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TELSON INFORMATION & COMMUNICATION CO., LTD.

TEL : 82-2-851-2780~5(EXT 210)  
FAX : 82-2-857-9583

*NT-20*

*INSTRUCTION MANUAL*

*VHF HAND-HELD*

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FCC ID: OBANT-20  
EXHIBIT #: 8

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# NT-20

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## **1. PRODUCT INTRODUCTION**

THE NT-20 LMR(LAND MOBILE RADIO) OF TELSON I&C CO., LTD. IS A SOPHISTICATED STATE-OF-THE-ART UNIT WHICH INCORPORATES THE MODERN TECHNOLOGY AVAILABLE IN TWO-WAY RADIO COMMUNICATIONS.

THE USE OF MICROPROCESSOR TECHNOLOGY MAKES CHANGING RADIO CHARACTERISTICS SUCH AS OPERATING FREQUENCIES AND SQUELCH CODES BOTH FAST AND ECONOMICAL. ANY COMPUTER EQUIPPED NT-20 DEALER CAN EASILY REPROGRAM YOUR RADIO'S OPERATING CHARACTERISTICS, OR YOUR RADIO CAN BE "CLONED" FROM A RADIO ALREADY PROGRAMMED TO YOUR DESIRED FREQUENCIES AND CODES. THE NT-20 LMR SATISFIES TOUGH ENVIRONMENTAL REQUIREMENTS WHILE PROVIDING COST EFFECTIVE AND RELIABLE COMMUNICATIONS.

## **2. HOW TO USE**

### **2.1. POWER ON/OFF, VOLUME CONTROL**

TURNES THE RADIO ON AND OFF AND ADJUSTS THE VOLUME LEVEL.

### **2.2. ROTARY CHANNEL SELECTOR SWITCH (10 CHANNELS)**

SELECTS THE OPERATING CHANNEL OR INITIATES SCAN OPERATION(ON APPLICABLE MODELS)

### **2.3. ACCESSORY CONNECTOR(PHONE JACK AND MIC JACK)**

PROVIDES ACCESSIBILITY FOR CONNECTION TO REMOTE ACCESSORIES SUCH AS A REMOTE SPEAKER MICROPHONE.

NOTE : THE ACCESSORY CONNECTOR PROTECTS THE ACCESSORY CONNECTOR. THIS COVER SHOULD REMAIN IN PLACE WHENEVER THE RADIO IS NOT BEING USED WITH AN ACCESSORY.

### **2.4. PUSH-TO-TALK(PTT) SWITCH**

WHEN DEPRESSED AND HELD, ENGAGES THE TRANSMITTER AND PUTS RADIO IN THE TRANSMIT MODE. WHEN RELEASED, THE RADIO OPERATES IN THE RECEIVE MODE.

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**2.5. MONITOR BUTTON**

SELECTS THE MODE OF OPERATION, CARRIER SQUELCH OR TONE SQUELCH.

CASE 1 ; IN CASE OF PRESSING THE MONITOR KEY FOR LESS THAN 2 SEC, CHECKS THE CHANNEL IN USE SCANNING EACH CHANNEL. THEN MONITOR OPERATION STOPS AS MONITOR KEY IS RELEASED, THE RECEIVE MODE BEGINS.

CASE 2 ; IN CASE OF PRESSING THE MONITOR KEY FOR 2 SEC, STOPS TO THE CHANNEL IN USE AND KEEPS THE RECEIVE MODE UNTIL IDENTIFYING THE NEXT MONITOR KEY. WHEN THE MONITOR KEY IS PRESSED, THE CURRENT OPERATION STOPS AND RETURNS TO THE RECEIVE MODE.

**2.6. ANTENNA**

HELIFLEX OR WHIP WITH THREADED BASE.

**2.7. LED INDICATOR**

A TRI-COLORED LIGHT-EMITTING DIODE(LED) INDICATES SCAN OPERATING STATUS.

**2.8. MULTIFUNCTION LED INDICATORS**

- 1) TRANSMIT MODE(PTT SWITCH DEPRESSED)
  - CONTINUOUS RED LIGHT : NORMAL TRANSMISSION
  - FLASHING RED LIGHT : LOW BATTERY
- 2) RECEIVE MODE(PTT SWITCH NOT DEPRESSED)
  - CONTINUOUS GREEN : CHANNEL MONITOR ACTIVE
  - FLASHING PINK : RECEIVING WITH TONE(CTCSS/DCS)
  - FLASHING GREEN : CHANNEL SCAN FEATURE ACTIVE
- 3) PC TO LMR PROGRAMMING DOWN-LOADING
  - FLASHING GREEN AND RED : DOWN-LOADING STANDBY STATUS
  - FLASHING PINK : DOWN-LOADING ACTIVE
- 4) LMR TO LMR CLONING
  - FLASHING GREEN AND RED : UP-LOADING STANDBY STATUS
  - FLASHING PINK : DOWN-LOADING ACTIVE



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## 2.9 TIME-OUT-TIMER(T.O.T) (PROGRAMMABLE)

THE T.O.T FEATURE ENDS A TRANSMISSION WHICH IS OVER 60/90/120/150/180 SECONDS IN LENGTH. AFTER TIME OUT, A CONTINUOUS ALERT TONE SOUNDS UNTIL THE PTT SWITCH IS RELEASED.

## 2.10 CHANNEL SCAN

TO INITIATE THE SCAN FEATURE, ROTATE THE CHANNEL SELSCTOR TO THE LOCATION WITH THE SCAN LIST PROGRAMMED TO IT.

- 1) NON PARIORITY CHANNEL SCAN(NOMAL SCAN)
- 2) PRIORITY CHANNEL SCAN

## 2.11 DEFINITION OF PRIORITY CHANNEL

- . ONLY ONE PRIORITY CHANNEL.
- . PARAMETER FORMAT IS DESIGNATED BY PC PROGRAM.
- . PRIORITY CHANNEL IS DESIGNATED BY PC PROGRAM.
- . HOME CHANNEL IS ALSO DESIGNATED BY PC PROGRAM.

### -. METHODS OF PRIORITY SCAN

PRIORITY SCAN IS PROCEEDED AS FOLLOWS ;

CH#1	P CH	CH#2	P CH	CH#3	.....	P CH	CH#N
------	------	------	------	------	-------	------	------

## 2.12 POWER SAVING MODE

- 1) POWER SAVING MODE OPERATES BY THE FOLLOWING CONDITIONS.
  - . ONLY IF THE RECEIVE MODE DOES NOT HAVE THE CARRIER, POWER SAVING MODE IS ON. BUT, IT IS OFF IN THE SCAN MODE.
  - . NO CARRIER.
  - . POWER SAVING MODE IS DESIGNATED BY PC PROGRAM.
- 2) POWER SAVING MODE STARTS AFTER 4 SEC OF THE FOLLOWING CONDITIONS
  - . AFTER POWER ON.
  - . AFTER SELECTING THE NEW CHANNEL.
  - . AFTER ENDING THE CALLS(AFTER RECEIVING OR TRANSMITTING)

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## 2.13 PROGRAMMING INSTRUCTIONS

### SET #1

CHANNEL	FREQ. (MHz)	CH SPACE (kHz)	TONE
1	150.025	12.5	NONE
2	160.025		
3	150.025	25	NONE
4	160.025		
5	NONE	NONE	NONE
6			
7			
8			
9			
10			

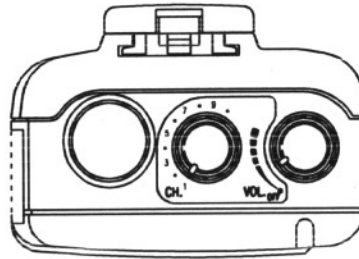
### SET #2

CHANNEL	FREQ. (MHz)	CH SPACE (kHz)	TONE
1	173.975	12.5	NONE
2	173.975	25	NONE
3	NONE	NONE	NONE
4			
5			
6			
7			
8			
9			
10			

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LINE DRAWING  
NT-20



ANTENNA

CHANEL V/R

SWITCH V/R

BELT CLIP

MONITOR

LED(TX/RX)

SPEAKER

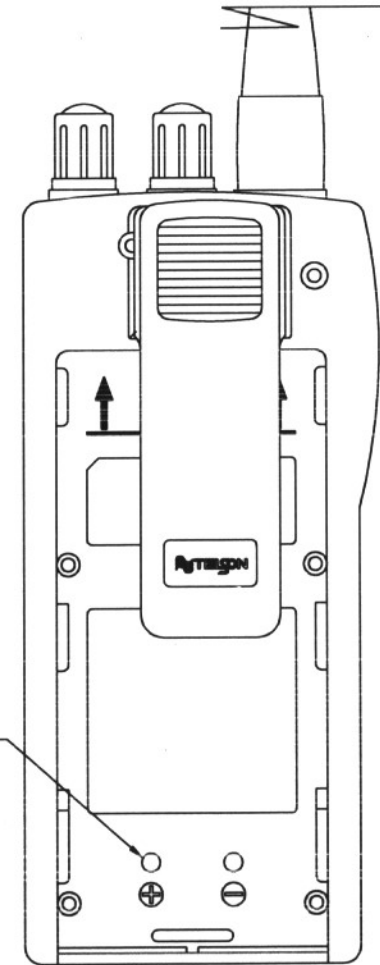
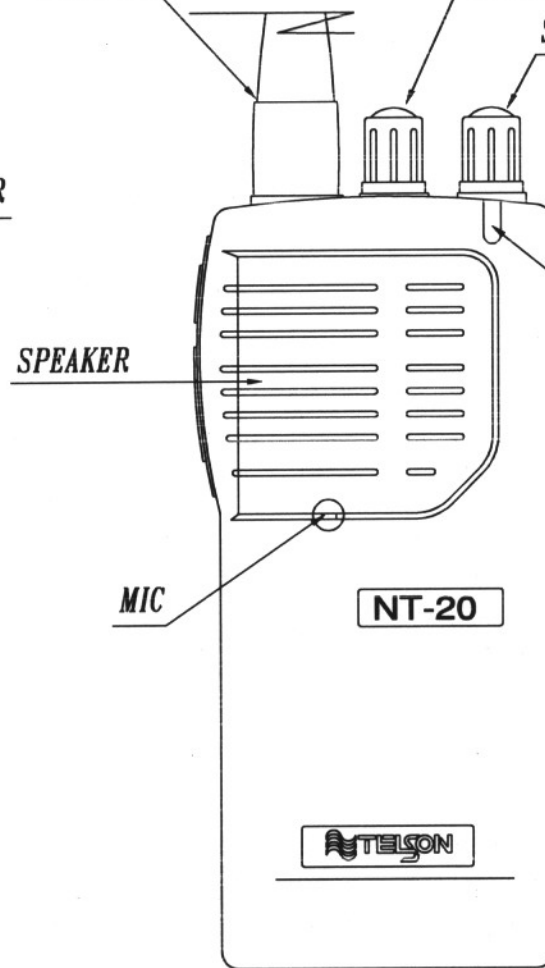
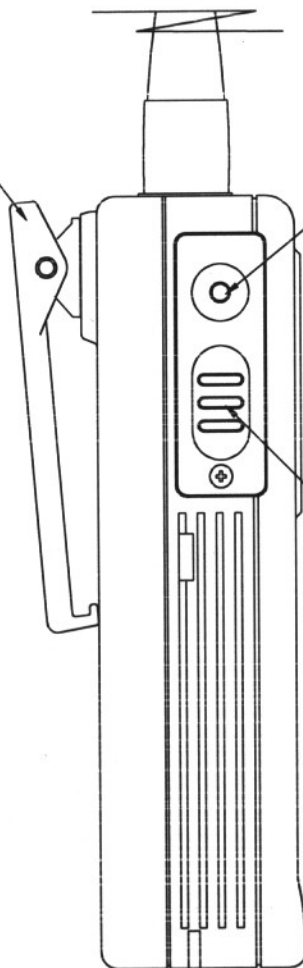
PTT

MIC

NT-20

TERMINAL

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### 3. GENERAL SPECIFICATIONS

1. NOMINAL OPERATING VOLTAGE	7.2V DC (NI-CD BATTERY 800mA/h)
2. TEMPERATURE	-30°C TO 60°C
3. ANTENNA IMPEDANCE	50Ω
4. MICROPHONE	CONDENSER MICROPHONE
5. SPEAKER IMPEDANCE AUDIO OUTPUT @ THD 10%	8Ω 450mW
6. FREQUENCY CONTROL	FREQ. SYNTHESIZED WITH E <sup>2</sup> PROM PROGRAMMING
7. FREQUENCY OF OPERATION	LOW 150.025MHz MID 162.025MHz HIGH 173.975MHz
8. PERFORMANCE BANDWIDTH	24MHz
9. FREQUENCY TOLERANCE AND STABILITY	±2.5PPM
10. DUTY CYCLE	5%(RX) 5%(TX) 90%(ST/BY)
11. HIGH HUMIDITY	95% @50°C PER EIA EIA RS-152-B SEC.13
12. VIBRATION STABILITY	EIA RS-152-B SEC.14
13. SHOCK STABILITY	EIA RS-152-B SEC.15
14. CHANNEL CAPABILITY	10 CHANNELS
15. CURRENT DRAIN	STANDBY 60mA RECEIVE 200mA TRANSMIT 800mA
16. SIZE(H×W×L)	37.5(H)×63.5(W)×133(L) IN mm
17. WEIGHT	360g WITH BATTERY
18. CHANNEL (SPACING CAPABILITY)	ANY MULTIPLE OF 12.5KHz OR 25KHz

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**4. RECEIVER PERFORMANCE SPECIFICATIONS**

1. SENSITIVITY	12dB SINAD 0.354 $\mu$ V @ 50 $\Omega$
2. SQUELCH SENSITIVITY	6 - 12dB SINAD
3. SQUELCH BLOCKING	DETECTABLE
4. RECEIVE ATTACK TIME	150ms MAX.(WITH TONE OPTION)
5. RECEIVE CLOSING TIME	200ms MAX.
6. SIGNAL DISPLACEMENT BANDWIDTH	MORE THAN 12KHz
7. ADJACENT CHANNEL SENSITIVITY	60dB MIN. (70dB)
8. SPURIOUS RESPONSE REJECTION	60dB MIN. (70dB)
9. INTERMODULATION REJECTION	60dB MIN.
10. OFFSET CHANNEL SELECTIVITY	18dB MIN. (REFER TO RS-119)
11. AUDIO FREQUENCY RESPONSE	PER EIA
12. HUM & NOISE	40dB MIN.

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**5. TRANSMITTER PERFORMANCE SPECIFICATIONS**

1. RF POWER OUTPUT	2Watt
2. SPURIOUS & HARMONIC EMISSION	60dB MIN.
3. FM HUM & NOISE	34dB MIN. (40dB CCITT)
4. AUDIO FREQUENCY RESPONSE	PER EIA
5. AUDIO FREQUENCY DISTORTION	5% MAX.
6. ADJACENT CHANNEL POWER RATIO	70dB MIN.

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## **6. THEORY OF OPERATION**

### **6.1 FREQUENCY GENERATION CIRCUITRY**

THE FREQUENCY GENERATION CIRCUITRY IS COMPOSED OF THE SYNTHESIZER IC (U103) AND THE VCO. THE BLOCK DIAGRAM ILLUSTRATES THE INTERCONNECT AND SUPPORT CIRCUITRY USED IN THE DESIGN. REFER TO THE SCHEMATIC FOR REFERENCE DESIGNATOR.

THE SUPPLY FOR THE SYNTHESIZER IS REGULATED 5 VOLTS WHICH ALSO SERVES THE REST OF THE RADIO. IN ADDITION TO THE VCO, THE SYNTHESIZER MUST INTERFACE WITH THE LOGIC AND AF FILTER CIRCUITRY. PROGRAMMING FOR THE SYNTHESIZER IS ACCOMPLISHED THROUGH THE CLOCK, DATA AND ENABLE SIGNALS (PIN 9, 10 AND 11) FROM THE MICROPROCESSOR U200.

A SERIAL DATA IS SENT WHENEVER THE SYNTHESIZER IS PROGRAMMED. A 5 VOLTS DC SIGNAL FROM PIN 7 INDICATES TO THE MICROPROCESSOR THAT THE SYNTHESIZER IS LOCKED. WHILE UNLOCK IS INDICATED BY A LOW VOLTAGE ON THIS PIN. THE AUDIO SIGNAL FROM THE AF FILTER IS MODULATED BY THE VARICAP DIODE D107 OF VCO.

#### **6.1.1 PLL FREQUENCY SYNTHESIZER**

THE U103 PLL IC INCLUDES ALL THE FUNCTIONS SUCH AS THE PHASE COMPARATOR, THE PROGRAMMABLE DIVIDER, THE LOCK DETECTOR, AND REFERENCE OSCILLATOR. THE SYNTHESIZER USES A 14.4 MHz CRYSTAL (U104) TO PROVIDE THE REFERENCE FREQUENCY FOR THE SYSTEM. THE OTHER REFERENCE OSCILLATOR COMPONENTS EXTERNAL TO THE IC (U103) ARE VR5, R145, R146, AND R147. THE 14.4 MHz SIGNAL IS DIVIDED INTO THE RF SIGNAL FROM THE VCO.

THE CHARGE PUMP CIRCUIT AND LOOP FILTER, COMPRISED OF Q106, Q107 AND C178, C179, C180, R138, R139, R140, R141, PROVIDE THE NECESSARY DC STEERING VOLTAGE FOR THE VCO AS WELL AS FILTERING OF SPURIOUS SIGNALS FROM THE PHASE DETECTOR. THE PRE-SCALER FOR THE LOOP IS INTERNAL TO U103 WITH THE VALUE DETERMINED BY THE FREQUENCY BAND OF OPERATION.

THE TCXO(14.4MHz) IS THE TEMPERATURE COMPENSATION CIRCUIT TO MAINTAIN THE FREQUENCY WITHIN THE ALLOWABLE ERROR RANGE EVEN UNDER A LOW TEMPERATURE OF -30°C.

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**6.1.2 VCO**

THE VCO IS OSCILLATED BY THE CONTROL VOLTAGES SUPPLIED FROM THE SYNTHESIZER(U103) AND CONSISTS OF THE COLPITTS OSCILLATOR OF THE Q108(RX) AND Q110(TX).

THE OPERATION OF RX AND TX IS SELECTED BY 5.5V SWITCH TR(Q121, Q122) AND THE VCO OSCILLATES FROM 150.000MHz TO 174.000MHz BY CONTROL VOLTAGE(1.2~5.4V) GENERATED FROM THE SYNTHESIZER. THE RX VCO OSCILLATES FROM 171.400MHz TO 195.400MHz BY CONTROL VOLTAGE(1.2~5.4V).

IN THE TRANSMIT MODE, THE VCO IS OSCILLATED BY THE COLPITTS OSCILLATOR, WHICH CONSISTS OF Q110, C196, C197, C198, VC2, C199, C201, C202, L123, D106 AND D107.

C191 AND D107 MODULATE THE VOICE SIGNALS PROCESSED FROM THE AF BOARD. THE PASSIVE FILTER, WHICH CONSISTS OF C205, L95, C206, AND C204, STABLY MAINTAINS THE VOLTAGE TO BE SUPPLIED INTO THE TX VCO.

IN THE RECEIVE MODE, THE VCO IS OSCILLATED BY THE COLPITTS OSCILLATOR, WHICH CONSISTS OF Q108, C185, C186, VC1, C187, C189, C190, L122 AND D105.

THE ACTIVE FILTER, WHICH CONSISTS OF Q109, R159, R160, C194, AND C193, STABLY MAINTAINS THE VOLTAGE TO BE SUPPLIED INTO THE RX VCO. THE Q112 AND PERIPHERAL COMPONENTS AMPLIFY AN RF CARRIER OSCILLATED FROM TX AND RX VCO, MAINTAIN 0dBm OUTPUT LEVEL AND REJECT THE EFFECTS OF REVERSE POWER CONNECTED TO OUTPUT TERMINAL.

**6.1.3 TX DRIVE**

IN ORDER TO MAINTAIN THE SUFFICIENT OUTPUT OF RF POWER, THE TX DRIVE STAGE AMPLIFIES 300mW. IT IS COMPOSED OF Q114, Q115, L128 L129, L96, L130, L131, L132, C220, C224, C225, C230 AND C231.

**6.1.4 TX MODULE**

THE TX MODULE WHICH IS COMPOSED OF Q99, C235, C236, L134 AND L133, FINALLY AMPLIFIES THE RF CARRIER. IT AMPLIFIES 300mW OBTAINED FROM TX DRIVE TO 2W. THE VOLTAGE OF TX MODULE IS SUPPLIED FROM BATTERY AFTER BEING STABILIZED BY C243, C245, C241, AND C239.

THE L104 NOT ONLY SUPPLIES A VOLTAGE BUT ALSO REMOVES THE SPURIOUS RADIATIONS.

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**6.1.5 ANTENNA SWITCH**

THE ANTENNA SWITCH IS COMPOSED OF SWITCHING PART AND LOW PASS FILTER, THE FORMER SELECTS TX CARRIER OR RX SIGNAL AND THE LATTER REMOVES THE SPURIOUS RADIATION IN TRANSMIT MODE.

THE TX/RX SWITCHING IS ACCOMPLISHED WITH THE PIN DIODE D101 AND D102.

IN TRANSMIT MODE, 5.5V IS APPLIED TO L104, D100 AND D101 IS ON, THE RF CARRIER TO BE RECEIVED IS BLOCKED BY THEM, AND THEN AN RF CARRIER PASSED BY LOW PASS FILTER RADIATES THROUGH AN ANTENNA.

IN RECEIVE MODE, AS THE SUPPLY VOLTAGE IS NOT APPLIED TO PIN DIODES, TX IS OPEN, THEN THE RF CARRIER TO BE RECEIVED IS APPLIED.

A LOW PASS FILTER USES 3rd ORDER LPF IN ORDER TO REMOVE THE SPURIOUS RADIATIONS.

IN TRANSMIT MODE, THE INSERTION LOSS IS LESS THAN 1dB, WHEREAS IN RECEIVE MODE, THE INSERTION LOSS IS LESS THAN 1.2dB.

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## **6.2 RECEIVER**

THE RECEIVER OF THE NT-20 CONSISTS OF 4 MAJOR BLOCKS EACH : FRONT-END, RF MIXER, 21.4MHz IF AND IF IC.

### **6.2.1 FRONT-END**

FRONT-END SELECTS AND AMPLIFIES THE SIGNALS OF WANTED BAND AMONG RF SIGNALS EXISTING IN THE FREE SPACE. IT CONSISTS OF THE FILTER AND LNA(LOW NOISE AMPLIFIER).

THE FILTER IS COMPOSED OF TWO PART, ONE IS 2nd ORDER HELICAL FILTER BEFORE AN LNA AND THE OTHER IS 1st ORDER HELICAL FILTER AFTER AN LNA, AND SELECTS THE BANDS BETWEEN 150MHz AND 174MHz.

ESPECIALLY THE BILATERAL DIODE D103 BLOCKS FOR LNA TO BE BROKEN OR SATURATED BY LIMITING THE CRITICAL RF SIGNALS FROM AN ANTENNA.

THE GAIN OF AN LNA(Q100) IS 13dB, AMPLIFIES THE SIGNALS MAXIMALLY, AND HAS THE MINIMUM NOISE FIGURE.

### **6.2.2 MIXER**

THE MIXER WHICH IS USED FET(Q101), GENERATE THE FIRST IF 21.4MHz BY MIXING THE RF CARRIER SIGNAL AND LOCAL SIGNAL FROM THE SYNTHESIZER. ITS FREQUENCY IS  $F_{IF} = F_{RF} \pm F_{LOCAL}$ .

### **6.2.3 LOCAL DRIVE**

IT SUPPLIES 171.4MHz~195.4MHz GENERATED FROM THE SYNTHESIZER INTO MIXER, AND BLOCKS TO AFFECT THE UNWANTED FREQUENCY GENERATED IN MIXING TO THE VCO. IT IS COMPOSED OF THE BUFFER(Q113), PERIPHERAL CAPACITORS AND RESISTORS. THE SIGNALS TO BE BUFFERED MAXIMALLY LIMIT THE SPURIOUS BY USING 2dB RESISTOR PAD AND 1st ORDER LOW PASS FILTER.

### **6.2.4 CRYSTAL FILTER AND IF AMP**

THE CRYSTAL FILTER CONSISTS OF A PAIR OF F2 AND F3, ITS PASS BAND WIDTH IS  $\pm 10$ kHz FOR 12.5kHz AND 25kHz. ITS RIPPLE IS LESS THAN 1dB AND INSERTION LOSS IS 4dB.

THE IF AMP AMPLIFIES THE FREQUENCY SELECTED BY THE CRYSTAL FILTER AND

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CONSISTS OF Q102 AND PERIPHERAL RESISTORS AND CAPACITORS.

THE GAIN OF AN IF AMP IS 20dB AND THE DISSIPATED CURRENT IS LESS THAN 5mA.

**6.2.5 IF IC**

THE IF IC(U102) CONSISTS OF THE 2nd MIXER, CERAMIC FILTER, PARALLEL LCR QUADRATURE TANK COIL, AND NOISE SQUELCH.

THE 2nd MIXER GENERATE THE SECOND IF 455kHz BY MIXING THE FIRST IF 21.4MHz AND LOCAL FREQUENCY 20.945MHz(X100). THEN THIS SIGNAL DECIDES THE ACR (ADJACENT CHANNEL REJECTION) IN PASSING CERAMIC FILTER(F4). THE PARALLEL LCR QUADRATURE TANK COIL(T3) AND DAMPING RESISTOR(R109) OPERATE WITH A QUADRATURE CIRCUITRY, AND ENABLE THE RECOVERED AUDIO BY 90° PHASE SHIFTING IF CENTER FREQUENCY. THE DAMPING RESISTOR DETERMINES THE PEAK SEPARATION OF THE DETECTOR AND IS SOMEWHAT CRITICAL.

WHEN THE WANTED SIGNAL IS NOT DETECTED, THE NOISE SQUELCH CIRCUITRY BLOCKS THE AUDIO BY USING THE DETECTED NOISE OF RECEIVER.

THE NOISE FILTER CONSISTS OF C159, C160, C161, 162, L91 AND L92, CONTROLS Q104, D104, Q103 BY SENSING THE FREQUENCY OF 15kHz TO 30kHz. THEN THE NOISE SQUELCH SIGNAL IS INDICATED TO MPU(U200) P2.0

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## 6.3 LOGIC PART

THE LOGIC IS COMPOSED OF THE MPU(MICROPROCESSOR UNIT) TO CONTROL ALL THE FUNCTIONS OF NT-20, MICROPHONE AMPLIFIER, ANALOG SWITCH, 300Hz HIGH PASS FILTER, ALC(AUTOMATIC LEVEL CONTROL) CIRCUIT, IDC(INSTANTANEOUS DEVIATION CONTROL) CIRCUIT, 3kHz LOW PASS FILTER, LOW PASS FILTER LESS THAN 250.3Hz, TONE DATA DETECTOR, AUDIO AMP, AND TONE GENERATION AND SO FORTH.

### 6.3.1 MPU(MICROPROCESSOR UNIT)

THE MPU(U200) IS THE HIGH SPEED AND HIGH PERFORMANCE 8-BIT SINGLE CHIP MICROCOMPUTER. THE MPU CONTAIN CPU CORE, 8KBYTE ROM, 256KBYTE RAM, INPUT/OUTPUT PORTS, AN A/D CONVERTER, SIX MULTI-FUNCTION TIMER/COUNTERS, TWO SERIAL INTERFACES, AND TWO CLOCK GENERATORS ON A CHIP.

#### MPU PORT ASSIGNMENT

PORT	PORT DEFINITION	FUNCTION	PORT	PORT DEFINITION	FUNCTION
P0	P0.0	PLL LOCK DETECTOR	P4	P4.0	NO CONNECTION
	P0.1	SERIAL DATA OUTPUT		P4.1	EXT PTT CONTROL
	P0.2	NO CONNECTION		P4.2	NO CONNECTION
	P0.3	NO CONNECTION		P4.3	NO CONNECTION
	P0.4	CALL TONE GENERATOR		P4.4	12.5/25KHz SELECT CONTROL
	P0.5	CALL TONE GENERATOR		P4.5	NO CONNECTION
	P0.6	CALL TONE GENERATOR		P4.6	DEVIATION CONTROL
	P0.7	CALL TONE GENERATOR		P4.7	NO CONNECTION
P1	P1.0	NO CONNECTION	P5	P5.0	MONITOR KEY
	P1.1	SPEAKER MUTE		P5.1	PTT KEY
	P1.2	TONE DETECTOR		P5.2	MSEL CLOCK GENERATOR
	P1.4	U201-C CONTROL		P5.3	RX POWER CONTROL
	P1.5	U201-B CONTROL		P5.4	NO CONNECTION
	P1.6	U201-A CONTROL	P6	P6.0	CH SWITCH SELECTION
	P1.7	NO CONNECTION		P6.1	"
				P6.2	"
P2	P2.0	SQUELCH	P6	P6.3	"
	P2.1	NO CONNECTION		P6.4	E <sup>2</sup> PROM DATA OUTPUT
	P2.2	NO CONNECTION		P6.5	E <sup>2</sup> PROM DATA INPUT
				P6.6	E <sup>2</sup> PROM CLOCK
P3	P3.0	RED LED		P6.7	E <sup>2</sup> PROM CHIP SELECTOR
	P3.1	NO CONNECTION	P7	P7.0	TONE DATA GENERATOR
	P3.2	GREEN LED		P7.1	"
	P3.3	NO CONNECTION		P7.2	"
	P3.4	TX POWER CONTROL		P7.3	"
	P3.5	NO CONNECTION		P7.4	PLL ENABLE
	P3.6	NO CONNECTION		P7.5	PLL DATA
	P3.7	NO CONNECTION		P7.6	PLL CLOCK
				P7.7	LOW BATTERY DETECTOR

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### 6.3.2 MIC AMP

THE MIC AMP IS THE AMPLIFIER WHICH AMPLIFIES THE MICROPHONE GAIN(66dB) BY USING OP AMP U204B, R342, AND R343

### 6.3.3 ANALOG SWITCH

ANALOG SWITCH U201 CONTROLS THE FLOW OF EACH SIGNAL, AND OPERATES AS THE FOLLOWING TABLE

**SELECTION GUIDE OF AUDIO FILTER(U201 CONTROL)**

MODE	SELECT MODE	P1.6(a)	P1.5(b)	P1.4(c)
TX	AUDIO	1	×	×
	AUDIO+CTCSS AUDIO+DCS	1	1	1
RX	AUDIO	0	×	×
	AUDIO+CTCSS AUDIO+DCS	0	0	0

### 6.3.4 HIGH PASS FILTER

THE HIGH PASS FILTER PASSES THE VOICE SIGNALS OF 300Hz ABOVE, AND REJECTS SUBAUDIBLE SIGNAL(CTCSS AND DCS) TO BE AMPLIFIED AT AUDIO AMP

THE HIGH PASS FILTER CONSISTS OF THE 6th HPF OF U202A, U202B, U202C AND THE 4th CHEBYSHEV HPF OF U202D. THE FILTER GIVES 20dB OF THE REJECTION BETWEEN 250Hz AND 300Hz.

### 6.3.5 ALC, IDC, LOW PASS FILTER AND DATA DETECTOR

THE ALC(AUTOMATIC LEVEL CONTROL) CIRCUIT AND IDC(INSTANTANEOUS DEVIATION CONTROL) CIRCUIT IS COMPOSED OF U203A, U203D, R320, R323, R324, R325, R326, VR20 AND C325. THESE CIRCUITS PREVENTS SIGNALS FROM AMPLIFYING WHEN A SIGNAL GREATER THAN REFERENCE LEVEL ENTERS. THE ALC AND IDC HAS THE DC 1.9V REFERENCE VOLTAGE, AMPLIFIES THE LEVEL FROM 0 TO 3.8V, AND SATURATES THE SIGNALS MORE THAN 3.8V TO KEEP THE CONSTANT LEVEL.

Q132, R330 AND R328 HAS THE FUNCTION OF KEEPING THE CONSTANT DEVIATION FOR EACH CHANNEL.

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THE LOW PASS FILTER CONSISTS OF THE 6th BUTTERWORTH LPF(U205) IS DESIGNED TO PASS THE FREQUENCY LESS THAN 254.1Hz.

THIS FILTER IS USED TO TRANSMIT OR RECEIVE THE CTCSS/DCS TONES.

THE DATA DETECTOR DETECTS THE ANALOG SIGNAL OF RECEIVED CTCSS OR DCS, LETS THE MPU IDENTIFY, AND CONSISTS OF U207B, R357, R360, R359, R358, C362, C363 AND C364.

### **6.3.6 AUDIO AMP AND TONE GENERATION**

THE AUDIO AMP AMPLIFIES AN AUDIO SIGNAL FOR A USER TO LISTEN TO THE VOICE, ALSO AMPLIFIES AN BEEP TONE OF EACH FUNCTION. IT IS COMPOSED OF THE VOLUME SWITCH, MUTE CIRCUITRY(Q134, Q135), AND AUDIO AMP(U206).

THE TONE GENERATION USES THE FOUR PORTS OF MPU, GENERATES THE TONES WITH THE DISTRIBUTED VALUE OF RESISTORS, AND CONSISTS OF R401, R402, R403, R404 AND R400.

### **6.3.7 PTT KEY AND MONITOR KEY**

THE PTT KEY IS COMPOSED OF SW2, R341 AND C346. WHEN THE PTT IS PRESSED, THE VOLTAGE TO FLOW THROUGH R341 LETS BE GROUNDED AND THEN "L" SIGNAL IS SENT TO MPU(U500) P5.1.

THE MONITOR KEY IS USED TO KNOW IF ONE'S CHANNEL IS USED OR NOT, AND CONSISTS OF SW1, C396, C397 AND R385. WHEN THE MONITOR KEY IS PRESSED, "H" LEVEL IS CHANGED TO "L", AND THEN "L" SIGNAL IS SENT TO MPU P5.0.

### **6.3.8 MULTIFUNCTION LED INDICATORS**

THE LED(LED501) HAS TWO COLORS, AND THE OPERATING COLORS ARE AS FOLLOWS.

- 1) TRANSMIT MODE(PTT SWITCH DEPRESSED)
  - CONTINUOUS RED LIGHT : NORMAL TRANSMISSION
  - FLASHING RED LIGHT : LOW BATTERY
- 2) RECEIVE MODE(PTT SWITCH NOT DEPRESSED AND CARRIER IN)
  - CONTINUOUS GREEN : NORMAL RECEPTION
  - FLASHING PINK : RECEPTION MODE WITH TONE OPTION
  - FLASHING GREEN : CHANNEL SCAN FEATURE ACTIVE
- 3) PC TO LMR PROGRAM DOWN-LOADING
  - FLASHING GREEN AND RED : DOWN-LOADING STANDBY STATUS
  - FLASHING PINK : DOWN-LOADING ACTIVE

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## 7. TRANSISTOR AND IC FUNCTION

SYMBOL	TYPE NUMBER	MODE	FUNCTION
Q100	BF998	RX	LOW NOISE AMP
Q101	BF998	RX	RF MIXER
Q102	2SC4226	RX	IF AMPLIFIER
Q103	KTC3875	RX	NOISE SQUELCH CONTROL
Q104	KTC3875	RX	NOISE SQUELCH CONTROL
Q126	KRC113S	RX	NOISE SQUELCH CONTROL
Q127	KRC113S	RX	NOISE SQUELCH CONTROL
Q105	KTA1504	RX/TX	LOCK DETECTOR
Q106	KTA1504	RX/TX	PLL CHARGE PUMP
Q107	KTC3875	RX/TX	PLL CHARGE PUMP
Q108	2SC4226	RX	RX VCO OSCILLATOR
Q109	KTA1504	RX	RX VCO VOLTAGE ACTIVE FILTER
Q110	2SC4226	TX	TX VCO OSCILLATOR
Q112	2SC4226	RX/TX	RX/TX VCO BUFFER
Q113	2SC4226	RX	RX LOCAL BUFFER
Q114	2SC3356	TX	TX DRIVER BUFFER
Q115	BFG94	TX	TX DRIVE AMPLIFIER
Q99	BLT50	TX	TX RF FINAL AMPLIFIER
Q118	KRC113S	TX	TX AMP SUPPLY VOLTAGE ON/OFF CONTROL
Q120	KRA224S	TX	EXT PTT CONTROL
Q121	KRA224S	TX	TX VOLTAGE SWITCHING
Q122	KRA224S	RX	RX VOLTAGE SWITCHING
Q131	KRC113S	TX	12.5/25kHz MODULATION CONTROL
Q132	KRC113S	TX	MAX DEVIATION STABILITY CONTROL
Q133	KRA224S	TX	MICROPHONE MUTE CONTROL
Q134	KRC113S	RX	AUDIO MUTE CONTROL
Q135	KTA1505	RX	AUDIO MUTE CONTROL
U102	MC3361BD	RX	IF IC
U101	PF0350	TX	TX POWER MODULE IC
U103	MB15A02	RX/TX	PLL IC
U103	MC3361BD	RX	IF IC
U104	14.4MHz OSC	RX/TX	TCXO MODULE
U105	TK11455	RX/TX	REGULATOR IC (DC 5.5V)
U106	TK11460	TX	REGULATOR IC (DC 6V)
U200	TMP87C841	RX/TX	MPU IC
U201	NJU4053	RX/TX	AUDIO ANALOG SWITCH
U202	NJM324	RX/TX	AUDIO HIGH PASS FILTER
U203	NJM324	TX	ALC, IDC, SPLATTER FILTER
U204	NJM324	RX/TX	AUDIO BUFFER AND HIGH PASS FILTER
U205	MSELP	RX/TX	TONE FILTER IC
U206	NJM386	RX	AUDIO POWER AMP
U207	GL393D	RX	TONE DATA DETECTOR
U210	AT93C66	RX/TX	E <sup>2</sup> PROM
U211	TK11450	RX/TX	REGULATOR IC (DC 5V)
U212	TC4S66F	TX	AUDIO ANALOG SWITCH



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**WARNING**

• You must not make, or have made, any internal modification to an NT-20 unit. Any internal modification cancels the FCC certification and voids your authority to operate the unit in the NT-20.

• You may not attach any antenna, power amplifier, or other apparatus to an NT-20 unit that has not been FCC certified as part of that NT-20 unit. There are no exceptions to this rule and attaching any such apparatus to a NT-20 unit cancels the FCC certification and voids everyone's authority to operate the unit in the NT-20.

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## 9. PARTS LIST

ITEM	NAME & DESCRIPTION	REF. NO.	Q'TY	MAKER
1	TANTALUM CAP. ; 10uF/16V	C95,131,175,227,247,263,266,314, 329,335,342,371,404	13	SPRAGUE
2	TANTALUM CAP. ; 22uF/6.3V	C150,173,193,204,257,389,406	7	SPRAGUE
3	TANTALUM CAP. ; 47uF/10V	C165,239,369	3	SPRAGUE
4	TANTALUM CAP. ; 3.3uF/16V	C174,178	2	SPRAGUE
5	TANTALUM CAP. ; 4.7uF/16V	C232,	1	SPRAGUE
6	TANTALUM CAP. ; 68uF/10V	C243	1	SPRAGUE
7	TANTALUM CAP. ; 0.1uF/35V	C179,180,361,365,383	5	SPRAGUE
8	TANTALUM CAP. ; 100uF/6.3V	C374	1	SPRAGUE
9	TANTALUM CAP. ; 1uF/16V	C363	1	
10	CHIP CERAMIC CAP. ; 0.001uF	C100,115,123,137,151,171,208,212, 223,228,234,245,337,346,356,376, 380,386,397,398,399,400,401,450, 451,	25	MURATA
11	CHIP CERAMIC CAP. ; 12pF	C101,220	2	MURATA
12	CHIP CERAMIC CAP. ; 4pF	C102,118,186,198	4	MURATA
13	CHIP CERAMIC CAP. ; 30pF	C103,104,196	3	MURATA
14	CHIP CERAMIC CAP. ; 33pF	C105,111,114,117,230,237	6	MURATA
15	CHIP CERAMIC CAP. ; 5pF	C106,134	2	MURATA
16	CHIP CERAMIC CAP. ; 24pF	C107	1	MURATA
17	CHIP CERAMIC CAP. ; 68pF	C108,142	2	MURATA
18	CHIP CERAMIC CAP. ; 82pF	C109	1	MURATA
19	CHIP CERAMIC CAP. ; 3pF	C110,116,210	3	MURATA
20	CHIP CERAMIC CAP. ; 22pF	C121	1	MURATA
21	CHIP CERAMIC CAP. ; 0.1uF	C122,136,144,145,146,147,148,152, 166,169,192,205,206,207,233,246, 248,255,256,258,262,265,302,306, 313,315,322,324,330,341,358,366, 368,370,372,385,388,390,391,395, 405,407	42	MURATA
22	CHIP CERAMIC CAP. ; 20pF	C125,185,202	3	MURATA
23	CHIP CERAMIC CAP. ; 15pF	C126,187,190,236	4	MURATA

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ITEM	NAME & DESCRIPTION	REF. NO.	Q'TY	MAKER
24	CHIP CERAMIC CAP. ; 0.01uF	C138,153,158,159,188,200,211,222, 226,241,349,384,387,396,403	15	MURATA
25	CHIP CERAMIC CAP. ; 120pF	C143	1	MURATA
26	CHIP CERAMIC CAP. ; 0.022uF	C154	1	MURATA
27	CHIP CERAMIC CAP. ; 47pF	C155,224	2	MURATA
28	CHIP CERAMIC CAP. ; 0.082uF	C156	1	MURATA
29	CHIP CERAMIC CAP. ; 220pF	C157	1	MURATA
30	CHIP CERAMIC CAP. ; 6800pF	C160,355,359	3	MURATA
31	CHIP CERAMIC CAP. ; 5600pF	C161,364	2	MURATA
32	CHIP CERAMIC CAP. ; 3300pF	C162,357	2	
33	CHIP CERAMIC CAP. ; 4700pF	C163	1	MURATA
34	CHIP CERAMIC CAP. ; 0.047uF	C167,303,304,305,307,308,311,312, 316,317,318,319,343,344,345,347, 348,360	18	MURATA
35	CHIP CERAMIC CAP. ; 2700pF	C168	1	MURATA
36	CHIP CERAMIC CAP. ; 2pF	C170	1	MURATA
37	CHIP CERAMIC CAP. ; 9pF	C189	1	MURATA
38	CHIP CERAMIC CAP. ; 2.4pF	C191,203	2	MURATA
39	CHIP CERAMIC CAP. ; 1pF	C197	1	MURATA
40	CHIP CERAMIC CAP. ; 27pF	C199,381,382	3	MURATA
41	CHIP CERAMIC CAP. ; 10pF	C201,209,213,235	4	MURATA
42	CHIP CERAMIC CAP. ; 5.6pF	C231	1	MURATA
43	CHIP CERAMIC CAP. ; 470pF	C172,177,259,260,261,264,267,301, 309,323,336,338,350,377	14	MURATA
44	CHIP CERAMIC CAP. ; 1uF	C176,321,367	3	MURATA
45	CHIP CERAMIC CAP. ; 56pF	C325,340	2	MURATA
46	CHIP CERAMIC CAP. ; 0.015uF	C326	1	MURATA
47	CHIP CERAMIC CAP. ; 1800pF	C327	1	MURATA
48	CHIP CERAMIC CAP. ; 820pF	C328	1	MURATA
49	CHIP CERAMIC CAP. ; 3900pF	C331	1	MURATA
50	CHIP CERAMIC CAP. ; 270pF	C332	1	MURATA

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ITEM	NAME & DESCRIPTION	REF. NO.	Q'TY	MAKER
51	CHIP CERAMIC CAP. ; 2200pF	C339	1	MURATA
52	CHIP CERAMIC CAP. ; 0.056uF	C373	1	MURATA
53	CHIP CERAMIC CAP. ; 6pF	C96	1	MURATA
54	TRIMMER CAP. ; 6pF	VC1,VC2	2	MURATA
55	PIN DIODE ; MMBV3401	D101,102	2	MOTOROLA
56	CHIP DIODE ; KDS226	D103	1	KEC
57	CHIP DIODE ; KDS193	D104,204,206	3	KEC
58	VARICAP DIODE ; HVU356	D105,106	2	HITACHI
59	VARICAP DIODE ; KDV154C	D107	1	KEC
60	PIN DIODE ; KDV175	D109	1	KEC
61	CHIP DIODE ; KDS181	D201	1	KEC
62	TVS DIODE ; SM12	D202	1	SEMTECH
63	CRYSTAL FILTER ; 21M12BU5	F2.3	1	KONY
64	CERAMIC FILITE ; CFWM455G	F5	1	MURATA
65	FUSE ; 4A	F10	1	KOA
66	CHIP COIL ; 4.7uH	L90,99,120,121,125	5	TDK
67	CHIP COIL ; 820uH	L91,92	2	TOKO
68	CHIP COIL ; 10uH	L95,202,200	3	MURATA
69	CHIP COIL ; 56nH	L96,127,212	3	TOKO
70	SPRING COIL ; 65nH	L100,101,102,103	4	LS
71	CHIP COIL ; 1.2uH	L104,132	2	KOA
72	CHIP COIL ; 39nH	L122,123	2	TOKO
73	CHIP COIL ; 220nH	L124	1	TOKO
74	CHIP COIL ; 220nH	L130	1	KOA
75	CHIP COIL ; 100nH	L126	1	TOKO
76	CHIP COIL ; 22nH	L128	1	TOKO
77	CHIP COIL ; 560nH	L129	1	TOKO
78	CHIP COIL ; 18nH	L131	1	TOKO
79	SPRING COIL ; 25nH	L133	1	LS
80	SPRING COIL ; 38nH	L134	1	LS

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ITEM	NAME & DESCRIPTION	REF. NO.	Q'TY	MAKER
81	CONDENSER MIC ; CMP-66	M1	1	BSE
82	LED	LED501	1	HP
83	SPEAKER 8ohm	SP1	1	KYRIN
84	RF SI-TRANSISTOR ; BLT50	Q99	1	PHILIPS
85	MOS FET ; BF998	Q100,101	2	PHILIPS
86	RF SI-TRANSISTOR ; 2SC4226	Q102,108,110,112,113	5	NEC
87	CHIP SI-TRANSISTOR ; KTC3875	Q103,104,107	3	KEC
88	RF SI-TRANSISTOR ; 2SC3356	Q114	1	NEC
89	RF SI-TRANSISTOR ; BFG94	Q115	1	PHILIPS
90	SWITCHING TRANSISTOR ; KRC113S	Q118,126,127,131,132,134	6	KEC
91	SWITCHING TRANSISTOR ; KRA224S	Q120,121,122,133	4	KEC
92	CHIP SI-TRANSISTOR ; KTA1505	Q135	1	KEC
93	CHIP SI-TRANSISTOR ; KTA1504	Q105,106,109	3	KEC
94	CHIP RESISTOR ; 56ohm	R91	1	ROHM
95	CHIP RESISTOR ; 6.8Kohm	R92,313,342,365	4	ROHM
96	CHIP RESISTOR ; 10Kohm	R93,97,118,134,137,148,156,157, 159,162,163,168,176,351,381	15	ROHM
97	CHIP RESISTOR ; 47Kohm	R95,130,131,132,146,185,306,352, 353,367,386,387,390,391,392,394, 395,396,397,400	20	ROHM
98	CHIP RESISTOR ; 100ohm	R96,99,110,124,147	5	ROHM
99	CHIP RESISTOR ; 470ohm	R105,139,158,164	4	ROHM
100	CHIP RESISTOR ; 270Kohm	R106	1	ROHM
101	CHIP RESISTOR ; 68Kohm	R109,350	2	ROHM
102	CHIP RESISTOR ; 22Kohm	R111,113,114,115,379	5	ROHM
103	CHIP RESISTOR ; 33Kohm	R112,125,142,328,334,340,341,360 385	9	ROHM
104	CHIP RESISTOR ; 3.3Kohm	R116,357	2	ROHM
105	CHIP RESISTOR ; 2.7Kohm	R117,140,307	3	ROHM
106	CHIP RESISTOR ; 4.7Kohm	R119,169,172,177,315	5	ROHM
107	CHIP RESISTOR ; 5.6Kohm	R120,180,369	3	ROHM
108	CHIP RESISTOR ; 180Kohm	R121	1	ROHM

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ITEM	NAME & DESCRIPTION	REF. NO.	Q'TY	MAKER
109	CHIP RESISTOR ; 10ohm	R133,174,371	3	ROHM
110	CHIP RESISTOR ; 12Kohm	R135,136,314	3	ROHM
111	CHIP RESISTOR ; 2.2Kohm	R141,399	2	ROHM
112	CHIP RESISTOR ; 100Kohm	R143,144	2	ROHM
113	CHIP RESISTOR ; 20Kohm	R145,320	2	ROHM
114	CHIP RESISTOR ; 220Kohm	R149,301	2	ROHM
115	CHIP RESISTOR ; 680Kohm	R150	1	ROHM
116	CHIP RESISTOR ; 56Kohm	R160,336,337,405	4	ROHM
117	CHIP RESISTOR ; 680ohm	R170	1	ROHM
118	CHIP RESISTOR ; 15Kohm	R171,312,325,380	4	ROHM
119	CHIP RESISTOR ; 430ohm	R173,175	2	ROHM
120	CHIP RESISTOR ; 1ohm	R178	1	ROHM
121	CHIP RESISTOR ; 2Kohm	R181	1	ROHM
122	CHIP RESISTOR ; 330ohm	R182,186,316	3	ROHM
123	CHIP RESISTOR ; 0ohm	R100	1	ROHM
124	CHIP RESISTOR ; 51ohm	R200	1	ROHM
125	CHIP RESISTOR ; 330Kohm	R302,378,401	3	ROHM
126	CHIP RESISTOR ; 3.6Kohm	R303,345	2	ROHM
127	CHIP RESISTOR ; 27Kohm	R304	1	ROHM
128	CHIP RESISTOR ; 3Kohm	R305	1	ROHM
129	CHIP RESISTOR ; 220ohm	R122,138,155,161,167	5	ROHM
130	CHIP RESISTOR ; 390Kohm	R123	1	ROHM
131	CHIP RESISTOR ; 150Kohm	R310,326,377,402	4	ROHM
132	CHIP RESISTOR ; 1Kohm	R311	1	ROHM
133	CHIP RESISTOR ; 470Kohm	R321	1	ROHM
134	CHIP RESISTOR ; 100Kohm	R322,327,333,344	4	ROHM
135	CHIP RESISTOR ; 120Kohm	R323,343,366	3	ROHM
136	CHIP RESISTOR ; 18Kohm	R324,335,347	3	ROHM
137	CHIP RESISTOR ; 4.3Kohm	R330	1	ROHM
138	CHIP RESISTOR ; 82Kohm	R331,332,376,403	4	ROHM



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ITEM	NAME & DESCRIPTION	REF. NO.	Q'TY	MAKER
139	CHIP RESISTOR ; 2.4Kohm	R346,348	2	ROHM
140	CHIP RESISTOR ; 39Kohm	R349,375,404	3	ROHM
141	CHIP RESISTOR ; 24Kohm	R354,355,356	3	ROHM
142	CHIP RESISTOR ; 1.2Mohm	R358	1	ROHM
143	CHIP RESISTOR ; 150ohm	R359	1	ROHM
144	CHIP RESISTOR ; 1.2Kohm	R368	1	ROHM
145	CHIP RESISTOR ; 33ohm	R370	1	ROHM
146	CHIP RESISTOR ; 560ohm	R372,373	2	ROHM
147	CHIP RESISTOR ; 1Mohm	R374	1	ROHM
148	CHIP RESISTOR ; 7.5Kohm	R382	1	ROHM
149	CHIP RESISTOR ; 51Kohm	R406	1	ROHM
150	CHIP VOLUME ; 22Kohm	VR20	1	NOBLE
151	CHIP VOLUME ; 10Kohm	VR8,9	2	NOBLE
152	CHIP VOLUME ; 50Kohm	VR2,3,5	3	NOBLE
153	I.F.T COIL ; 455kHz	T3	1	TOKO
154	HELICAL FILTER ; 3½T	T101,102,103,104	4	TOKO
155	IF IC ; MC3361BD	U102	1	MOTOROLA
156	PLL IC ; MB15A02	U103	1	FUJISTU
157	TCXO ; VX23V	U104	1	RIVER
158	REGULATOR ; TK11455	U105	1	TOKO
159	REGULATOR ; TK11460	U106	1	TOKO
160	REGULATOR ; TK11450	U211	1	TOKO
161	MPU IC ; TMP87C841	U200	1	TOSHIBA
162	ANALOG SWITCH ; NJU4053	U201	1	JRC
163	OP AMP IC ; NJM324	U202,203,204	3	JRC
164	TONE FILTER IC ; MSELF	U205	1	MSI
165	AUDIO AMP IC ; NJM386	U206	1	JRC
166	OP AMP IC ; GL393D	U207	1	GOLDSTAR
167	E²PROM IC ; 93C66	U210	1	ATMEL
168	ANALOG SWITCH ; TC4S66F	U212	1	TOSHIBA

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FAX : 82-2-857-9583

ITEM	NAME & DESCRIPTION	REF. NO.	Q'TY	MAKER
169	CRYSTAL UNIT ; 4.194304MHz	X5	1	IT INDST.
170	CRYSTAL UNIT ; 20.945MHz	X100	1	KONY
171	THERMISTOR ; 33Kohm	TH10	1	KOA

**10. RF PARTS DATA**

- ATTACHED