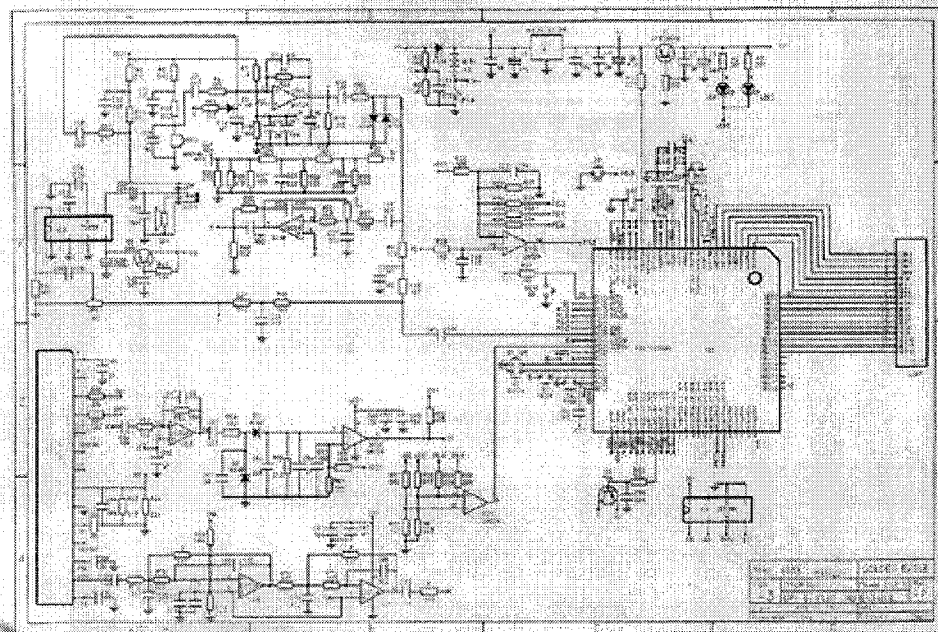
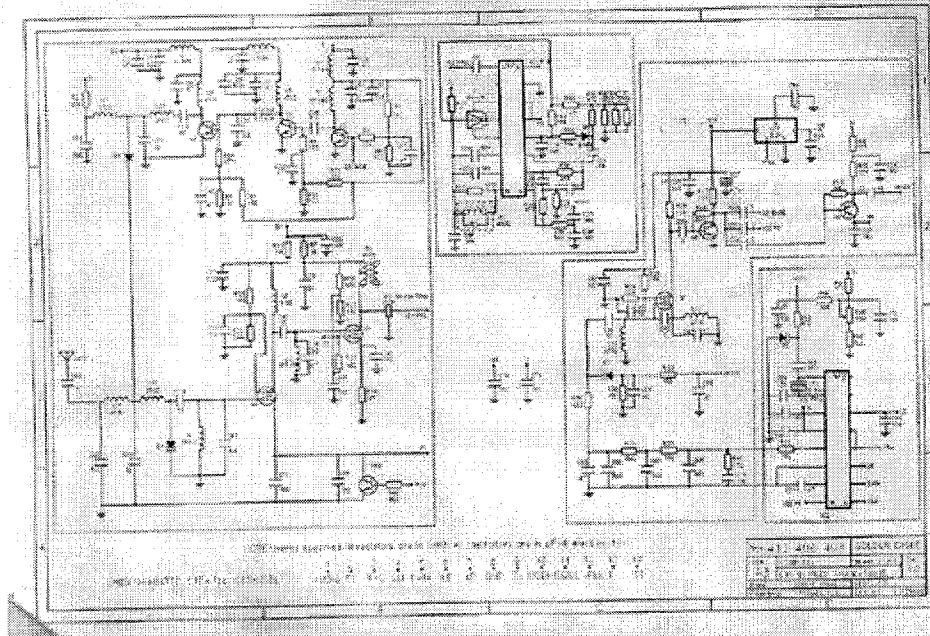


PLANNED PRODUCTION QUANTITY :
100,000 PIECES PER YEAR

DESCRIPTION OF CIRCUITS FOR DETERMINING AND STABILIZING FREQUENCY

Frequency generation is by P.L.L. synthesizer and stabilization is by a 3.59μm crystal reference oscillator.

Refer to schematic page 2. The transmit and receive oscillator is composed of a VCO phase-locked by a 2-ppts crystal oscillator at 20.54MHz. The PLL VCO is programmed by the microprocessor to have a reference frequency of 12.5KHz which is phase-locked to the divide-down VCO to generate the error voltage which is used to control the VCO. The VCO is composed of the dual-gate mosfet Q7, the main oscillator, and the buffer amp Q6. The tuning range of the VCO is 20MHz per volt and covers the frequency for both receiver and transmitter. The supply to the whole circuitry is controlled by the microprocessor and is regulated to 3V by low-drop-out



FUNCTION OF EACH SOLID STATE DEVICE

Receiver

Refer to schematic page 2. RF signal comes through the antenna, low-pass filter and band-pass filter and enters gate 1 of the dual-gate mosfet Q9 which amplifies it. It then goes into the mixer which is composed of dual-gate mosfet Q8. The local oscillator, which is 21.4MHz displaced from the RF input, is buffered by Q5 and injected into gate 2 of Q8 which is slightly biased to 0.6ma. The 21.4MHz IF is band-limited by B2 and filtered by the crystal filter F2. The IF enters IC1 which further down-converts the IF to 450KHz. This second IF is amplified and filtered by ceramic filter F1 and then demodulated to recover the audio signal. IC1 has an RSSI output which is a voltage proportional to the signal strength. This RSSI is compared with a fixed voltage and the resultant high or low is input to the microprocessor to determine whether a reasonably well received signal is present. If positive, the microprocessor will turn on the supply to the audio amplifier IC3, otherwise it will shut it down, a squelched condition. If CTCSS is used, then the valid sub-tone is needed to turn on the amplifier, as determined by the microprocessor. The power supply to all the relevant circuitry are controlled by the microprocessor. It turns on the power intermittently in synchronization with the LED display which blinks on and off. When the above receive condition is met, the power stays put and reception continues.

Transmitter

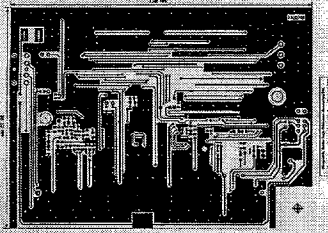
Refer to schematic page 2. When the PTT switch is pressed, the microprocessor turns on the power to the microphone amplifier, PLL oscillator, pre-driver Q3 and bias to driver Q2 and Q1. Audio signal enters the microphone which is amplified by op-amp and is amplitude-limited by the diode clipper D7 and D8. It then passes through three stages of RC low-pass (composed of R30,31,34 and C5,12,16,44) and fed into the VCO for FM modulation. This serves the purpose of modulation limiting. The modulated VCO is fed to pre-driver Q3 whose supply is controlled by the microprocessor and is a regulated 3-volt supply. This stabilizes the driving power into pre-driver Q2 and hence the power amplifier Q1. Q1 and Q2 have their supply directly from the batteries and are current-limited and protected by resettable fuses FUS1 and FUS2. The final amplified signal passes through the RF switch formed by PIN diode D1 and passes through a band-pass filter realized by L15 and stripline.

Finally it goes through three stages of LC low-pass and to the antenna. The antenna is of helical type which has a very narrow bandwidth and provide further filtering of the signal. The DC voltages and currents of the power amplification elements are as follows:

Element	Function	Voltage	Current
Q3	pre-driver	3V	10ma
Q2	driver	4.5V	100ma
Q1	power amp	4.5V	200ma

Following is a tabulized summary.

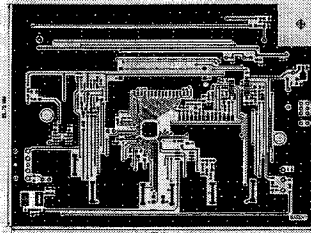
Position	Function
Q7	Voltage control oscillator
Q6	Voltage control oscillator output buffer
Q5	Receive local oscillator buffer
Q9	Receive RF amplifier
Q8	Receive first IF mixer
Q3	Transmit power pre-driver
Q2	Transmit power driver
Q1	Transmit power amplifier



CIRCUIT DIAGRAM

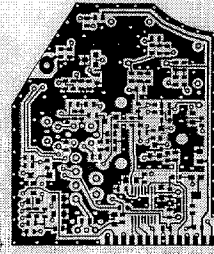
Symbol	Description
[Symbol]	Resistor
[Symbol]	Capacitor
[Symbol]	Inductor
[Symbol]	Diode
[Symbol]	Transistor
[Symbol]	IC

CIRCUIT DIAGRAM

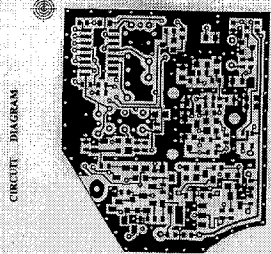


Symbol	Description
[Symbol]	Resistor
[Symbol]	Capacitor
[Symbol]	Inductor
[Symbol]	Diode
[Symbol]	Transistor
[Symbol]	IC

CIRCUIT DIAGRAM

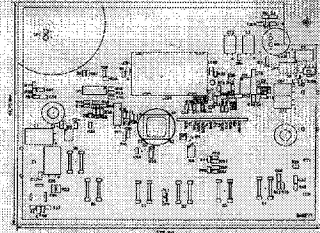


Symbol	Description
[Symbol]	Resistor
[Symbol]	Capacitor
[Symbol]	Inductor
[Symbol]	Diode
[Symbol]	Transistor
[Symbol]	IC



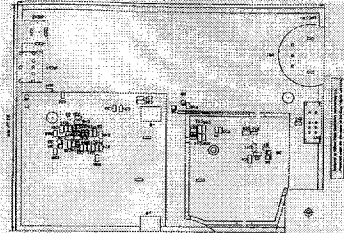
Symbol	Description
[Symbol]	Resistor
[Symbol]	Capacitor
[Symbol]	Inductor
[Symbol]	Diode
[Symbol]	Transistor
[Symbol]	IC

CIRCUIT DIAGRAM



Symbol	Description
[Symbol]	Resistor
[Symbol]	Capacitor
[Symbol]	Inductor
[Symbol]	Diode
[Symbol]	Transistor
[Symbol]	IC

CIRCUIT DIAGRAM



DESCRIPTION OF CIRCUITS EMPLOYED FOR SUPPRESSION OF SPURIOUS EMISSIONS, LIMITING MODULATION AND LIMITING POWER

Refer to schematic page 2. When the PTT switch is pressed, the microprocessor turns on the power to the microphone amplifier, PLL oscillator, pre-driver Q3 and bias to driver Q2 and Q1. Audio signal enters the microphone which is amplified by op-amp and is amplitude-limited by the diode clipper D7 and D8. It then passes through three stages of RC low-pass (composed of R30,31,34 and C5,12,16,44) and fed into the VCO for FM modulation. This serves the purpose of modulation limiting. The modulated VCO is fed to pre-driver Q3 whose supply is controlled by the microprocessor and is a regulated 3-volt supply. This stabilizes the driving power into pre-driver Q2 and hence the power amplifier Q1. Q1 and Q2 have their supply directly from the batteries and are current-limited and protected by resettable fuses FUS1 and FUS2. The final amplified signal passes through the RF switch formed by PIN diode D1 and passes through a band-pass filter realized by L15 and stripline. Finally it goes through three stages of LC low-pass and to the antenna. The antenna is of helical type which has a very narrow bandwidth and provide further filtering of the signal. The DC voltages and currents of the power amplification elements are as follows:

Element	Function	Voltage	Current
Q3	pre-driver	3V	10ma
Q2	driver	4.5V	100ma
Q1	power amp	4.5V	200ma

Transmit spurious emission is suppressed by band-pass filter L15 and stripline and two stages of LC low-pass composed of L16, L17 and C62,63,64.

Limiting modulation

Modulation limiting is accomplished by diode clipper D7,D8 which limits the amplitude of the audio amplifier output and low-passed filtered by three RC steps to limit high frequency response.

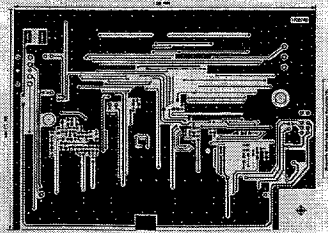
Limiting power

Power limiting is accomplished by regulating the supply voltage of the pre-driver to 3V by use of voltage regulator. Additionally, the biases to the pre-driver and power amplifier are regulated and their supply current are limited by resettable fuses.

DESCRIPTION OF CIRCUITS FOR DETERMINING AND STABILIZING FREQUENCY

Frequency generation is by PLL synthesizer and stabilization is by a 2-ppm crystal reference oscillator.

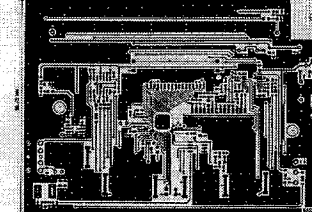
Refer to schematic page 2. The transmit and receive oscillator is composed of a VCO phase-locked by a 2-ppm crystal oscillator at 20.94MHz. The PLL IC2 is programmed by the microprocessor to have a reference frequency of 12.5KHz which is phase-compared to the divide-down VCO to generate the error voltage which is used to control the VCO. The VCO is composed of the dual-gate mosfet Q7, the main oscillator, and the buffer amp Q6. The tuning range of the VCO is 20Mhz per volt and covers the frequency for both receiver and transmitter. The supply to the whole circuitry is controlled by the microprocessor and is regulated to 3V by low-drop-out regulator.



CIRCUIT DIAGRAM

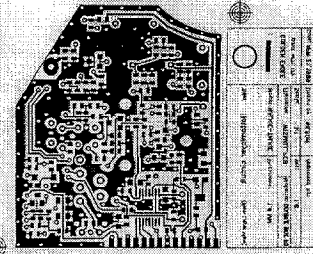
Part No.	Quantity	Part Name
1	1	Resistor
2	1	Capacitor
3	1	Transistor
4	1	Diode
5	1	IC
6	1	IC
7	1	IC
8	1	IC
9	1	IC
10	1	IC
11	1	IC
12	1	IC
13	1	IC
14	1	IC
15	1	IC
16	1	IC
17	1	IC
18	1	IC
19	1	IC
20	1	IC
21	1	IC
22	1	IC
23	1	IC
24	1	IC
25	1	IC
26	1	IC
27	1	IC
28	1	IC
29	1	IC
30	1	IC
31	1	IC
32	1	IC
33	1	IC
34	1	IC
35	1	IC
36	1	IC
37	1	IC
38	1	IC
39	1	IC
40	1	IC
41	1	IC
42	1	IC
43	1	IC
44	1	IC
45	1	IC
46	1	IC
47	1	IC
48	1	IC
49	1	IC
50	1	IC
51	1	IC
52	1	IC
53	1	IC
54	1	IC
55	1	IC
56	1	IC
57	1	IC
58	1	IC
59	1	IC
60	1	IC
61	1	IC
62	1	IC
63	1	IC
64	1	IC
65	1	IC
66	1	IC
67	1	IC
68	1	IC
69	1	IC
70	1	IC
71	1	IC
72	1	IC
73	1	IC
74	1	IC
75	1	IC
76	1	IC
77	1	IC
78	1	IC
79	1	IC
80	1	IC
81	1	IC
82	1	IC
83	1	IC
84	1	IC
85	1	IC
86	1	IC
87	1	IC
88	1	IC
89	1	IC
90	1	IC
91	1	IC
92	1	IC
93	1	IC
94	1	IC
95	1	IC
96	1	IC
97	1	IC
98	1	IC
99	1	IC
100	1	IC

CIRCUIT DIAGRAM



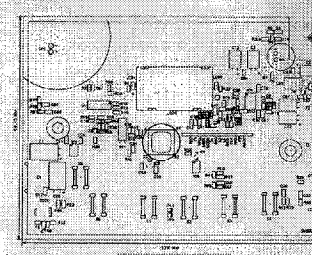
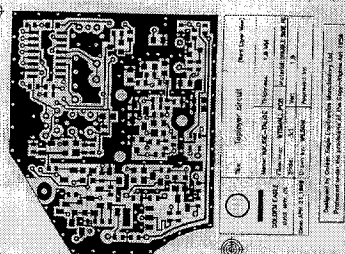
Part No.	Quantity	Part Name
1	1	Resistor
2	1	Capacitor
3	1	Transistor
4	1	Diode
5	1	IC
6	1	IC
7	1	IC
8	1	IC
9	1	IC
10	1	IC
11	1	IC
12	1	IC
13	1	IC
14	1	IC
15	1	IC
16	1	IC
17	1	IC
18	1	IC
19	1	IC
20	1	IC
21	1	IC
22	1	IC
23	1	IC
24	1	IC
25	1	IC
26	1	IC
27	1	IC
28	1	IC
29	1	IC
30	1	IC
31	1	IC
32	1	IC
33	1	IC
34	1	IC
35	1	IC
36	1	IC
37	1	IC
38	1	IC
39	1	IC
40	1	IC
41	1	IC
42	1	IC
43	1	IC
44	1	IC
45	1	IC
46	1	IC
47	1	IC
48	1	IC
49	1	IC
50	1	IC
51	1	IC
52	1	IC
53	1	IC
54	1	IC
55	1	IC
56	1	IC
57	1	IC
58	1	IC
59	1	IC
60	1	IC
61	1	IC
62	1	IC
63	1	IC
64	1	IC
65	1	IC
66	1	IC
67	1	IC
68	1	IC
69	1	IC
70	1	IC
71	1	IC
72	1	IC
73	1	IC
74	1	IC
75	1	IC
76	1	IC
77	1	IC
78	1	IC
79	1	IC
80	1	IC
81	1	IC
82	1	IC
83	1	IC
84	1	IC
85	1	IC
86	1	IC
87	1	IC
88	1	IC
89	1	IC
90	1	IC
91	1	IC
92	1	IC
93	1	IC
94	1	IC
95	1	IC
96	1	IC
97	1	IC
98	1	IC
99	1	IC
100	1	IC

CIRCUIT DIAGRAM

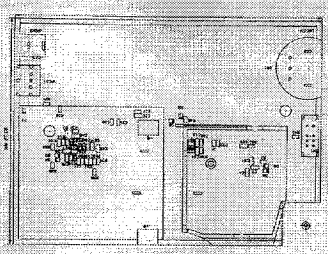


Part No.	Quantity	Part Name
1	1	Resistor
2	1	Capacitor
3	1	Transistor
4	1	Diode
5	1	IC
6	1	IC
7	1	IC
8	1	IC
9	1	IC
10	1	IC
11	1	IC
12	1	IC
13	1	IC
14	1	IC
15	1	IC
16	1	IC
17	1	IC
18	1	IC
19	1	IC
20	1	IC
21	1	IC
22	1	IC
23	1	IC
24	1	IC
25	1	IC
26	1	IC
27	1	IC
28	1	IC
29	1	IC
30	1	IC
31	1	IC
32	1	IC
33	1	IC
34	1	IC
35	1	IC
36	1	IC
37	1	IC
38	1	IC
39	1	IC
40	1	IC
41	1	IC
42	1	IC
43	1	IC
44	1	IC
45	1	IC
46	1	IC
47	1	IC
48	1	IC
49	1	IC
50	1	IC
51	1	IC
52	1	IC
53	1	IC
54	1	IC
55	1	IC
56	1	IC
57	1	IC
58	1	IC
59	1	IC
60	1	IC
61	1	IC
62	1	IC
63	1	IC
64	1	IC
65	1	IC
66	1	IC
67	1	IC
68	1	IC
69	1	IC
70	1	IC
71	1	IC
72	1	IC
73	1	IC
74	1	IC
75	1	IC
76	1	IC
77	1	IC
78	1	IC
79	1	IC
80	1	IC
81	1	IC
82	1	IC
83	1	IC
84	1	IC
85	1	IC
86	1	IC
87	1	IC
88	1	IC
89	1	IC
90	1	IC
91	1	IC
92	1	IC
93	1	IC
94	1	IC
95	1	IC
96	1	IC
97	1	IC
98	1	IC
99	1	IC
100	1	IC

CIRCUIT DIAGRAM



CIRCUIT DIAGRAM



CIRCUIT DIAGRAM

DESCRIPTION OF CIRCUITS EMPLOYED FOR SUPPRESSION OF SPURIOUS EMISSIONS, LIMITING MODULATION AND LIMITING POWER

Refer to schematic page 2. When the PTT switch is pressed, the microprocessor turns on the power to the microphone amplifier, PLL oscillator, pre-driver Q3 and bias to driver Q2 and Q1. Audio signal enters the microphone which is amplified by op-amp and is amplitude-limited by the diode clipper D7 and D8. It then passes through three stages of RC low-pass (composed of R30,31,34 and C5,12,16,44) and fed into the VCO for FM modulation. This serves the purpose of modulation limiting. The modulated VCO is fed to pre-driver Q3 whose supply is controlled by the microprocessor and is a regulated 3-volt supply. This stabilizes the driving power into pre-driver Q2 and hence the power amplifier Q1. Q1 and Q2 have their supply directly from the batteries and are current-limited and protected by resettable fuses FUS1 and FUS2. The final amplified signal passes through the RF switch formed by PIN diode D1 and passes through a band-pass filter realized by L15 and stripline. Finally it goes through three stages of LC low-pass and to the antenna. The antenna is of helical type which has a very narrow bandwidth and provide further filtering of the signal. The DC voltages and currents of the power amplification elements are as follows:

Element	Function	Voltage	Current
Q3	pre-driver	3V	10ma
Q2	driver	4.5V	100ma
Q1	power amp	4.5V	200ma

Transmit spurious emission is suppressed by band-pass filter L15 and stripline and two stages of LC low-pass composed of L16, L17 and C62,63,64.

Limiting modulation

Modulation limiting is accomplished by diode clipper D7,D8 which limits the amplitude of the audio amplifier output and low-passed filtered by three RC steps to limit high frequency response.

Limiting power

Power limiting is accomplished by regulating the supply voltage of the pre-driver to 3V by use of voltage regulator. Additionally, the biases to the pre-driver and power amplifier are regulated and their supply current are limited by resettable fuses.

DESCRIPTION OF CIRCUITS FOR DETERMINING AND STABILIZING FREQUENCY

Frequency generation is by PLL synthesizer and stabilization is by a 2-ppm crystal reference oscillator.

Refer to schematic page 2. The transmit and receive oscillator is composed of a VCO phase-locked by a 2-ppm crystal oscillator at 20.94MHz. The PLL IC2 is programmed by the microprocessor to have a reference frequency of 12.5KHz which is phase-compared to the divide-down VCO to generate the error voltage which is used to control the VCO. The VCO is composed of the dual-gate mosfet Q7, the main oscillator, and the buffer amp Q6. The tuning range of the VCO is 20Mhz per volt and covers the frequency for both receiver and transmitter. The supply to the whole circuitry is controlled by the microprocessor and is regulated to 3V by low-drop-out regulator.

DC VOLTAGES AND CURRENTS IN ALL ELEMENTS OF THE FINAL STAGE

Refer to schematic page 2. The transmit and receive oscillator is composed of a VCO phase-locked by a 2-pin crystal oscillator at 20.94MHz. The PLL IC2 is programmed by the microprocessor to have a reference frequency of 12.5kHz which is phase-locked to the divide-down VCO to generate the error voltage which is used to control the VCO. The VCO is composed of the dual-gate MOSFET Q1, the main oscillator, and the buffer amp Q6. The tuning range of the VCO is 20kHz per volt and covers the frequency for both receiver and transmitter. The supply to the whole circuitry is controlled by the microprocessor and is regulated to 3V by low-drop-out regulator.

3.0 Microprocessor plus control interfacing

The microprocessor has interface to the inputs, namely, keyboard, channel switch and temperature limit detector. Different functions will be performed according to the inputs and details can be found in the operating manual. Outputs include LCD display (optional), audible alarm tones, LED display and power supplies to receiver, transmitter and PLL oscillator circuitry.

2.0 Receiver

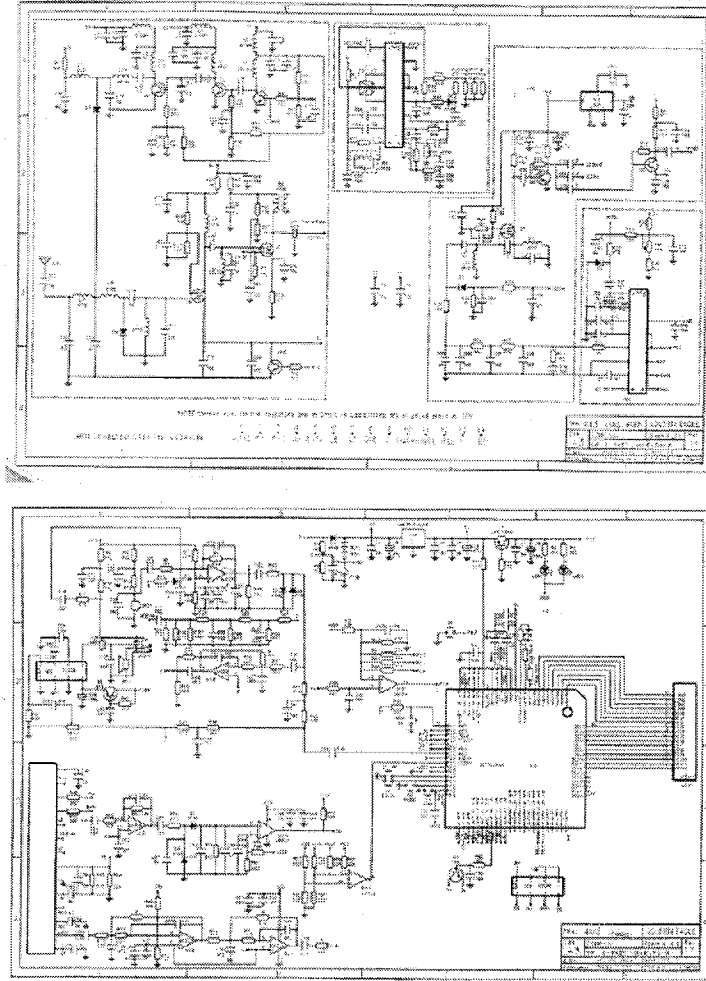
Refer to schematic page 2. RF signal comes through the antenna, low-pass filter and band-pass filter and enters gate 1 of the dual-gate MOSFET Q7 which amplifies it. It then goes into the mixer which is composed of dual-gate MOSFET Q8. The local oscillator, which is 21.4MHz displaced from the RF input, is buffered by Q5 and injected into gate 2 of Q8 which is slightly biased to 0.6mA. The 21.4MHz IF is band-limited by R2 and filtered by the crystal filter P2. The IF enters IC1 which further down-converts the IF to 459kHz. This second IF is amplified and filtered by ceramic filter F1 and then demodulated to recover the audio signal. IC1 has an RSSI output which is a voltage proportional to the signal strength. This RSSI is compared with a fixed voltage and the resultant high or low is input to the microprocessor to determine whether a reasonably well received signal is present. If positive, the microprocessor will turn on the supply to the audio amplifier IC3, otherwise it will

start it down, a squelched condition. If CTCSS is used, then the valid sub-tone is needed to turn on the amplifier, as determined by the microprocessor. The power supply to all the relevant circuitry are controlled by the microprocessor. It turns on the power intermittently in synchronism with the LED display which blinks on and off. When the above receive condition is met, the power stays on and reception continues.

3.0 Transmitter

Refer to schematic page 2. When the PTT switch is pressed, the microprocessor turns on the power to the microphone amplifier, PLL oscillator, pre-driver Q3 and has to drive Q2 and Q1. Audio signal enters the microphone which is amplified by op-amp and is amplitude-limited by the diode clipper D7 and D8. It then passes through three stages of RC low-pass (composed of R20, R21, R22 and C5, C6, C7) and fed into the VCO for FM modulation. This serves the purpose of modulation limiting. The modulated VCO is fed to pre-driver Q3 whose supply is controlled by the microprocessor and is a regulated 3-volt supply. This stabilizes the driving power into pre-driver Q2 and hence the power amplifier Q1. Q1 and Q2 have their supply directly from the batteries and are current-limited and protected by resettable fuses FUS1 and FUS2. The final amplified signal passes through the RF switch formed by PIN diode D1 and passes through a band-pass filter realized by L15 and L16. Finally it goes through three stages of LC low-pass and to the antenna. The antenna is of helical type which has a very narrow band-width and provides further filtering of the signal. The DC voltages and currents of the power amplification elements are as follows:

Element	Function	Voltage	Current
Q3	pre-driver	3V	10mA
Q2	driver	4.5V	100mA
Q1	power amp	4.5V	200mA



[illegible]

Element	Function	Voltage	Current
Q1	pre driver	3V	10mA
Q2	driver	4.5V	100mA
Q1	power amp	4.5V	200mA

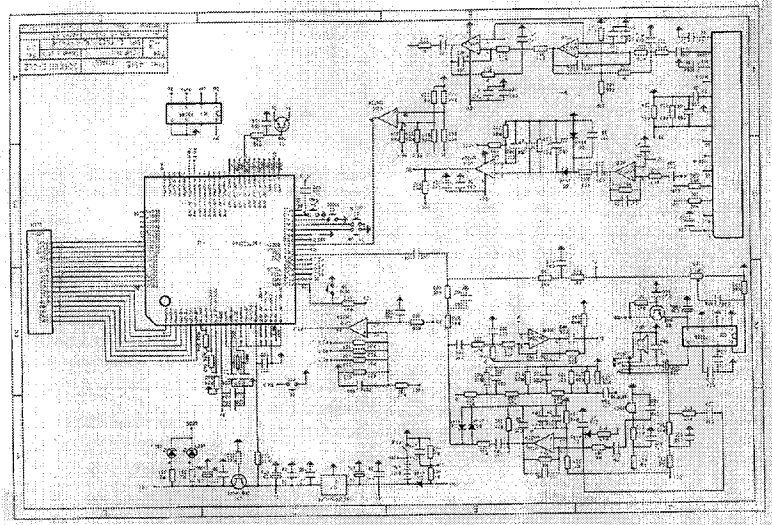
Page 1 of 2

Lipidic modulation

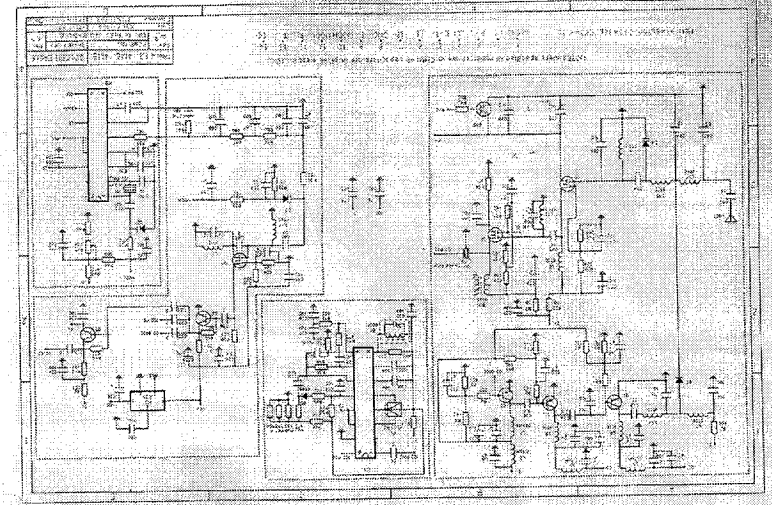
Training courses

Power limiting is accomplished by regulating the supply voltages of the pre-driver to 3 V by use of voltage regulator. Additionally, the biases to the pre-driver and the driver are regulated and their steady current are limited by resistable loads.

1	100	100
2	100	100
3	100	100
4	100	100
5	100	100
6	100	100
7	100	100
8	100	100
9	100	100
10	100	100
11	100	100
12	100	100
13	100	100
14	100	100
15	100	100
16	100	100
17	100	100
18	100	100
19	100	100
20	100	100
21	100	100
22	100	100
23	100	100
24	100	100
25	100	100
26	100	100
27	100	100
28	100	100
29	100	100
30	100	100
31	100	100
32	100	100
33	100	100
34	100	100
35	100	100
36	100	100
37	100	100
38	100	100
39	100	100
40	100	100
41	100	100
42	100	100
43	100	100
44	100	100
45	100	100
46	100	100
47	100	100
48	100	100
49	100	100
50	100	100
51	100	100
52	100	100
53	100	100
54	100	100
55	100	100
56	100	100
57	100	100
58	100	100
59	100	100
60	100	100
61	100	100
62	100	100
63	100	100
64	100	100
65	100	100
66	100	100
67	100	100
68	100	100
69	100	100
70	100	100
71	100	100
72	100	100
73	100	100
74	100	100
75	100	100
76	100	100
77	100	100
78	100	100
79	100	100
80	100	100
81	100	100
82	100	100
83	100	100
84	100	100
85	100	100
86	100	100
87	100	100
88	100	100
89	100	100
90	100	100
91	100	100
92	100	100
93	100	100
94	100	100
95	100	100
96	100	100
97	100	100
98	100	100
99	100	100
100	100	100



Page 2 of 2



TUNE UP PROCEDURE

Unless otherwise specified, the component numbering refers to schematic page 2 at the following descriptions.

1.0 Receive

Connect the antenna terminal to a RF signal generator with output set at -60dbm and modulation of 2KHz and 1KHz tone. Output frequency should be set at the middle channel. Connect the speaker terminal to a SINAD meter and AC voltmeter. Tune B1 until audio signal is observed. Tune volume until the best SINAD is read. Tune B1 again until best SINAD is read. Set signal generator to -113dbm and observe SINAD to be better than 12db. Loosen L12 if necessary to improve SINAD.

2.0 Transmit

Connect the antenna terminal to a spectrum analyser with a 20db attenuator. Set frequency to read from 400MHz to 2.5GHz. Set device to transmit, observe fundamental frequency to read 27dbm maximum. Loosen L4 if necessary to obtain correct reading. Observe all harmonics and spurious to be 60 db down from the fundamental. Loosen L15 to L17 if necessary. Now tune analyser center frequency to be the transmit frequency, span 25KHz, resolution 300Hz. Connect microphone input to audio generator with output set to 100mv. Sweep frequency from 300Hz to 3KHz. Observe spread to be within 15KHz, i.e. either side of the plateau to be 30db down from the top. With a demodulation meter, also observe that the deviation from 300Hz to 3KHz to be less than 4KHz and that modulation at 3KHz should rolled off 6db from 1KHz. Adjust R40.67 (schematic page 1) so that this figure is achieved.

3.0 PLL synthesizer

At receive, tune L11 such that the voltage at R39 appears to be 0.6V. At transmit, it should read 1.8V. Put epox onto L11 after tuning.

