the coils off of the drill. Bend the coil wire ends down so they can be installed in the board. You can get a nice clean bend with long-nose pliers. The coils should be firmly against the board.

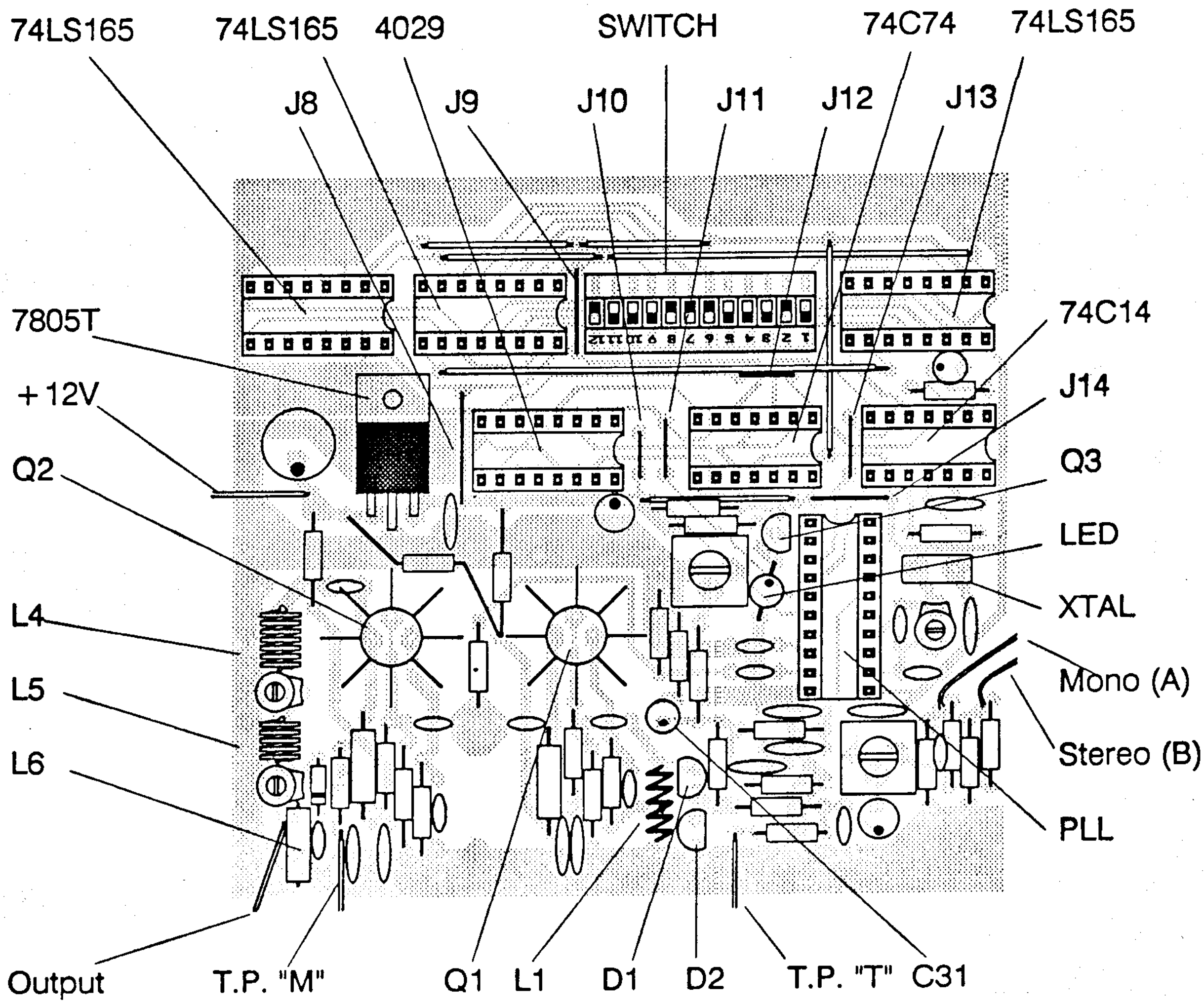

Figure 5 - Assembly Drawing

Take a short piece of #24 bare wire and form a "hook" at one end. Slip the straight end down through the coil and into the "middle" hole under coil L1. The bent end of the wire should hook onto the 2nd coil turn which rests on the board. This is not extremely critical - the middle (2 and 1/2 turns) is ok. Pull the wire snug and bend it over on the foil side of the board to hold it in place.

Hold the coil firmly against the board and solder all three wires. Solder the "hook" to the 2nd turn (or middle) by reaching through the coil's end with your pencil-type soldering iron. You can feed it a little solder from between the coil turns. Cut off the excess lead length. It is important that the coil be installed firmly against the board. Long lead lengths, where the coil is above the board by an 1/8 of an inch or more, can interfere with the PLL being able to lock on frequency. Coil L7 has no tap.

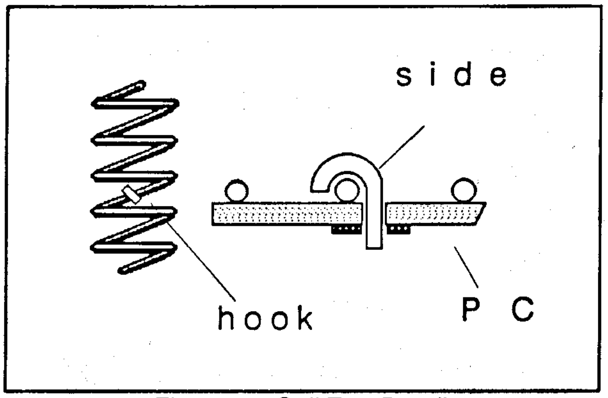

Figure 6 - Coil Tap Detail

Coil L4 consists of 7 turns of #20 solid varnish-insulated wire close-wound on a 1/4" drill shank. Slip the coil off of the drill and bend the coil wire ends down. Use a little emery cloth, fine sand paper, lacquer thinner (fingernail polish remover) etc. to remove the varnish insulation from the wire ends. The insulation may not have to be removed in this manner if you use the "solderable" type varnished wire. It only requires a litle heat and solder to melt away the insulation.Install the coil after the wire ends have been prepared for soldering. Hold it firmly against the board while soldering. Coil L5 is wound the same way but has only 5 turns. Solder in place and remove any excess lead length.

****Congratulations....you're now a full-fledged coil winder and installer*****

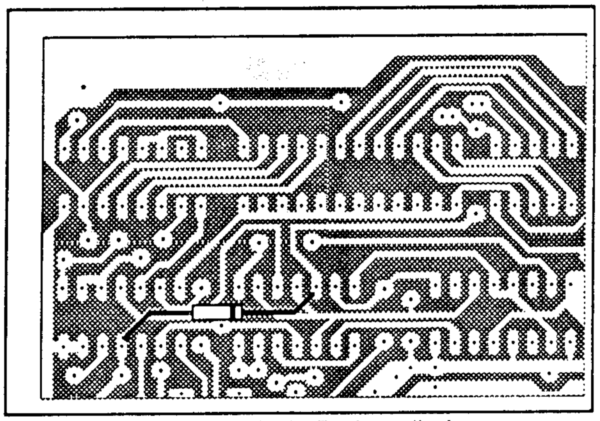

Figure 7 - Diode D4 Installation

Install the DIP switch and sockets. Be sure the switch numbers are as shown in the drawings. Each of the sockets has a half-moon, notch, or some other indication at one end. That end must be installed as shown. Solder.

Diode D4 is installed on the copper side of the board. Strip some insulation from a piece of hook-up wire. Cut it into two pieces almost as long as the leads on D4. Slip the insulation onto the D4 leads. Install (solder) D4 (observe banded end) between the IC socket pins shown in the assembly drawing.

Each of the connecting wires can now be installed. You may insert them from the top or tack solder then on the bottom if you don't want them to be seen from the top. You can also use small solder terminals if you like. Wires are insulated #24 at least 6" long. To be conventional the +12 volt wire should be color coded RED, the other wires however may be whatever color you wish. (solder)

Last of all install the crystal. Put the leads all they way in from the top side of the board so the base of the crystal can is against the board. Bend the leads over to hold the crystal in place. DO NOT CUT THE WIRES YET - SOLDER FIRST, COOL, then you may cut off excess lead length.

Inspect the board carefully. Look for possible solder bridges, cold joints (they look dull in color), and unsoldered points. Check that all parts are in the right places. Clean the board with a flux "stripper" or alcohol and a stiff bristled brush. You are now ready for testing.

PRE-FLIGHT TESTING

Without the IC's in place, connect your 12 volt power supply. Set R23 to about mid-range. Tune your FM radio receiver to the middle of the band (100 MHz). You should be able to find your "carrier" - it will produce a "quiet" spot on your dial. Adjustment of R23 should take the carrier all the way down to 87 MHz and all the way up to 109 MHz. The LED should be glowing. Turn off the power supply and go to the next step.

The IC's can now be put in their sockets. **CAUTION::::** be sure they are in their sockets in the right direction...observe the half-moon marking at the ends...if installed wrong they can be damaged. If there is no half-moon then look for a small hole next to pin 1. The leads are sometimes spread too far out to fit in the socket properly. This can be corrected by holding the IC with one row of pins against a flat surface and pressing down. This will bend the row of pins together all at once so they won't be misaligned.

Turn on the power supply. Check to see if anything gets very hot, or smokes..if so turn things off and find out why! The PLL and the 7805T voltage regulator get warm to hot which is ok - VERY hot is not ok. They will also tend to get hotter if you leave your finger touching them (heat can't escape). Switch off the power supply and read over the next section.

OPERATION AND TESTING

For best operation the FME-500 should be in a metal enclosure. Each corner of the pc board should be grounded to the enclosure with metal spacers and 4-40 screws. The voltage regulator should also have a metal spacer and screw connecting it to the metal enclosure.

All wires, with the exception of the antenna wire, should be RF by-passed if they enter or leave the enclosure. This is done with "feed through" capacitors for each wire. If you do not use feed through caps then at least connect a .1 uF capacitor between each wire and the enclosure (except for audio wires - use .001 uF). Additional RF suppression can be obtained by slipping ferrite beads over each of the wires. All of this is done INSIDE of the enclosure.

Connect a dummy load to the antenna wire (output jack). Any CB type dummy load can be used. A simple 47 or 51 ohm resistor connected from the center pin of of the jack to ground will work. Keep the leads short...

Set the programming switches for your desired frequency. Refer to "theory" for checking auto-reset and digital message.

Listen to your radio. You should find a carrier at your desired frequency. If not, check the PLL error voltage.... Connect a 20,000 ohm/volt multi-meter between circuit ground and test point "T". You should get a reading of between +1 and +3.5 volts. Also refer back to the "theory" section as an aid to finding out what's wrong. If the error voltage is below .5 volt or above 3.5 volts then the PLL is not locked. Under these conditions any carrier found may have whistles, buzz, etc.

You should be able to put your finger on the top of Q1 and still hear your frequency at the same spot on the dial. If the frequency shifts when you touch Q1 then the PLL is probably not locked.

If the PLL doesn't lock try adjusting trimmer capacitor C17 (reference oscillator adjust). The oscillator may "drop out" at certain settings of C17. Simply adjust C17 until the oscillator starts working again. Also try adjusting R23 (main oscillator trim).

Check possible wiring, soldering, and component placement if the PLL doesn't lock. If no visual problems are found then you may have to troubleshoot the problem with an oscilloscope. Very careful assembly usually results in a working unit the first time.

Next check the output tuning. Still with the dummy load connected, connect your voltmeter between circuit common (ground) and test point "M". Adjust trimmer capacitor C12 and C11 for maximum voltage output.

The following voltages and output loads indicate approximate output power in milliwatts:

Volts	50 Ohms	75 Ohms
2	80	53
3	180	120
4	320	213
5	500	333

PROGRAMMING YOUR FREQUENCY

There are 12 switches used for setting your frequency. Refer to the "theory" section for more information. The number of the switch represents the division code to be used, thus:

Switch	Division By	Frequency	
12	4096	102.4	MHz
11	2048	51.2	MHz
10	1024	25.6	MHz
9	512	12.8	MHz
8	256	6.4	MHz
7	128	3.2	MHz
6	64	1.6	MHz
5	32	800	KHz
4	16	400	KHz
3	8	200	KHz
2	4	100	KHz
1	2	50	KHz

Your frequency's INDEX NUMBER is found by the formula: (freq-.025)/.025 where freq is in MHz.

Example: $\frac{107.9 - .025}{.025} = 4315$

To determine which switches should be ON you subtract the "division by" from the "index" and each "remainder" until there is nothing left to subtract like so: (Also see page 13 switch codes)

		Switch
4315-4096	=219	12
219 - 128	= 91	7
91 - 64	= 27	6
27 - 16	=11	4
11 - 8	=3	3
3 - 2	=1	1
1		

The setting would be: 1,0,0,0,0,1,1,0,1,1,0,1 as shown on page 13 switch codes. **NOTE:** The assembly drawings show the setting for 91.1 MHz

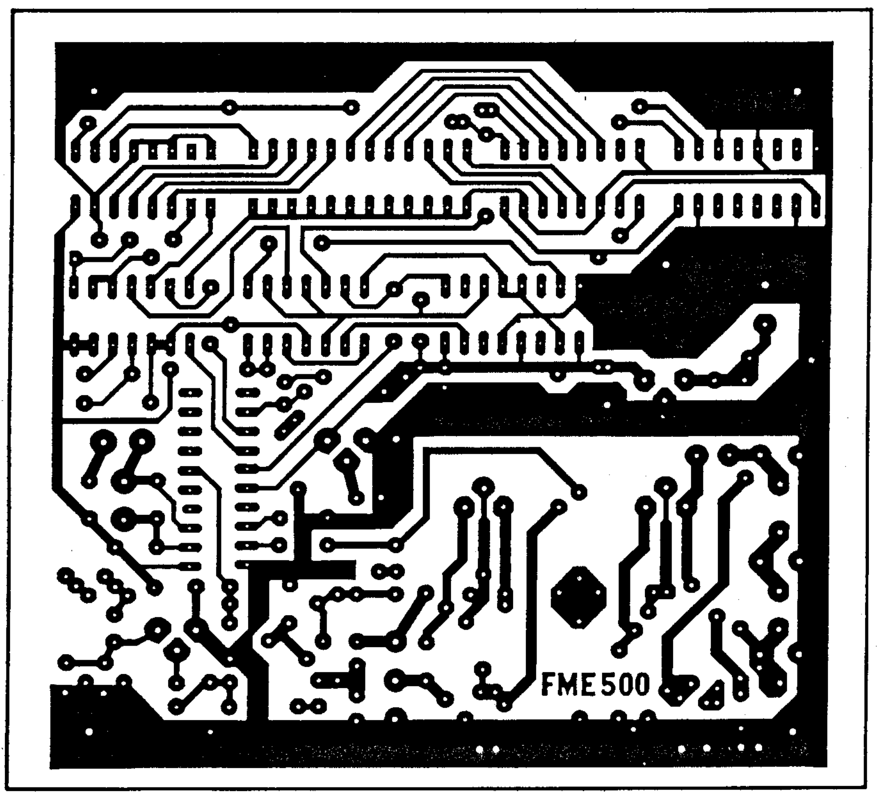

Figure 8 - Full-Size Printed Circuit Artwork

When this unit is used with a cable system its output should be attenuated to match the input level of that cable system. A low-pass RFI FILTER should be placed between the FME-500 and a non-resonant load such as a cable system. An RF attenuator may also be required to reduce the output to the proper level for the cable system. Check with the cable technicians to determine their signal level requirements.

You have just finished a fairly complex piece of equipment. It should give you many hours of enjoyment if you use it wisely.

SWITCH CODES FOR STANDARD FREQUENCIES

The previous examples may be used for determining "between channel" frequencies. For standard channel frequencies you can use the following table:

FREQUENCY	SWITCH CODE 12	11	10	9	8	7	6	5	4	3	2	1
87.1	0	1	1	0	1	1	0	0	1	1	0	1
87.3	0	1	1	0	1	1	0	1	0	0	0	1
87.5	0	1	1	0	1	1	0	1	0	1	0	1
87.7	0	1	1	0	1	1	0	1	1	0	0	1
87.9	0	1	1	0	1	1	0	1	1	1	0	1
88.1	0	1	1	0	1	1	1	0	0	0	0	1
88.3	0	1	1	0	1	1	1	0	0	1	0	1
88.5	0	1	1	0	1	1	1	0	1	0	0	1
88.7	0	1	1	0	1	1	1	0	1	1	0	1
88.9	0	1	1	0	1	1	1	1	0	0	0	1
89.1	0	1	1	0	1	1	1	1	0	1	0	1
89.3	0	1	1	0	1	1	1	1	1	0	0	1
89.5	0	1	1	0	1	1	1	1	1	1	0	1
89.7	0	1	1	1	0	0	0	0	0	0	0	1
89.9	0	1	1	1	0	0	0	0	0	1	0	1
90.1	0	1	1	1	0	0	0	0	1	0	0	1
90.3	0	1	1	1	0	0	0	0	1	1	0	1
90.5	0	1	1	1	0	0	0	1	0	0	0	1
90.7	0	1	1	1	0	0	0	1	0	1	0	1
90.9	0	1	1	1	0	0	0	1	1	0	0	1
91.1	0	1	1	1	0	0	0	1	1	1	0	1
91.3	0	1	1	1	0	0	1	0	0	0	0	1
91.5	0	1	1	1	0	0	1	0	0	1	0	1
91.7	0	1	1	1	0	0	1	0	1	0	0	1
91.9	0	1	1	1	0	0	1	0	1	1	0	1
92.1	0	1	1	1	0	0	1	1	0	0	0	1
92.3	0	1	1	1	0	0	1	1	0	1	0	1
92.5	0	1	1	1	0	0	1	1	1	0	0	1
92.7	0	1	1	1	0	0	1	1	1	1	0	1
92.9	0	1	1	1	0	1	0	0	0	0	0	1
93.1	0	1	1	1	0	1	0	0	0	1	0	1
93.3	0	1	1	1	0	1	0	0	1	0	0	1
93.5	0	1	1	1	0	1	0	0	1	1	0	1
93.7	0	1	1	1	0	1	0	1	0	0	0	1
93.9	0	1	1	1	0	1	0	1	0	1	0	1
94.1	0	1	1	1	0	1	0	1	1	0	0	1
94.3	0	1	1	1	0	1	0	1	1	1	0	1
94.5	0	1	1	1	0	1	1	0	0	0	0	1
94.7	0	1	1	1	0	1	1	0	0	1	0	1
94.9	0	1	1	1	0	1	1	0	1	0	0	1
95.1	0	1	1	1	0	1	1	0	1	1	0	1
95.3	0	1	1	1	0	1	1	1	0	0	0	1
95.5	0	1	1	1	0	1	1	1	0	1	0	1
95.7	0	1	1	1	0	1	1	1	1	0	0	1
95.9	0	1	1	1	0	1	1	1	1	1	0	1
96.1	0	1	1	1	1	0	0	0	0	0	0	1
96.3	0	1	1	1	1	0	0	0	0	1	0	1
96.5	0	1	1	1	1	0	0	0	1	0	0	1
96.7	0	1	1	1	1	0	0	0	1	1	0	1
96.9	0	1	1	1	1	0	0	1	0	0	0	1
97.1	0	1	1	1	1	0	0	1	0	1	0	1
97.3	0	1	1	1	1	0	0	1	1	0	0	1
97.5	0	1	1	1	1	0	0	1	1	1	0	1
97.7	0	1	1	1	1	0	1	0	0	0	0	1
97.9	0	1	1	1	1	0	1	0	0	1	0	1

Ok

FREQUENCY	SWITCH CODE 12	11	10	9	8	7	6	5	4	3	2	1
98.1	0	1	1	1	1	0	1	0	1	0	0	1
98.3	0	1	1	1	1	0	1	0	1	1	0	1
98.5	0	1	1	1	1	0	1	1	0	0	0	1
98.7	0	1	1	1	1	0	1	1	0	1	0	1
98.9	0	1	1	1	1	0	1	1	1	0	0	1
99.1	0	1	1	1	1	0	1	1	1	1	0	1
99.3	0	1	1	1	1	1	0	0	0	0	0	1
99.5	0	1	1	1	1	1	0	0	0	1	0	1
99.7	0	1	1	1	1	1	0	0	1	0	0	1
99.9	0	1	1	1	1	1	0	0	1	1	0	1
100.1	0	1	1	1	1	1	0	1	0	0	0	1
100.3	0	1	1	1	1	1	0	1	0	1	0	1
100.5	0	1	1	1	1	1	0	1	1	0	0	1
100.7	0	1	1	1	1	1	0	1	1	1	0	1
100.9	0	1	1	1	1	1	1	0	0	0	0	1
101.1	0	1	1	1	1	1	1	0	0	1	0	1
101.3	0	1	1	1	1	1	1	0	1	0	0	1
101.5	0	1	1	1	1	1	1	0	1	1	0	1
101.7	0	1	1	1	1	1	1	1	0	0	0	1
101.9	0	1	1	1	1	1	1	1	0	1	0	1
102.1	0	1	1	1	1	1	1	1	1	0	0	1
102.3	0	1	1	1	1	1	1	1	1	1	0	1
102.5	1	0	0	0	0	0	0	0	0	0	0	1
102.7	1	0	0	0	0	0	0	0	0	1	0	1
102.9	1	0	0	0	0	0	0	0	1	0	0	1
103.1	1	0	0	0	0	0	0	0	1	1	0	1
103.3	1	0	0	0	0	0	0	1	0	0	0	1
103.5	1	0	0	0	0	0	0	1	0	1	0	1
103.7	1	0	0	0	0	0	0	1	1	0	0	1
103.9	1	0	0	0	0	0	0	1	1	1	0	1
104.1	1	0	0	0	0	0	1	0	0	0	0	1
104.3	1	0	0	0	0	0	1	0	0	1	0	1
104.5	1	0	0	0	0	0	1	0	1	0	0	1
104.7	1	0	0	0	0	0	1	0	1	1	0	1
104.9	1	0	0	0	0	0	1	1	0	0	0	1
105.1	1	0	0	0	0	0	1	1	0	1	0	1
105.3	1	0	0	0	0	0	1	1	1	0	0	1
105.5	1	0	0	0	0	0	1	1	1	1	0	1
105.7	1	0	0	0	0	1	0	0	0	0	0	1
105.9	1	0	0	0	0	1	0	0	0	1	0	1
106.1	1	0	0	0	0	1	0	0	1	0	0	1
106.3	1	0	0	0	0	1	0	0	1	1	0	1
106.5	1	0	0	0	0	1	0	1	0	0	0	1
106.7	1	0	0	0	0	1	0	1	0	1	0	1
106.9	1	0	0	0	0	1	0	1	1	0	0	1
107.1	1	0	0	0	0	1	0	1	1	1	0	1
107.3	1	0	0	0	0	1	1	0	0	0	0	1
107.5	1	0	0	0	0	1	1	0	0	1	0	1
107.7	1	0	0	0	0	1	1	0	1	0	0	1
107.9	1	0	0	0	0	1	1	0	1	1	0	1
108.1	1	0	0	0	0	1	1	1	0	0	0	1
108.3	1	0	0	0	0	1	1	1	0	1	0	1
108.5	1	0	0	0	0	1	1	1	1	0	0	1
108.7	1	0	0	0	0	1	1	1	1	1	0	1
108.9	1	0	0	0	1	0	0	0	0	0	0	1

Ok