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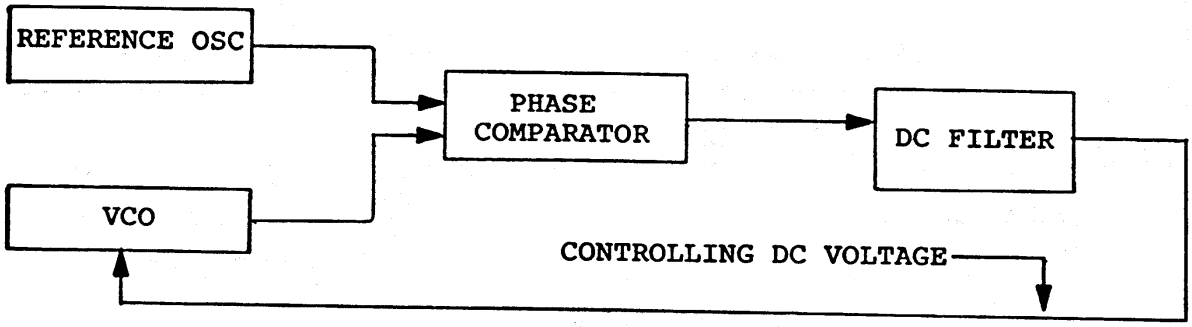
Model 40 Plus

OPERATING THEORY OF PLL FREQUENCY SYNTHESIZER
FOR MODEL 40 PLUS

1. Fundamental Theory Of PLL Circuitry

The purpose of PLL (Phase Locked Loop) circuit is to generate multiple number programable frequencies from a signal reference frequency with quartz crystal accuracy.

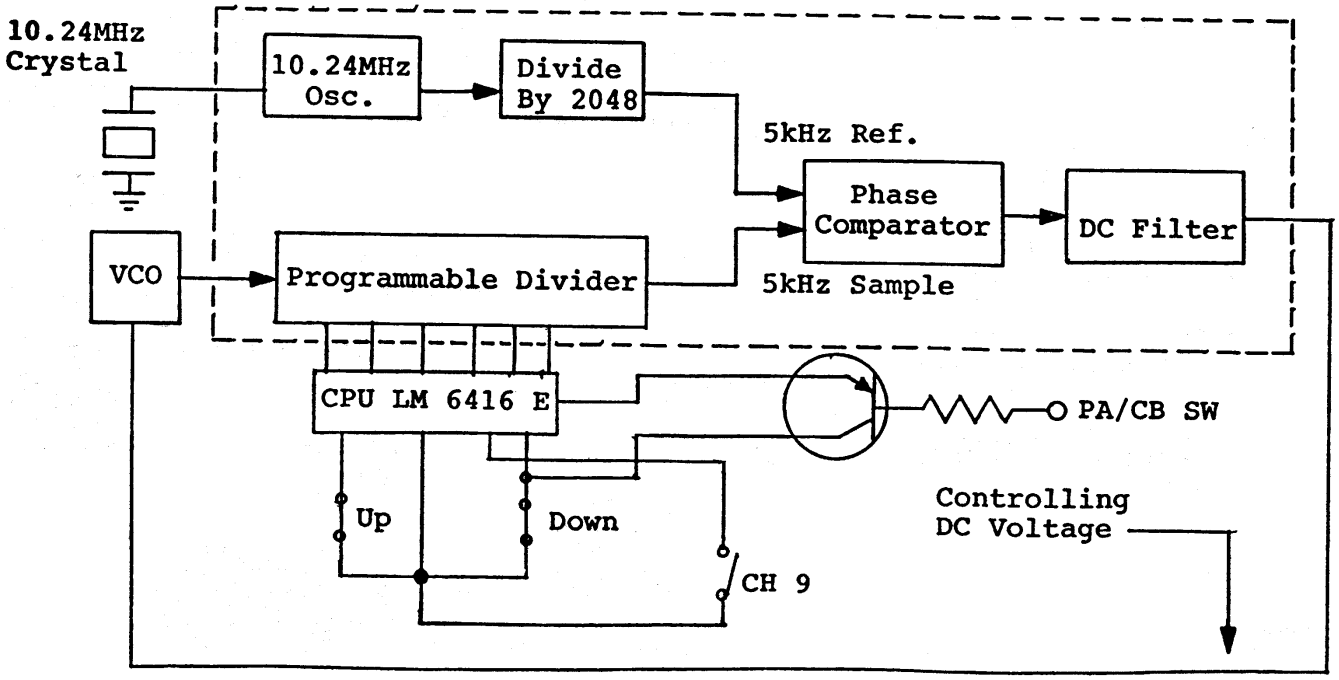
A basic PLL circuit consists of reference oscillator, VCO, phase comparator and DC filter (low pass filter).



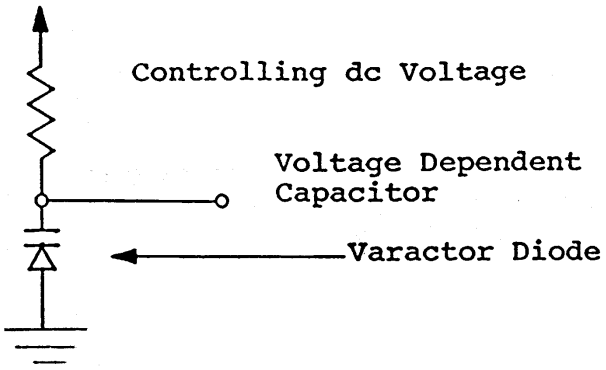
With the above circuit the VCO (Voltage Controlled Oscillator) frequency is effectively locked to the reference oscillator, and its accuracy is as good as the reference oscillator.

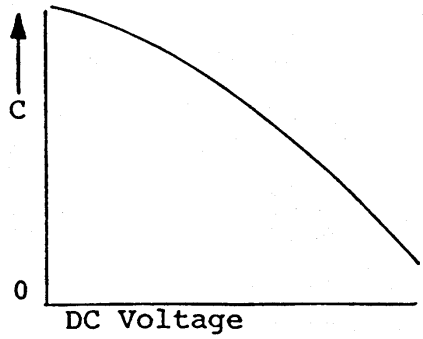
Since the CB radio's adjacent channel spacing is 10 kHz (or multiple of 5 kHz), our purpose should be to produce multiples of programable frequencies that are spaced apart by 10 kHz.

Therefore the basic PLL circuitry is expanded as follow:



The most important part of VCO circuitry is a voltage controlled variable capacitor called varicap or varactor diode whose capacitance depends on DC voltage applied to its cathode.





The varactor diode is responsible for setting VCO frequency, and once set it regulates the VCO frequency against the reference. The VCO frequencies are chosen in 16 to 17 MHz range as shown on table 1. To obtain transmit signal the VCO is mixed with 10.24MHz. As an example for channel 1:
10.24 + 16.725 = 26.965MHz

For receiver mode the VCO is used as a first local oscillator. Example, channel 1:
26.965 - 16.27 = 10.695MHz

The above first IF of 10.695MHz is mixed again with 10.24MHz crystal oscillator frequency which serves as the second local oscillator.
10.695 - 10.24 = 0.455MHz

As can be seen above the VCO frequency shifts from 16.725 to 16.27MHz when changed from transmit to receive for the same channel 1. The shift is accomplished by "read only memory" incorporated inside the PLL IC-202 between the selector switch and the VCO divider (programable). When transmit logic signal is applied to the IC-202 through pin 19, the programable divider will divide incoming VCO frequency by 3345 to produce 5kHz sampling signal. 16,725 ÷ 3345 = 5kHz

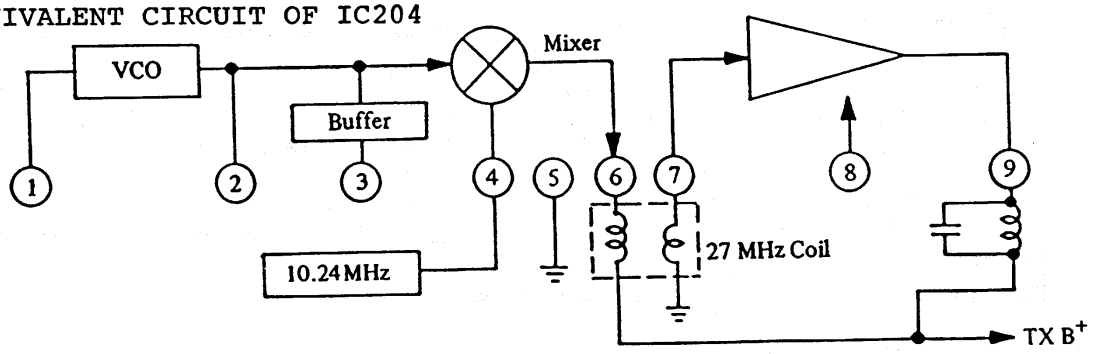
For the receiver mode the programable divider will automatically change to divide the VCO frequency by 3254.
16270 ÷ 3254 = 5kHz

Note that the reference frequency of 5kHz is obtained by dividing the 10.24MHz by 2048 times. (5kHz reference is used instead of 10kHz for division convenience). See table 1 for transmit/receive mode VCO frequencies.

2. Transmitter Circuit

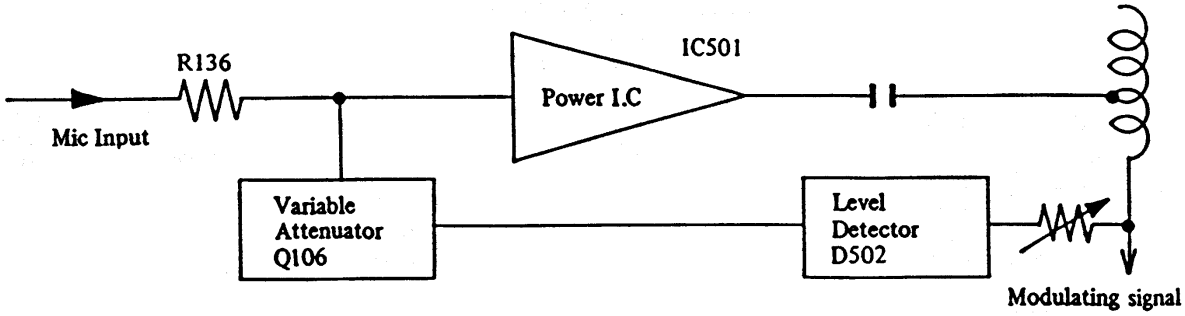
IC203 (PLL-LSI), VCO section of IC203 (pins 1,2, and 3) are operational regardless of the receive or transmit mode. When the radio is set to the transmit mode, mixer/amplifier section of IC204 (pins 4,6,7 and 9), Q203, Q301, Q302 and Q303 are activated. The VCO frequency selected by the microprocessor is mixed with 10.24MHz to generate desired transmit frequency. The mixing is done by a balanced mixer circuit located inside the IC203.

EQUIVALENT CIRCUIT OF IC204



The resulting transmit frequency from pin 9 of IC204 is filtered by L301 and L302. Q301 is an amplifier/switch circuit. When VCO frequency is out of "LOCK" condition pin 14 of IC202 pulls down bias voltage of Q301 to ground disabling Q301 from passing possible illegal frequencies. Q302 is a RF power driver circuit and Q303 is the final RF power amplifier.

A modulation audio signal is applied to the collectors of Q302 and Q303 through an audio power transformer T201. The audio signal (mic input) is amplified by a single power IC206. The modulation limiting is accomplished by an automatic level control circuit which is as follows:



L305 and C339 are series resonator, and L306, L307, C361, and C342 make up PI-LOW pass filter. C335 is factory selected and limits the RF output level to within the FCC limit of 4 watts.

3. Receiver Circuit

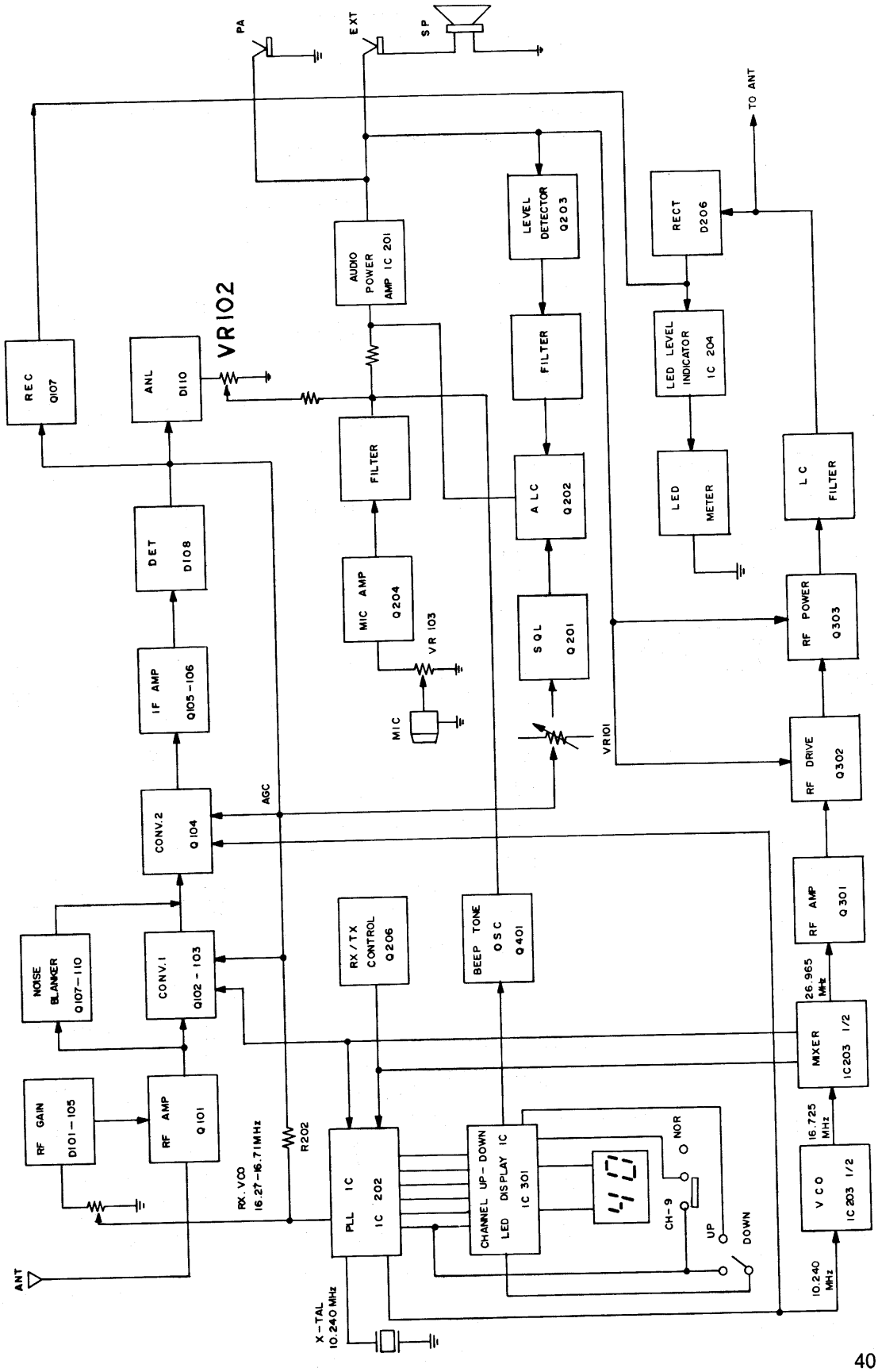
In the receiver mode of operation, Q206 transistor is turned off. Also bias voltage is applied to Q105 and a proper bias and AGC voltage is established to Q101, Q102, Q103 and Q105. Q101 is a 27MHz RF input amplifier and any excessive input signal is limited by diodes D101 and D105. The amplified 27MHz is mixed with VCO frequency selected by channel switch. For channel 1 VCO is set at 16.27MHz. The resulting first IF is 26.965 - 16.27 = 10.695MHz. Q102 and Q103 is the first converter, and the 10.695MHz is sharply filtered by L103 and a ceramic filter CF1. The first IF is again mixed with a second local oscillator of 10.24MHz. 10.695 - 10.24 = 0.455MHz. Q104 is the second converter and the 455kHz. Second IF is filtered by a razor sharp ceramic filter of CF2 coupled with L105. Q105 is a first 455kHz amplifier, with Q106 being the last amplifier. D108 is a detector diode which produces audio signal as well as a negative DC voltage for AGC action. The negative voltage also provides forward biasing to the cathode of ANL clipping diode of D110. The biasing voltage has a time constant determined by R126 and C121. Therefore, any sharp negative going pulse from D108 will back bias D110 and be clipped.

4. Channel Up/Down Operation

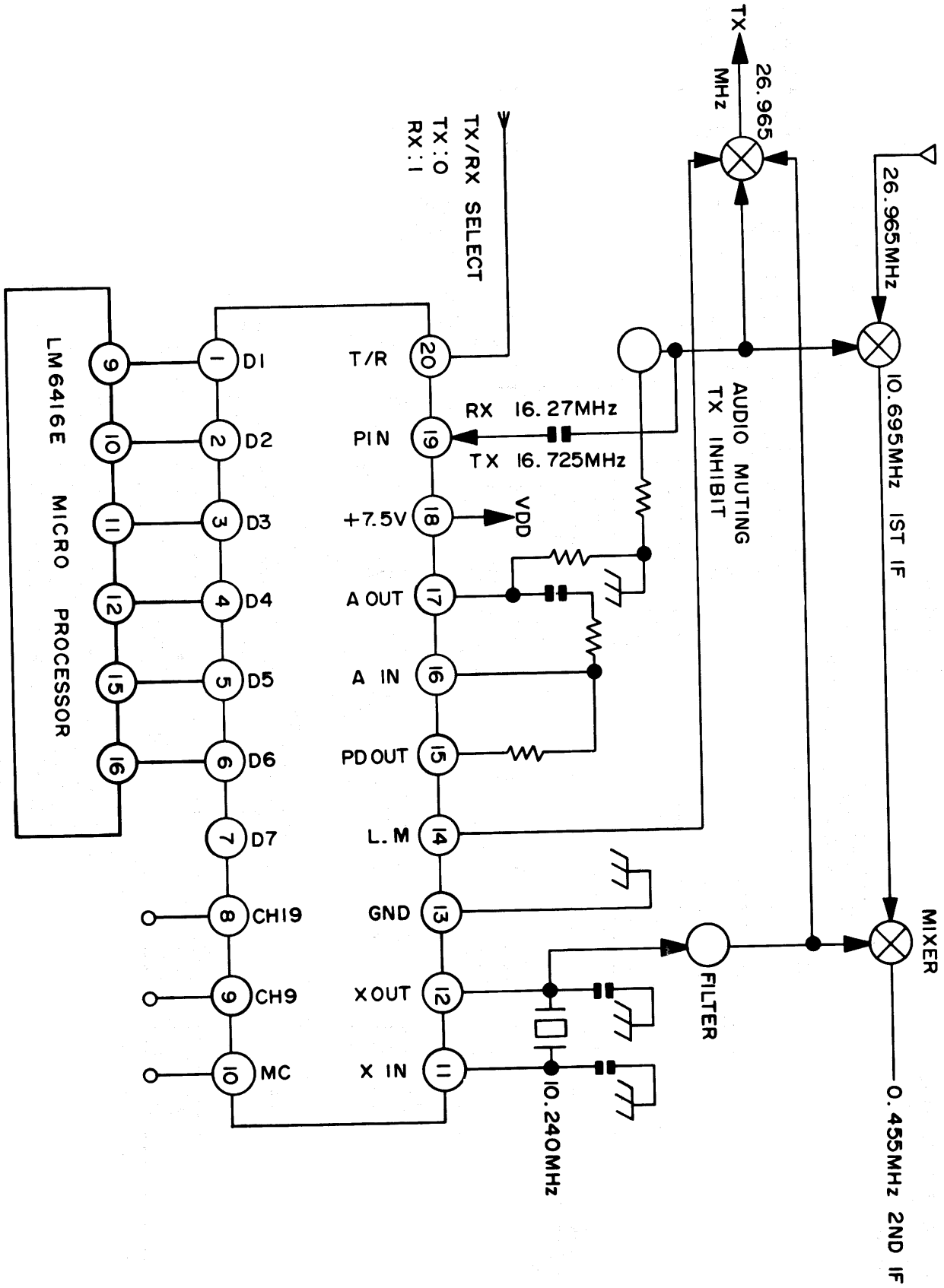
The PLL (TX/RX) frequency, channel number display, channel 9 select, and PA/CB mode select functions are controlled by a 4 bit microprocessor. The controls for channel selection are the Up and Down push buttons located on the front panel. Depending upon which button is pressed, instructions are given to the microprocessor to change the PLL frequency to the next channel. If the button is kept in the depressed position for approximately 1.2 seconds the microprocessor will then scan through the channels at a rate of approximately 5 channels per second.

During channel selection or scan function, the microprocessor inhibits the transmitter section of the unit, to prevent undesired signals from being radiated.

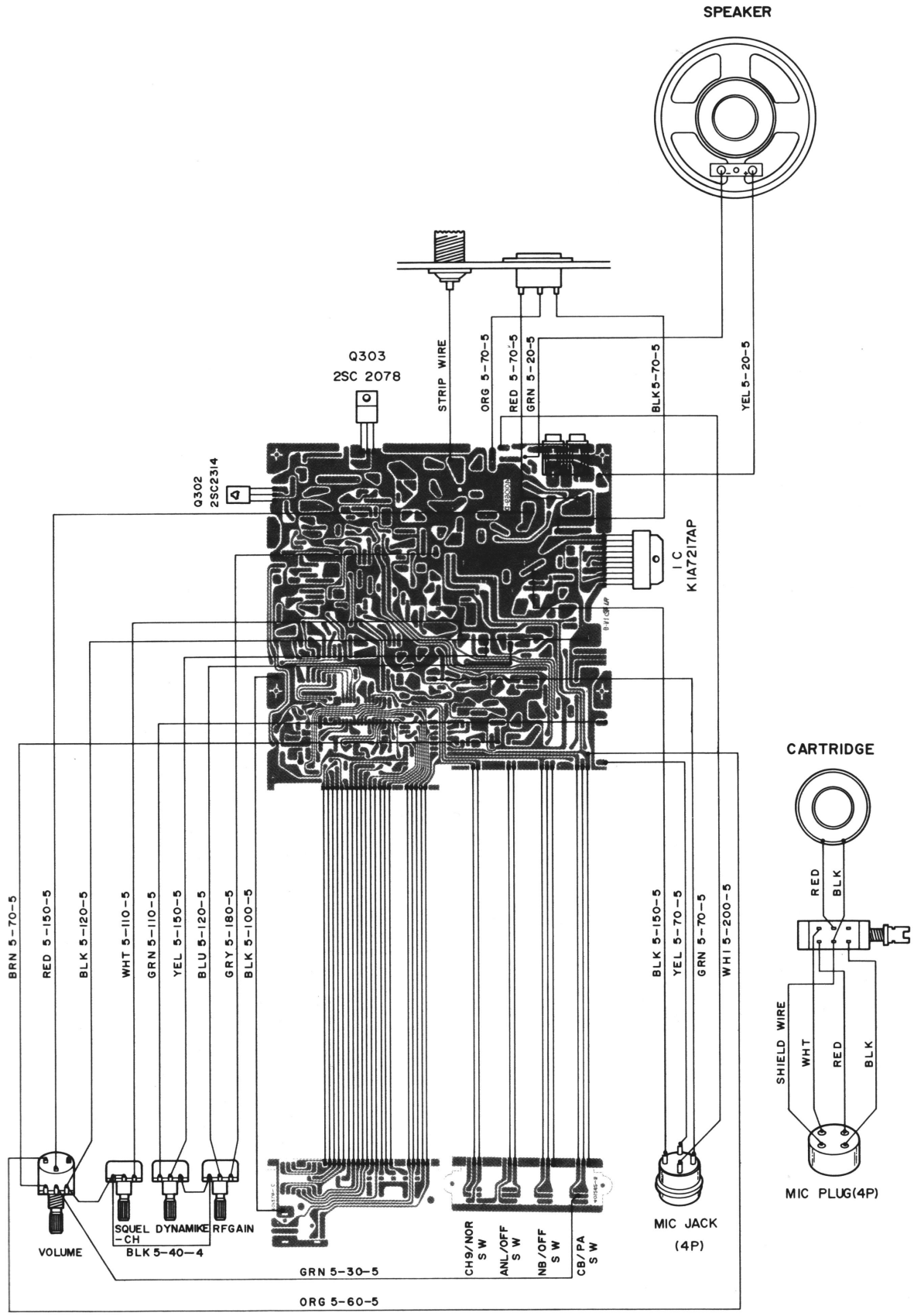
Block Diagram



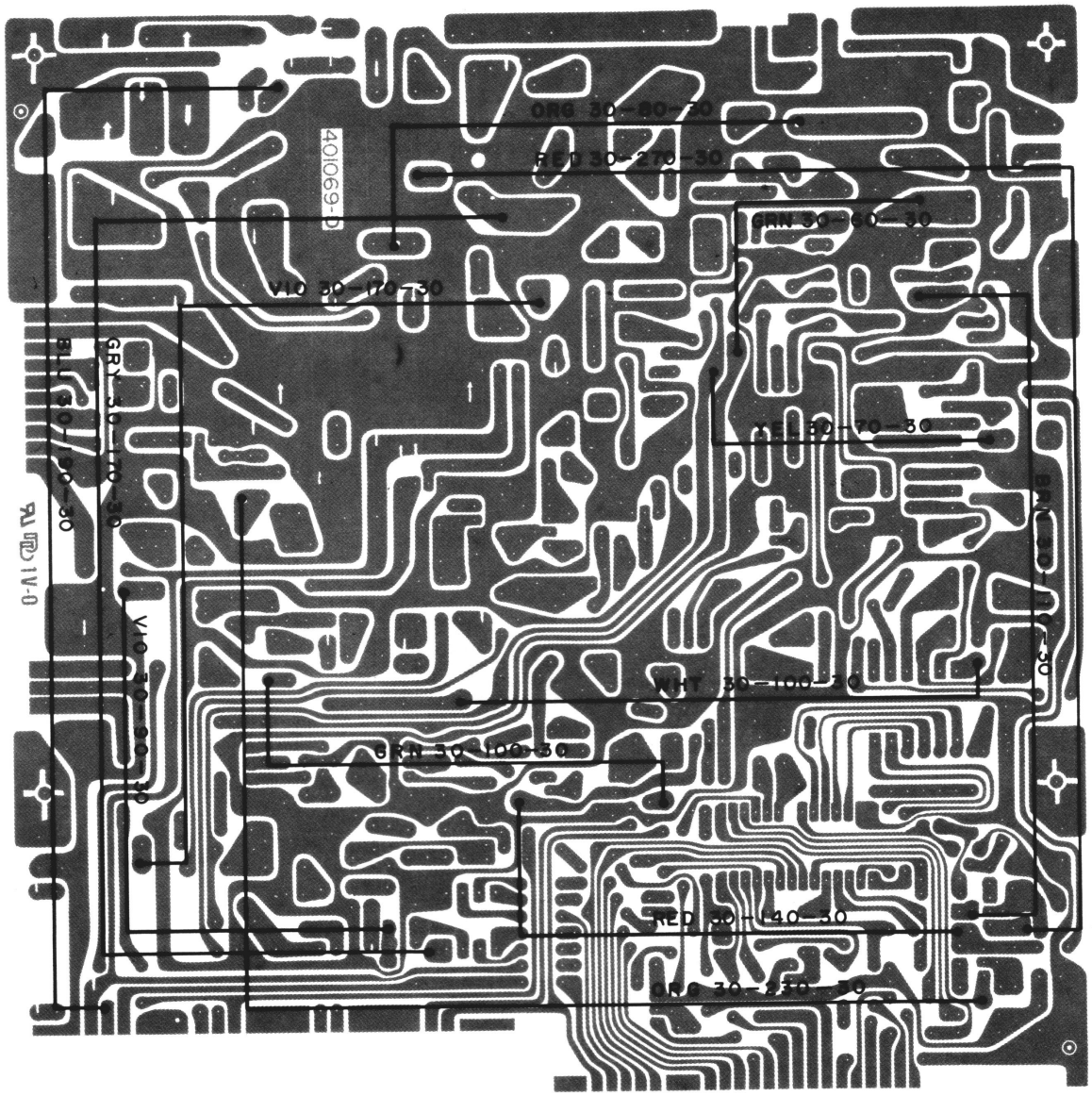
PLL Circuit Block Diagram



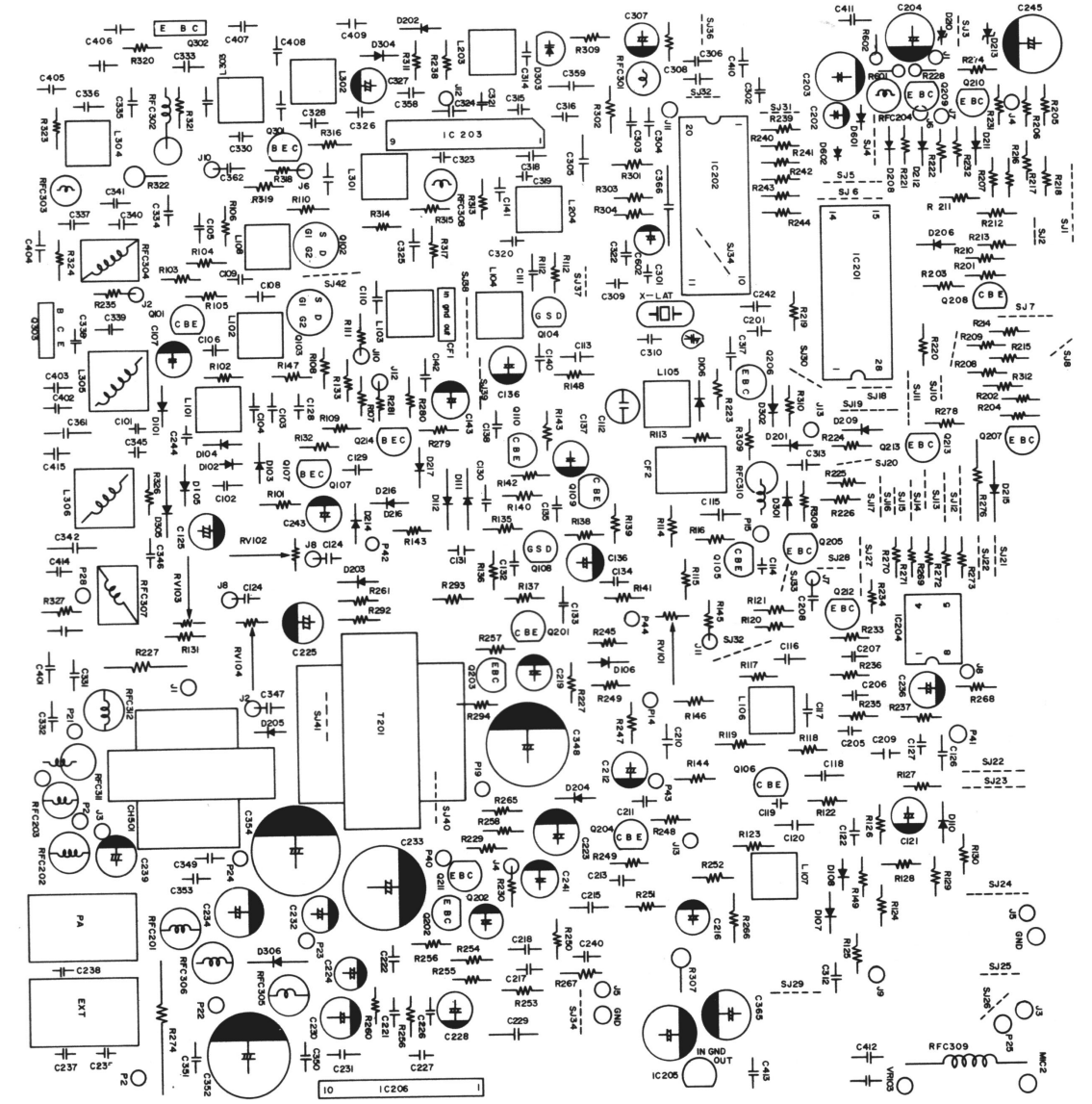
Wiring Diagram

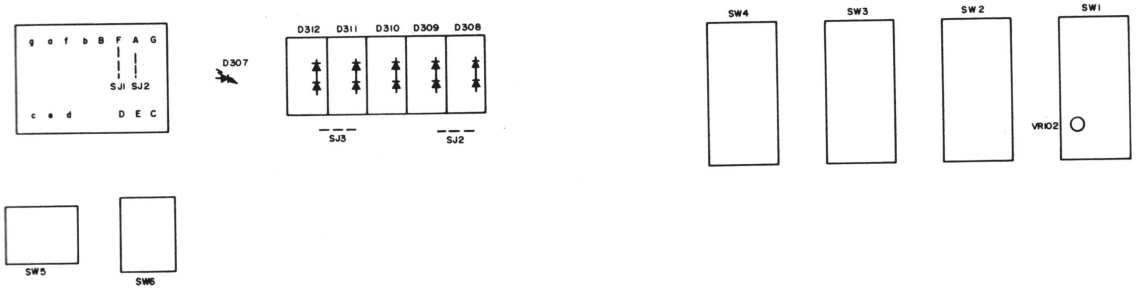


P.C.B Wiring Diagram

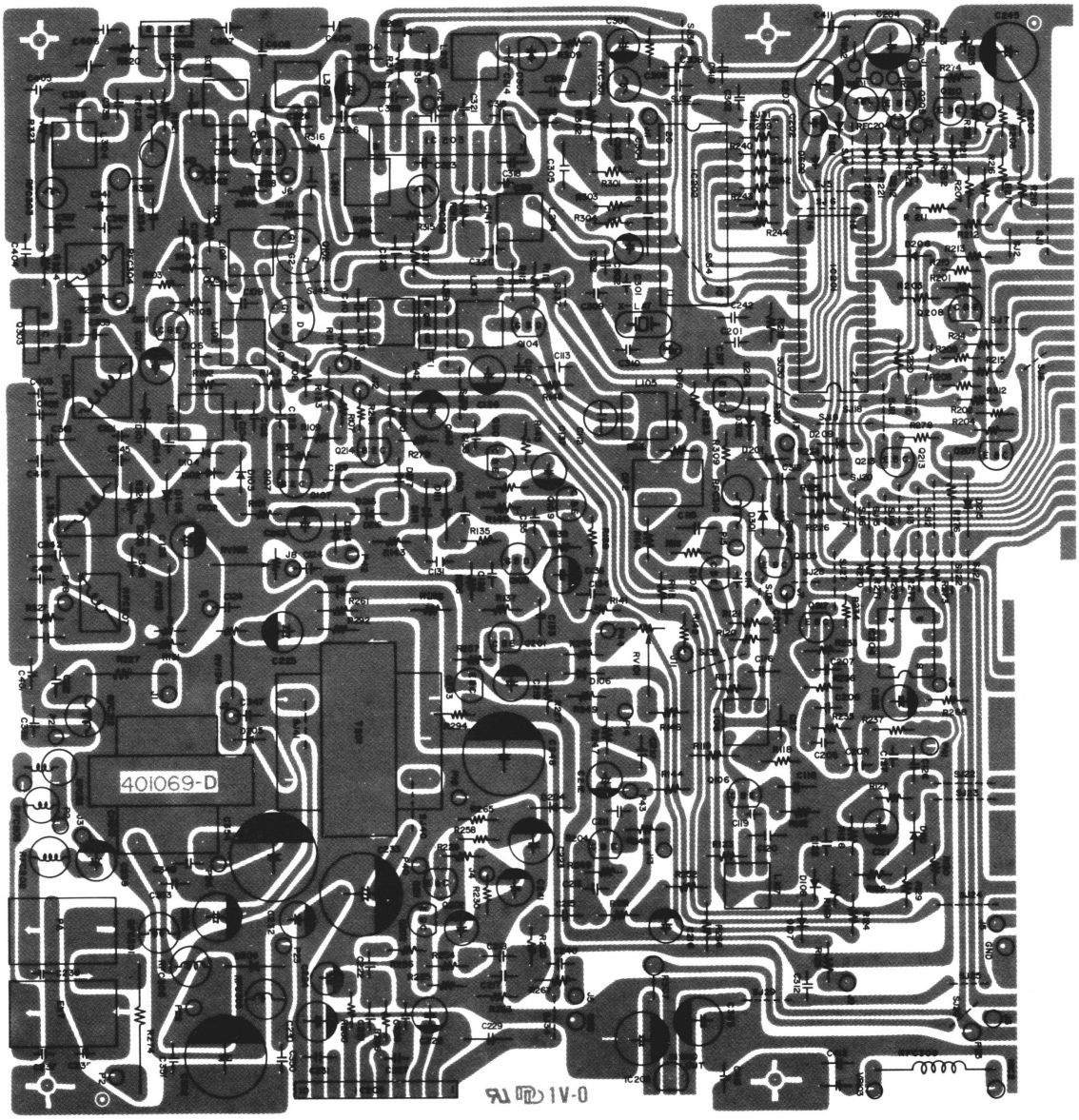


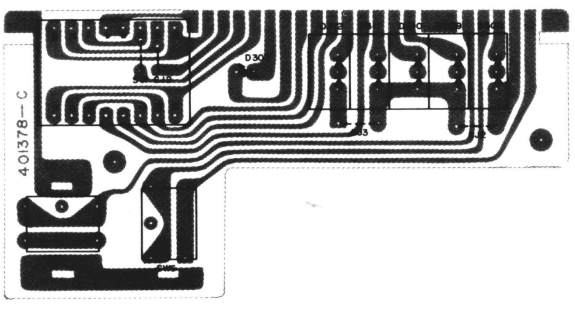
Bottom View

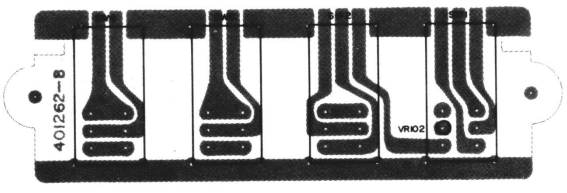

IC 203
IC202
IC201
IC204
IC205
IC206
T201
X-LAT
IN GND OUT
PA
EXT
SJ41
SJ40


g a f b B F A G
SJ1 SJ2
c e d D E C
D307
D312 D311 D310 D309 D308
SJ3
SJ2
SW4
SW3
SW2
SW1
VR102
SW5
SW6

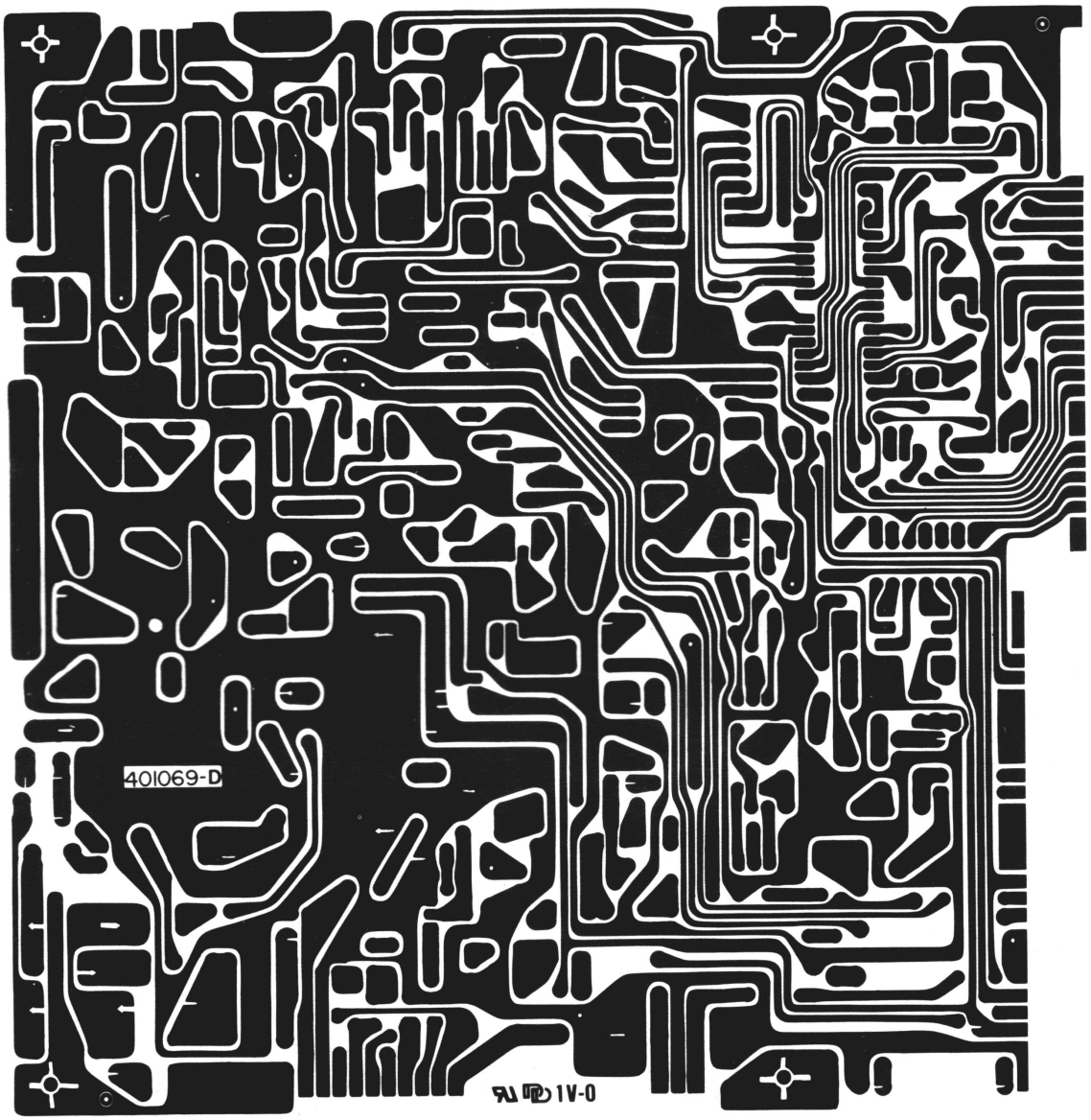
Bottom View

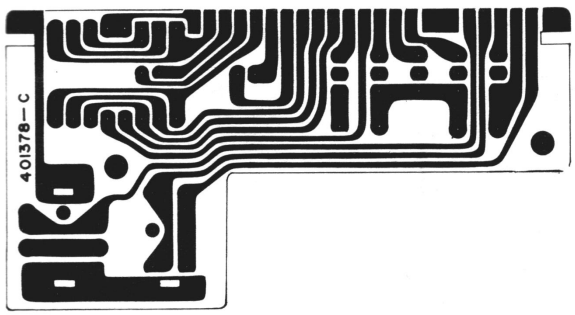


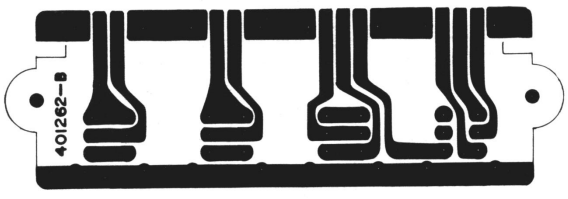




COPPER PATTERN

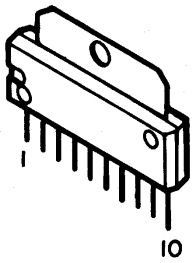




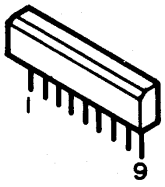


● INTEGRATED CIRCUITS

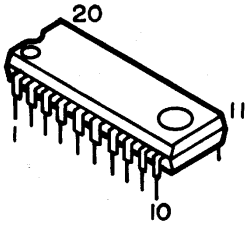
KIA7217AP



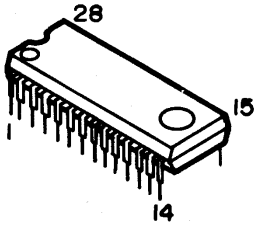
TA7310P OR AN103



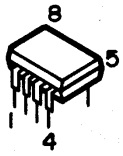
LC7131



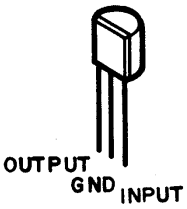
LM6416(E)



TL489CP



MC78L08CT



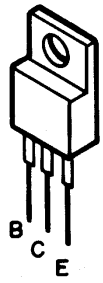
● TRANSISTORS

MPS9418
MPS9623
MPS9631
MPS9634
MPS9681

MPS9426

2SC1957 OR
2SC2314

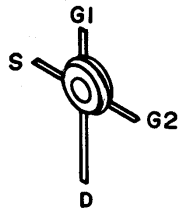
2SC2078 OR
2SC1306



● FET

JF1033S

BF964A



● DIODES

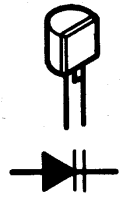
IN4002
IS2473
0A90

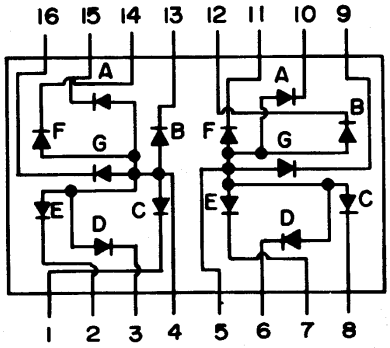
CATHODE MARK

BZX83-C5V6
UZP-8.2B

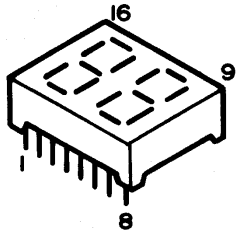
SLB55VR3

MV2209



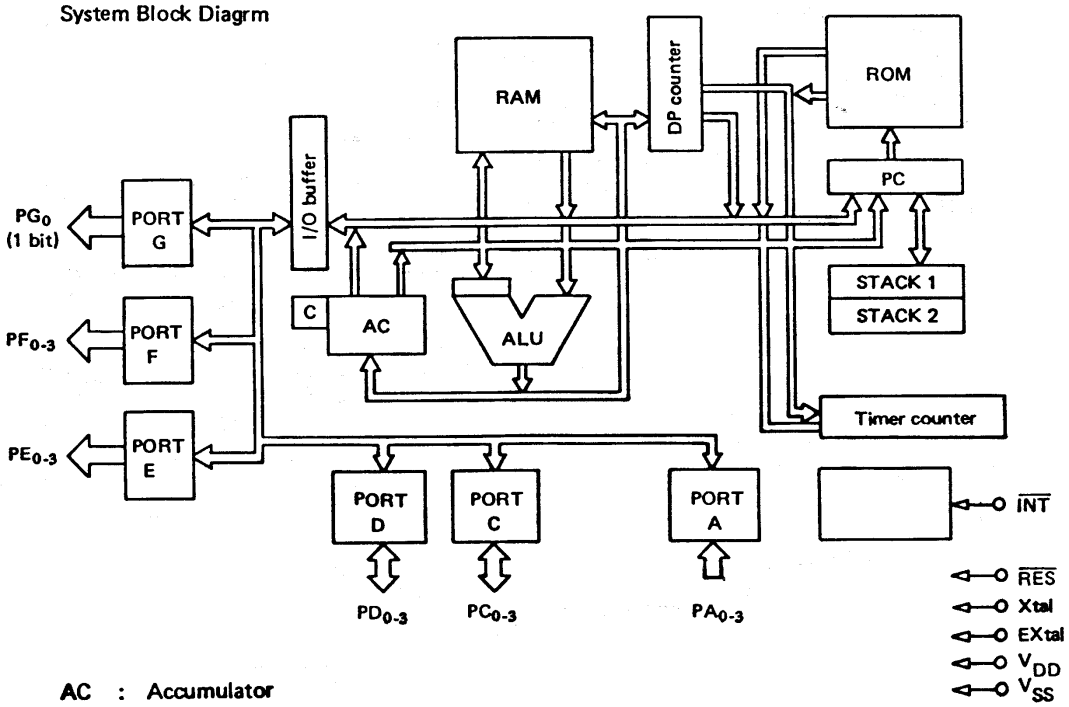


LTD-482G-Y



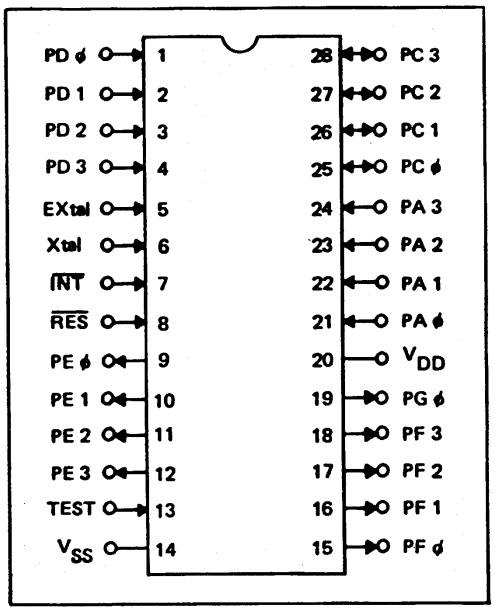
LD-001VR

System Block Diagrm



AC : Accumulator
ALU : Arithmetic and logic unit
DP : Data pointer
C : Carry FF
PC : Program counter

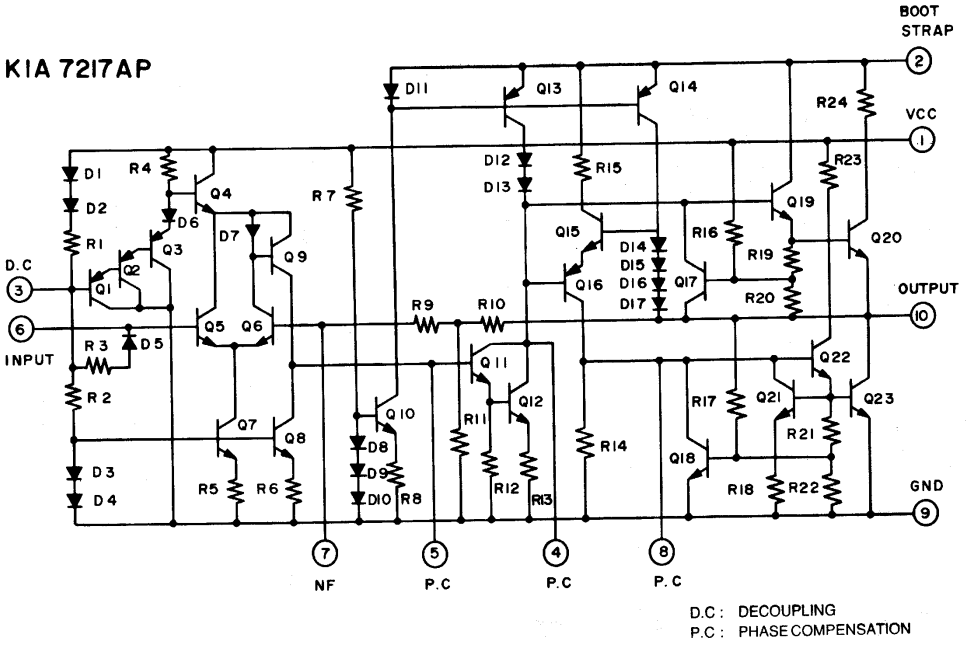
Package and Pin Assignment



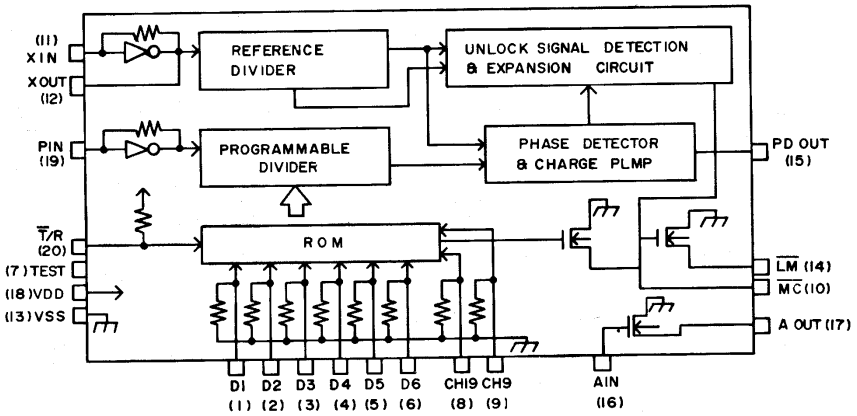
(Pin name)

Xtal, EXtal	:	OSC resonator	
INT	:	Interrupt	
RES	:	Reset	
PA_0 to 3	:	Input ports	A_0 to 3
PC_0 to 3	:	Input/output ports	C_0 to 3
PD_0 to 3	:	Input/output ports	D_0 to 3
PE_0 to 3	:	Output ports	E_0 to 3
PG_0	:	Output ports	G_0
TEST	:	Test	

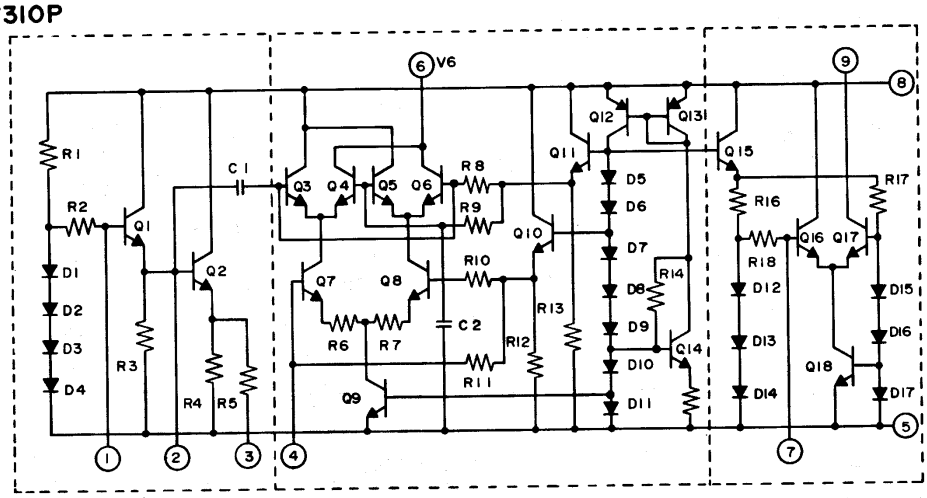
KIA 7217AP



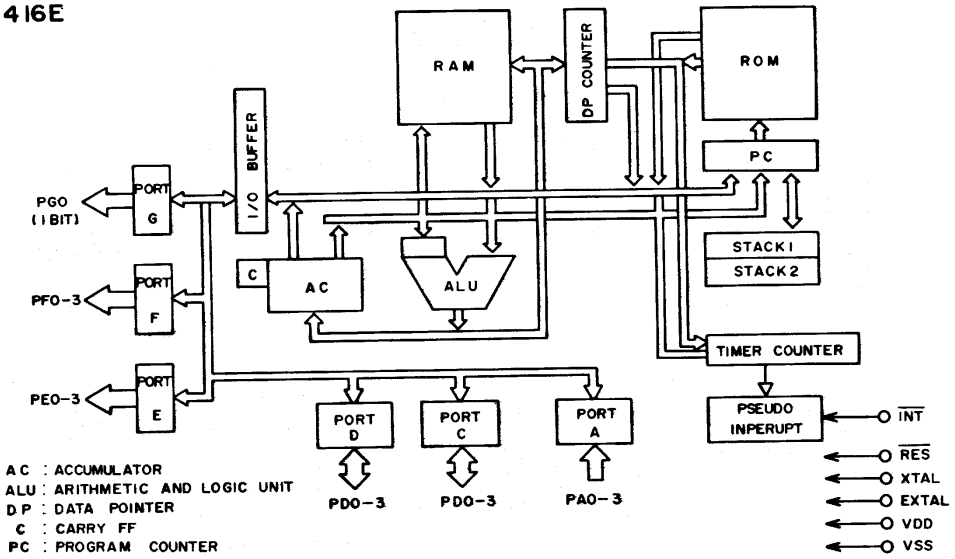
LC 7131



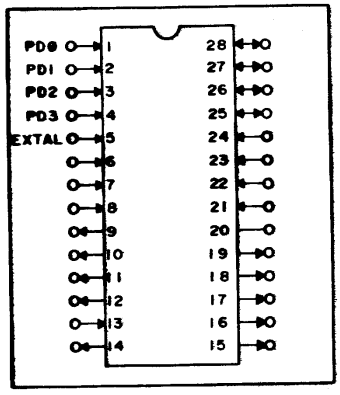
TA7310P



LM6416E

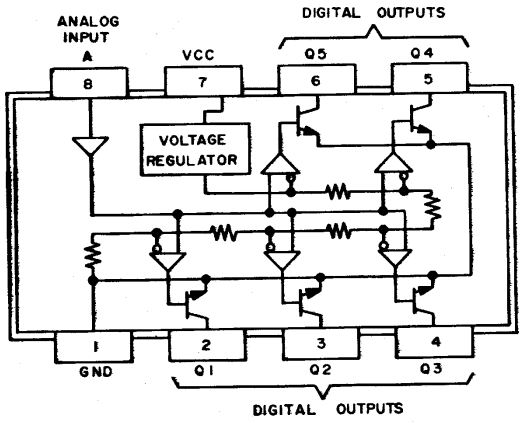


TL 489CP

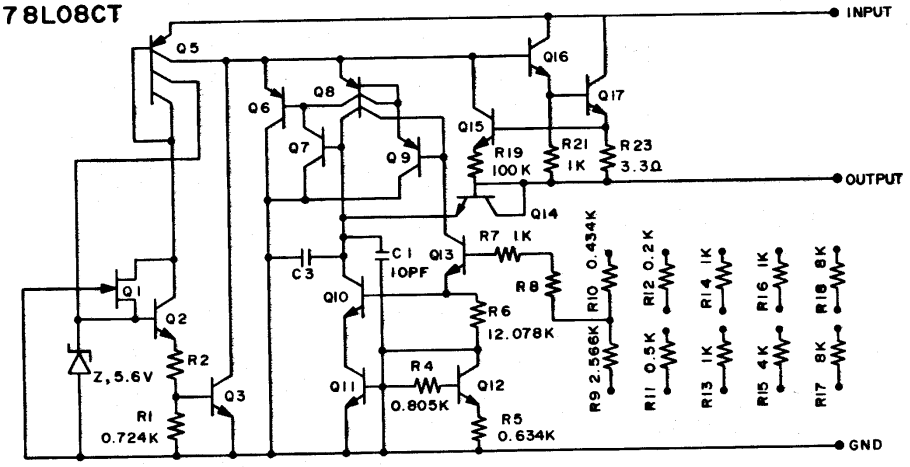


(PIN NAME)

XTAL,EXTAL	:OSC RESONATOR
INT	:INTERRUPT
RES	:RESET
PA0 TO 3	:INPUT PORTS A0 TO3
PC0 TO 3	:INPUT/OUTPUT PORTS C0 TO3
PD0 TO 3	:INPUT/OUTPUT PORTS D0 TO 3
PE0 TO3	:OUTPUT PORTS E0 TO3
PG0	:OUTPUT PORTS G0
TEST	:TEST



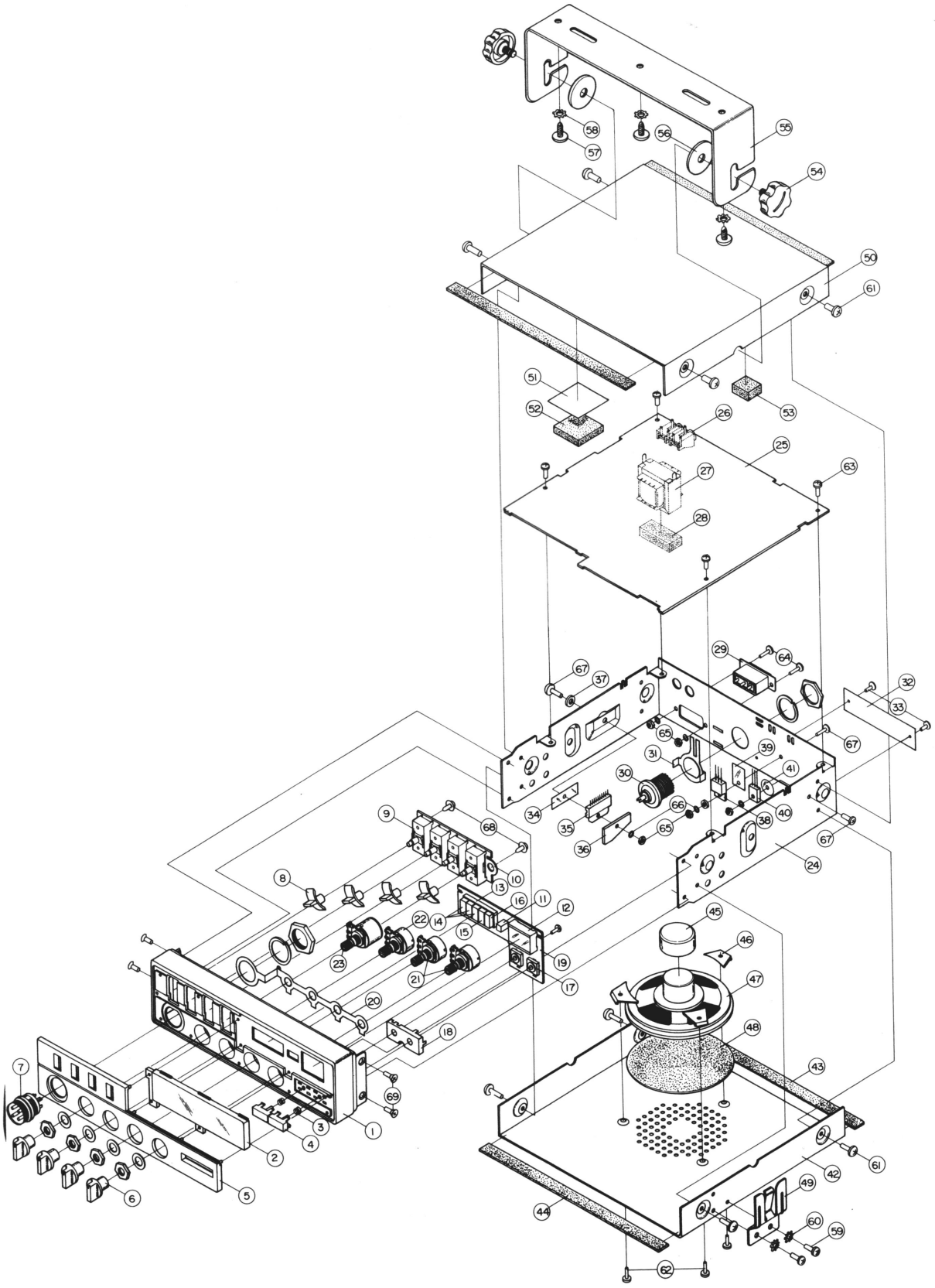
MC 78L08CT



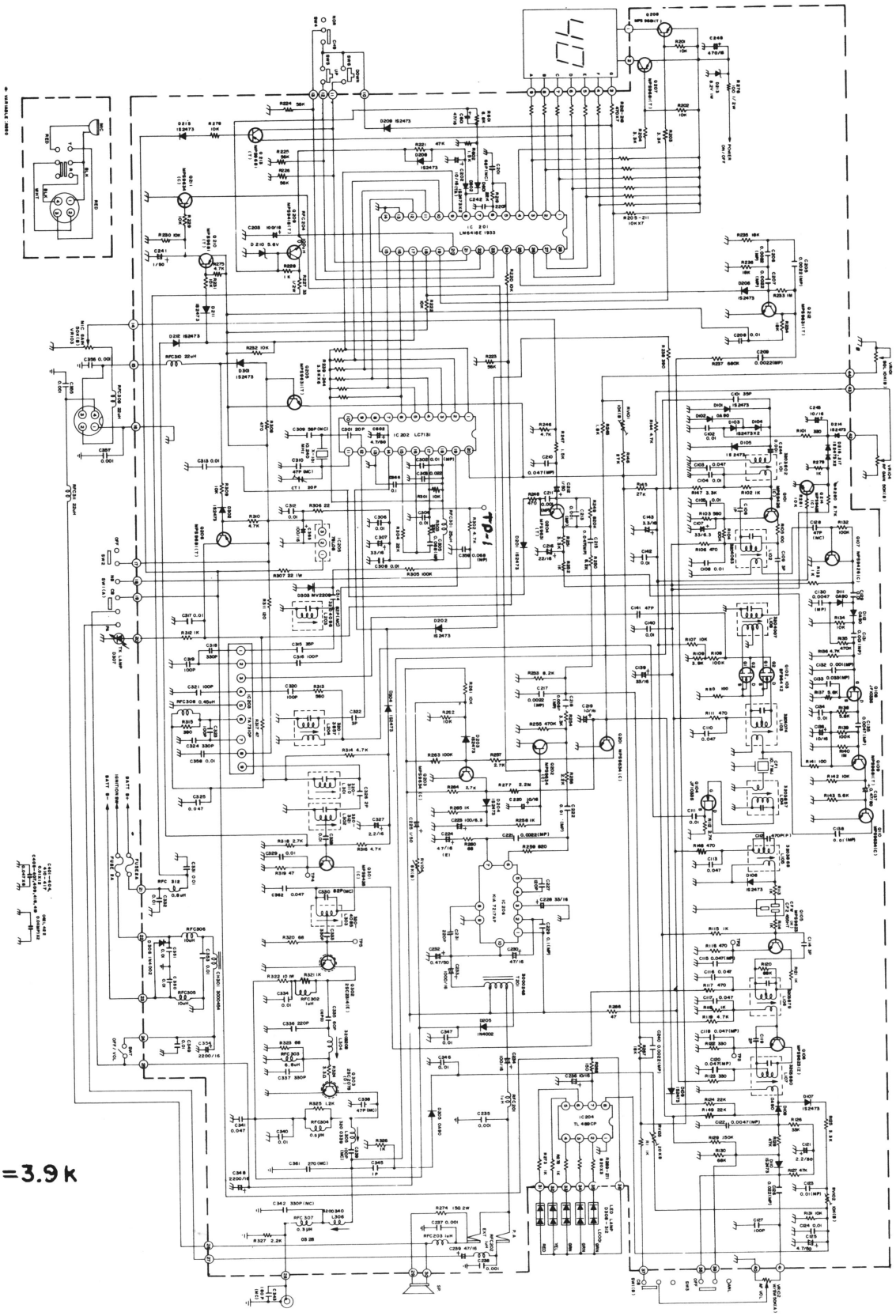
Exploded View Parts List

No.	Part No.	Description
1	800960	Escutcheon
2	813020	Lens
3	880880	Spring
4	823860	Knob (Push) (Up Down)
5	830530	Front Panel
6	823850	Knob (Control)
7	4215066	4 Pin Socket
8	823840	Knob (Toggle)
9	4390042	Lever S.W
10	4012620	P.C.B S.W
11	2510640	LED Lamp
12	2520261	LED Display
13	892550	Rubber Holder (Bar LED Lamp)
14	2520216	LED Display LD-OOIMG GRN
15	2520227	LED Display LD-OOIVR RED
16	2520238	LED Display LD-OOIYY YEL
17	4360069	Tack Switor
18	770800	Shield Plate
19	4013780	P.C.B LED
20	770820	Shield Plate
21	4506111	Resistor Variable (VR) K161100-50KB (WO/SW)
22	4504173	Resistor Variable (VR) K161110-5M1112-50KA
23	4506100	Resistor Variable (VR) K161100-10KC (WO/SW)
24	701380	Main Body
25	4010690	P.C.B Main
26	4207076	Jack Earphone
27	3000245	Transformer
28	892620	Bubber Sponge
29	4215374	Connector
30	992440	Ant Receptacle (W/Nut, Washer)
31	730343	Holder (Ant. MTG)
32	793130	Name Plate
33	670025	Rivet Blind
34	4400105	Mica
35	2220064	I.C
36	760704	Heat Sink (Ic MTG)
37	4410100	Bushing
38	2040091	Transistor
39	4400040	Mica
40	2040167	Transistor
41	4400051	Mica
42	715730	Bottom Cover
43	904000	Felt Strip
44	904020	Strip Felt
45	830043	Cap (Speaer)
46	730015	Holder (Speaker)
47	401029	Speaker
48	900708	Felt (Speaker)
49	720049	Bracket (Mic MTG)
50	715720	Upper Cover
51	900054	Insulation Plate (Cover)
52	891590	Rubber Sponge Rubber 25x25x5t
53	892630	Babber Sponge
54	600051	Securing Screw
55	722070	Set Mtg Bracket
56	660138	Washer Rubber
57	625007	(+) Tapping Screw (T.H)
58	664518	Washer (Lock "B" Type)
59	624066	(+) Tapping Screw (R.H)
60	664411	Washer (Lock "B" Type)
61	633082	(+) Tap Tite Screw (B.H)
62	623344	(+) Tapping Screw (B.H) 3x8 – 2S BLK
63	623265	(+) Tapping Screw (B.H) 3x6 – 2S ZN-PLAT
64	613271	(+) Machine Screw (B.H) M3x6 ZN-PLAT
65	651024	Nut
66	662305	Washer (Spring)
67	613332	(+) Machine Screw (B.H)
68	623344	(+) Tapping Screw (B.H)
69	613183	(+) Machine Screw (F.H)

Exploded View



Schematic Diagram



R125=3.9k

PARTS LIST 40 PLUS

SYMBOL	DESCRIPTION	PART NO.
	COVER ASSEMBLY	521 129 9 001
	SPEAKER 3" 8 OHM 2W	580 036 9 001
	UPPER COVER SPC. VINYL 167X233X0.75T	253 139 9 001
	ESCUTCHEON (COBRA 40PLUS) ABS BLACK	380 552 9 001
	LENS ACRYL SMOKE SILK	753 020 9 001
	KNOB (TOGGLE) ABS CR-PLATING	384 086 9 001
	KNOB (CONTROL) ABS CR-PLATING	384 084 9 002
	KNOB (PUSH) (UP,DWN) ABS CR-PLATING	384 084 9 003
	FRONT PANEL ABS STAMPING SILK	260 441 9 001
	FRONT BODY ASSEMBLY	521 130 9 001
Q303	XSTOR 2SC 2078 (D)	172 075 9 001
Q302	XSTOR 2SC 2314 (E)	176 120 9 001
IC206	I.C. KIA 7217AP	307 331 9 001
D307	LED LAMP SLB55VR3, RED	158 079 9 001
D308-310	LED DISPLAY LD001MG, GREEN	158 079 9 002
D311	LED DISPLAY LD-001VR RED	158 079 9 003
D312	LED DISPLAY LD-001YY YEL	158 079 9 004
LED	LED DISPLAY LTD-482G-Y	158 079 9 005
J1 2	JACK EARPHONE HSJ0615-01-010	773 126 9 001
SW5,6	TACTILE SWITCH KHG10905	088 155 9 001
	LEVER SW SLE 622	080 029 9 001
RV101	RES., VARIABLE (VR) WO/SW VM11A-5M1411-10KB 15MM SHAFT	008 851 9 001
	RES., VARIABLE (VR) K161110-5M1112 50KA	008 851 9 002
	RES., VARIABLE (VR) K161110-50KB (WO/SW) 15MM SHAFT	008 851 9 003
	ANT RECEPTACLE (W/NUT WASHER) KYEONG SEOVG M TYPE 8112	772 050 9 001
Q110,201-203,211	XSTOR MPS9634(C)	176 128 9 001
Q101,107,214,301	XSTOR MPS9426(C)	176 115 9 001
Q109,206-208, 210,213	XSTOR MPS9681(T)	177 049 9 001
Q209	XSTOR MPS9418(T)	176 115 9 004
Q105	XSTOR MPS9623(H)	176 125 9 001
Q106	XSTOR MPS9623(I)	176 115 9 002
Q204,205,212	XSTOR MPS9631(T)	176 132 9 001
Q104,108	FET JF 1033S	182 086 9 001
Q102,103	FET BF 964(A)	182 086 9 002
IC203	I.C. TA7310P	307 133 9 004
IC205	I.C. MC78L08CT	307 426 9 001
IC202	I.C. LC7131	307 272 9 002
IC201	I.C. LM6416E	307 426 9 002
IC204	I.C. TL 489CP	307 426 9 003
D210	DIODE BZX83-C5V6	152 160 9 001
D213	DIODE ZENER UZP-8.2B 1W	152 160 9 002
D303	DIODE VARICAP MV2209	151 028 9 007

PARTS LIST 40 PLUS

SYMBOL	DESCRIPTION	PART NO.
D101,103-107,109, 201-204,206,208, 209,211,212, 214-217,301,302, 304,601,602,110	DIODE SI 1S2473	151 035 9 001
D102,108,111, 112,305	DIODE GE 0A90	150 020 9 001
D205,306	DIODE SI 1N4002	151 082 9 001
X101	CRYSTAL 10.240MHz HV-18/U	132 036 9 001
CF2	CERAMIC FILTER CFW455HT	140 006 9 001
CF1	CERAMIC FILTER 10.7MJ	140 006 9 002
T201	TRANSFORMER OPT	061 064 9 001
CH301	TRANSFORMER CHOKE	047 052 9 001
RFC305,306	COIL RF CHOKE 10μH CORE	047 012 9 003
RFC302	COIL CHOKE 1μH BOBBIN	041 134 9 007
RF201-203	COIL RF CHOKE 1μH SPRING	047 041 9 001
RFC309-311	COIL RF CHOKE 22μH BOBBIN	041 134 9 002
RFC301	COIL RF CHOKE 25μH PC	047 041 9 002
RFC304	COIL RF CHOKE 0.5μH SPRING	041 134 9 008
RFC303	COIL RF CHOKE 6.8μH PC	047 041 9 004
RFC312	COIL RF CHOKE 0.8μH SPRING	047 052 9 002
RFC308	INDUCTOR 0.45μH MOLD TYPE	047 049 9 002
RF204	COIL CHOKE 100μH MO TYPE	047 027 9 001
RFC307	COIL AM TX ANT 27MHz A	046 039 9 012
L305	COIL AM TX ANT 27MHz B	046 039 9 013
L306	COIL AM IFT 27MHz TX ANT TUNING – C	046 039 9 014
L301	IFT 27MHz RF AMP-A	047 039 9 006
L302	IFT AM AMP 27MHz C	047 039 9 007
L304	27MHz RF-C (TX)	046 039 9 012
L101	27MHz RX ANT A	047 052 9 003
L104,204	10.7MHz MIXER B	047 052 9 004
L105	455KHz A	047 052 9 005
L106	455KHz B	047 052 9 006
L107	455KHz DET	047 052 9 007
L108	10.7MHz MIXER A	047 052 9 008
L103	RX AMP 10.7MHz	047 052 9 009
L303	RX ANT TUNING 27MHz	047 052 9 010
L203	RX VCO 16.5MHz	047 049 9 007
L102	RX ANT 27MHz	047 052 9 011
	DC POWER CORD ASS'Y. 2T-5C-192	428 134 9 001
	MIC ASS'Y. COBRA-40PLUS	561 002 9 001
	4 PIN PLUG FM 114-4P DIE CAST TYPE	777 016 9 001
	PUSH SW HPW0208-01-010	088 155 9 002
	SECURING SCREW M6 (P=1) X 9	634 166 9 001
	BRACKET (MIC MTG) SPC 35X55X1T	251 516 9 001
	SET MTG BRACKET BLACK PLATING	250 215 9 001
	NAME PLATE (UPPER) ALP3 30X80X0.3T	600 164 9 002
	SNOW BOX	503 327 9 001
	DISPLAY CTN (COBRA 40PLUS) SW.E 239X263X82	500 741 9 001