BENISON

V5

VHF FM TRANSCEIVERS

Service Manual

SPECIFICATIONS

GENERAL

. Frequency coverage	: 245.0000 ~245.9875 MHz
. Type of emission	: 8K50F3E
. Number of channels	: 80 ch + 10 ch
. Power supply requirement	: 7.2 V DC (negative ground; supplied battery pack)
. Current drain (approx.)	: Transmit at High (5.0 W) 1.7 A, at Low (1.0 W) 700 mA
	: Receive rated audio 250 mA
	: stand-by 70 mA
. Frequency stability	: ±0.001 %
. Usable temperature range	: -10°C～+60°C
. Dimensions (projections not included)	: 54(W)×132(H)×35(D) mm
. Weight (with ant., BP-512)	: 370 g ; 13.1 oz.

TRANSMITTER

. RF output power (at 7.2 V DC)	: 5 W / 1 W (High / Low)
	(with supplied battery pack)
. Modulation system	: Variable reactance frequency modulation
. Maximum frequency deviation	: ±2.5 kHz
. Spurious emissions	: 70 dB typical
. Adjacent channel power	: 60 dB typical
. Transmitter audio distortion	: Less than 3% at 1 kHz, 40% deviation

RECEIVER

. Receive system	: Double conversion superheterodyne system
. Intermediate frequencies	: 1st 21.700 MHz / 2nd 450 kHz
. Sensitivity	: 0.18 μV at 12 dB SINAD (typical)
. Squelch sensitivity	: 0.25 μV at threshold (typical)
. Adjacent channel selectivity	: 65 dB (typical)
. Spurious response rejection	: 70 dB (typical)
. Intermodulation rejection ratio	: 70 dB (typical)
. Hum and noise	: 40 dB (typical)
. Audio output power (at 7.2 V DC)	: 500 mW typical at 5% distortion with an 8 ohm load

All stated specifications are subject to change without notice or obligation.

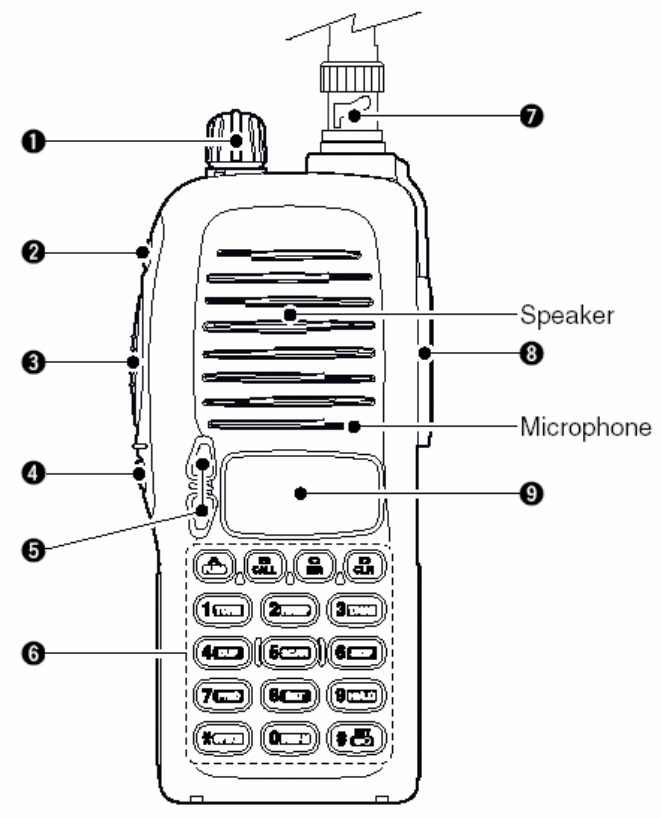
CHANNELS LIST

CH No.	FREQ.	CH No.	FREQ.	CH No.	FRQ.	CH No.	FREQ.
1	245.0000	21	245.2500	41	245.5000	61	245.7500
2	245.0125	22	245.2625	42	245.5125	62	245.7625
3	245.0250	23	245.2750	43	245.5250	63	245.7750
4	245.0375	24	245.2875	44	245.5375	64	245.7875
5	245.0500	25	245.3000	45	245.5500	65	245.8000
6	245.0625	26	245.3125	46	245.5625	66	245.8125
7	245.0750	27	245.3250	47	245.5750	67	245.8250
8	245.0875	28	245.3375	48	245.5875	69	245.8375
9	245.1000	29	245.3500	49	245.6000	69	245.8500
10	245.1125	30	245.3625	50	245.6125	70	245.8625
11	245.1250	31	245.3750	51	245.6250	71	245.8750
12	245.1375	32	245.3875	52	245.6375	72	245.8875
13	245.1500	33	245.4000	53	245.6500	73	245.9000
14	245.1625	34	245.4125	54	245.6625	74	245.9125
15	245.1750	35	245.4250	55	245.6750	75	245.9250
16	245.1875	36	245.4375	56	245.6875	76	245.9375
17	245.2000	37	245.4500	57	245.7000	77	245.9500
18	245.2125	38	245.4625	58	245.7125	78	245.9625
19	245.2250	39	245.4750	59	245.7250	79	245.9750
20	245.2375	40	245.4875	60	245.7375	80	245.9875

50 CTCSS TONES SQ. (Hz)									
NO.	TONE	NO.	TONE	NO.	TONE	NO.	TONE	NO.	TONE
1	67.0	11	94.8	21	131.8	31	171.3	41	203.5
2	69.3	12	97.4	22	136.5	32	173.8	42	206.5
3	71.9	13	100.0	23	141.3	33	177.3	43	210.7
4	74.4	14	103.5	24	146.2	34	179.9	44	218.1
5	77.0	15	107.2	25	151.4	35	183.5	45	225.7
6	79.7	16	110.9	26	156.7	36	186.2	46	229.1
7	82.5	17	114.8	27	159.8	37	189.9	47	233.6
8	85.4	18	118.8	28	162.2	38	192.8	48	241.8
9	88.5	19	123.0	29	165.5	39	196.6	49	250.3
10	91.5	20	127.3	30	167.9	40	199.5	50	254.1

PANEL DESCRIPTION

Switches, controls, keys and Connectors



1: POWER SWITCH [POWER]/CONTROL DIAL [VOL]

Rotate to adjust the volume level, to turn the power ON and OFF.

2:CTCSS SWITCH

Push and hold to force the CTCSS open and set the transceiver

3:PTT SWITCH [PTT]

Push and hold to transmit; release to receive.

4:SQUELCH SWITCH [SQL]

Push and hold to force the squelch open and set the transceiver

to the squelch level adjustable condition.

5:UP/DOWN KEYS

Selects the operating frequency.[UP]/[DN]

6:KEY PAD

Used to enter operating frequency, the DTMF codes, etc.

7:ANTENNA CONNECTOR

Connects the supplied antenna.

8:[SP]/[MIC] JACK

Connect an optional speaker-microphone or headset, if desired.

The internal microphone and speaker will not function when either is connected.

9:FUNCTION DISPLAY

*The assigned function for [SQL] and [DP]/[DN] can be traded in INITIAL SET MODE.

CIRCUIT DESCRIPTION

1) Receiver System

The receiver system is a double superheterodyne system with a 21.7MHz first IF and a 450kHz second IF.

1. Front End

The received signal at any frequency in the 245.0000- to 245.9875-MHz range is passed through the low-pass filter (L29, L28, L14, L13,C224, C220, C223,C219 and C222) and tuning circuit (L12 and D27), and amplified by the RF amplifier (Q29). The signal from Q29 is then passed through the tuning circuit (L9 and L11 varicaps D25 and D26) and converted into 21.7MHz by the mixer (Q28).The tuning circuit, which consists of L12, L9, varicaps D27 and D26, L11, varicaps D25 , is controlled by the tracking voltage form the CPU so that it is optimized for the reception frequency. The local signal from the VCO is passed through the buffer (Q24), and supplied to the source of the mixer (Q28). The radio uses the lower side of the superheterodyne system.

2. IF Circuit

The mixer mixes the received signal with the local signal to obtain the sum of and difference between them. The crystal filter (FL3, FL2) selects 21.7MHz frequency from the results and eliminates the signals of the unwanted frequencies. The first IF amplifier (Q17) then amplifies the signal of the selected frequency.

3. Demodulator Circuit

After the signal is amplified by the first IF amplifier (Q17), it is input to pin 16 of the demodulator IC (IC14). The second local signal of 21.25MHz (shared with PLL IC reference oscillation), which is oscillated by the internal oscillation circuit in IC13 and crystal (X4), is input through pin 2 of IC14. Then, these two signals are mixed by the internal mixer in IC14 and the result is converted into the second IF signal with a frequency of 450kHz. The second IF signal is output from pin 3 of IC14 to the ceramic filter (FL1), where the unwanted frequency band of that signal is eliminated, and the resulting signal is sent back to the IC14 through pins 5.The second IF signal input via pin 5 is demodulated by the internal limiter amplifier and quadrature detection circuit in IC14, and output as an audio signal through pin 9.

4. Audio Circuit

AF signals from the FM IF IC (IC14, pin 9) are applied to the mute switch (IC4, pin 1) via the AF filter circuit (IC14b, pins 6,7). The output signals from pin 11 are applied to the AF power amplifier (IC9, pin 4) after being passed through the [VOL] control (W1).The applied AF signals are amplified at the AF power amplifier circuit (IC9, pin 4) to obtain the specified audio level. The amplified AF signals, output from pin 10, are applied to the internal speaker (SP1) as the “SP” signal via the [SP] jack when no plug is connected to the jack.

5. Squelch Circuit

A squelch circuit cuts out AF signals when no RF signals are received. By detecting noise components in the AF signals, the squelch switches the AF mute switch. A portion of the AF signals from the FM IF IC (IC14, pin 9) are applied to the active filter section (IC14, pin 8) where noise components are amplified and detected with an internal noise detector. The active filter section amplifies noise components. The filtered signals are rectified at the noise detector section and converted into “NOIS” (pulse type) signals at the noise comparator section. The “NOIS” signal is applied to the CPU(IC6, pin 14). The CPU detects the receiving signal strength from the number of the pulses, and outputs an “AFB” signal from pin 33. This signal controls the mute switch (IC4) to cut the AF signal line.

2) Transmitter System

1. MICROPHONE AMPLIFIER CIRCUIT

The microphone amplifier circuit amplifies audio signals with +6 dB/octave pre-emphasis characteristics from the microphone to a level needed for the modulation circuit. The AF signals from the microphone are applied to the microphone amplifier circuit (IC1C, pin 10). The amplified AF signals are passed through the low-pass filter circuit (IC1D, pins 13, 14) via the mute switch (IC4, pins 4, 3). The filtered AF signals are

applied to the modulator circuit after being passed through the mute switch (IC4, pins 9, 8).

2. MODULATION CIRCUIT

The modulation circuit modulates the VCO oscillating signal (RF signal) using the microphone audio signal. The audio signals change the reactance of a diode (D7) to modulate an oscillated signal at the VCO circuit (Q20, Q23).The oscillated signal is amplified at the buffer-amplifiers (Q21,Q24), then applied to the T/R switching circuit (D9, D10).

3. DRIVE/POWER AMPLIFIER CIRCUITS

The signal from the VCO circuit passes through the T/R switching circuit (D9) and is amplified at the buffer (Q19),drive (Q27) and power amplifier (Q26) to obtain 5 W of RF power (at 7.2 V DC). The amplified signal passes through the antenna switching circuit (D11), and low-pass filter and is then applied to the antenna connector. The bias current of the drive (Q27) and the power amplifier (Q26) is controlled by the APC circuit.

4. APC CIRCUIT

The APC circuit (IC1A) protects the drive and the power amplifiers from excessive current drive, and selects HIGH or LOW output power. The signal output from the power detector circuit (D28, D29) is applied to the differential amplifier (IC1A, pin 2), and the “T1” signal from the expander (IC5, pin 11), controlled by the CPU (IC8), is applied to the other input for reference. When the driving current is increased, input voltage of the differential amplifier (pin 2) will be increased. In such cases the differential amplifier output voltage (pin 1) is decreased to reduce the driving current.

3) PLL Synthesizer Circuit

1. PLL

The dividing ratio is obtained by sending data from the CPU (IC8) to pin 28 and sending clock pulses to pin 39 of the PLL IC (IC13). The oscillated signal from the VCO is amplified by the buffer (Q22) and input to pin 6 of IC13. Each programmable divider in IC13 divides the frequency of the input signal by N according to the frequency data, to generate a comparison frequency of 12.5kHz.

2. PLL Loop Filter Circuit

If a phase difference is found in the phase comparison between the reference frequency and VCO output frequency, the charge pump output (pin 8) of IC11 generates a pulse signal, which is converted to DC voltage by the PLL loop filter and input to the varicap of the VCO unit for oscillation frequency control.

3. VCO Circuit

A PLL circuit provides stable oscillation of the transmit frequency and receive 1st LO frequency. The PLL output compares the phase of the divided VCO frequency to the reference frequency. The PLL output frequency is controlled by the divided ratio (N-data) of a programmable divider.The PLL circuit contains the VCO circuit (Q20, Q23). The oscillated signal is amplified at the buffer-amplifiers (Q21, Q22) and then applied to the PLL IC (IC11). The PLL IC contains a prescaler, programmable counter, programmable divider and phase detector, etc. The entered signal is divided at the prescaler and programmable counter section by the N-data ratio from the CPU. The divided signal is detected on phase at the phase detector using the reference frequency. If the oscillated signal drifts, its phase changes from that of the reference frequency, causing a lock voltage change to compensate for the drift in the oscillated frequency. A portion of the VCO signal is amplified at the buffer-amplifier (Q24) and is then applied to the receive 1st mixer (Q28) or transmit buffer-amplifier circuit (Q19) via the T/R switching diode (D9, D10).

4) CPU and Peripheral Circuits

1. LCD Display Circuit

The IC10 turns ON the LCD via segment and common terminals with 1/4 the duty and 1/3 the bias, at the frame frequency is 100Hz.

2. Display Lamp Circuit

When the key is pressed, “H” is output form pin 34 of CPU (IC8) to the bases of Q15. Q15 then turn ON and the LED (D14 – D22) light.

3. DTMF Encoder

The CPU (IC8) is equipped with an internal DTMF encoder. The DTMF signalis output from pin 8, through R75, and through the microphone amplifier (IC1), and is sent to the varicap of the VCO for modulation. At the same time, the monitoring tone passes through the AF circuit and is output form the speaker.

4. CTCSS Encoder

The CPU (IC8) is equipped with an internal tone encoder, The tone signal (67.0 to 254.3Hz) is output from pin 9 of the CPU to the varicap (D7) of the VCO for modulation.

5. CTCSS Decoder

The voice band of the AF output signal from pin 10 of IC5 is cut by sharp active filter IC2 (VCVS) and amplified, then led to pin 4 of CPU. The input signal is compared with the programmed tone frequency code in the CPU. The squelch will open when they match.

6. Clock Shift

In the unlikely event that CPU clock noise is present on a particular operating frequency programmed into the radio, you can shift the CPU clock frequency to avoid the CPU clock-noise. The output signal from pin 32 of the CPU turns on D4. Then the oscillation frequency of X2 will be shifted about 300 ppm.

ADJUSTMENT PROCEDURES

Note:

It is assumed that the unit is supplied with a regulated 8.4 volts during the adjustment procedure. Do not use a metal screw driver to adjust the ferrite cores as it causes variations in the inductance whilst adjustments are being performed. Use of the wrong size trimming tools can cause damage to the cores. A plastic or ceramic trimming tool is recommended.

ADJUSTMENT

1) Required Test Equipment

The following items are required to adjust radio parameters:

1. Regulated power supply
Supply voltage: 5~14V DC
Current: 3A or more

2. Digital multimeter
Voltage range: FS = Approx. 20V
Current: 10A or more
Input resistance: High impedance

3. Oscilloscope
Measurable frequency: Audio frequency

4. Audio dummy load
Impedance: 8 ohm
Dissipation: 1W or more
Jack: 3.5mm

5. SSG
Output frequency: 200MHz or more
Output level: -20dBu/0.1uV ~120dBu/1V
Modulation: FM

6. Spectrum Analyzer
Measuring range: Up to 2GHz or more

7. Power meter
Measurable frequency: Up to 200MHz
Impedance: 50, unbalanced
Measuring range: 0.1W ~10W

8. Audio volmeter
Measurable frequency: Up to 100kHz
Sensitivity: 1mV to 10V

9. Audio generator
Output frequency: 67Hz to 10kHz
Output impedance: 600, unbalanced

10.Distortion meter/SINAD meter
Measurable frequency: 1kHz
Input level: Up to 40dB
Distortion: 1% ~100%

11.Frequency counter

Measurable frequency: Up to 200MHz

Measurable stability: Approx. ±0.1ppm

12.Linear detector

Measurable frequency: Up to 200MHz

Characteristics: Flat

CN: 60dB or more

Note

Standard modulation: 1kHz ±2.5kHz/DEV

Reference sensitivity: 12dB SINAD

Specified audio output level: 200mW at 8

Adjustment Mode

The V5 does not require a serviceperson to manipulate the components on the printed-circuit board, except the trimmer when adjusting reference frequency and deviation. Most of the adjustments for the transceiver are made by using the keys on it while the unit is in the adjustment mode. Because the adjustment mode temporarily uses the channels, frequency must be set on each channel before adjustments can be made. For instructions on how to program the channels, In consideration of the radio environment, the frequency on each channel must be near the value (+/-1MHz) listed in the table below. To enter the adjustment mode, At same time push [*].[8]and [#]. Rotate [VOL] to the power ON.

Adjustment mode

KEY	Channel function	Display
1	T1 RX sensitivity adjustment	TV1-
2	T2 RX sensitivity adjustment	TV2-
3	T3 RX sensitivity adjustment	TV3-
4	Reference frequency adjustment	FQA-
5	Deviation	TAF-
6	No care	TDT-
7	High power adjustment	THP-
8	Low power adjustment	TLP-
9	No care	RES-ADJ

Reference Frequency Adjustment

1. In the adjustment mode, Press the [**4**]key.
2. Press the **PTT** key to start transmission.
3. Press the **UP** or **DOWN** key until the value on the frequency counter matches the one displayed on the LCD.
4. On 245.0000MHz measure TP1 near the VCO and to obtain 2.5V±0.5V
5. Press the SQL key to return.

High Power Adjustment

1. In the adjustment mode, Press the [**7]** key.
2. Hold down the **PTT** key to start transmission.
3. While watching the reading of the TX power meter, Press the **UP** or **DOWN** key set the output power to the value closest to 5 W
4. When the **PTT** key is released, the output power at that time will be stored as the high power setting.
5. Press the SQL key to return.

Low Power Adjustment

1. In the adjustment mode, Press the [**8]** key.
2. Hold down the **PTT** key to start transmission.
3. While watching the reading of the TX power meter, Press the **UP** or **DOWN** key set the output power to the value closest to 1 W.
4. When the **PTT** key is released.
5. Press the SQL key to return.

Sensitivity Adjustment

1. In the adjustment mode, Press the [1]/[2]/[3] key.
2. Press the **UP** or **DOWN** key Set the minimum frequency sensitivity.
3. Press the SQL key to return.

Deviation

1. In the adjustment mode, Press the [**5]** key.
2. Input a 30mVrms, 1000Hz signal with your transceiver tester through the external microphone jack.
3. With the tester, put the transceiver in the transmission mode.
4. Press the **UP** or **DOWN** key until the deviation is set to ±2.5KHz.
5. Press the SQL key to return.

PARTS LIST

Designator	Component	Designator	Component
C1	0.047	C61	100P
C2	0.0056	C62	0.1
C3	470P	C63	100P
C4	220P	C64	100P
C5	470P	C65	100P
C6	0.1	C66	100P
C7	470P	C67	100P
C8	470P	C68	470P
C9	470P	C69	180p
C10	470P	C70	0.01
C11	470P	C71	0.033
C12	470P	C72	0.0056
C13	0.22 (2210)	C73	470P
C14	0.01	C74	0.1
C15	470P	C75	47P
C16	470P	C76	470P
C17	0.1	C77	22P
C18	470P	C78	22P
C19	0.0033	C79	0.022
C20	0.0018	C80	0.1
C21	470P	C81	0.1
C22	470P	C85	0.01
C23	0.022	C86	0.001
C24	0.01	C87	470P
C25	0.0056	C88	0.047
C26	0.0027	C89	0.1
C27	470P	C90	0.1
C28	470P	C91	0.1
C29	22P	C92	47P
C30	0.1	C93	0.1
C31	470P	C94	470P
C32	470P	C95	470P
C33	22P	C97	0.1
C34	0.01	C98	470P
C35	0.1	C99	470P
C36	470P	C100	470P
C37	0.01	C101	0.1
C38	470P	C102	470P
C39	470P	C103	9P
C40	0.01	C104	27P
C41	470P	C105	27P
C42	0.0022	C106	9P
C43	0.1	C107	100P
C44	0.01	C108	100P
C45	0.0027	C110	470P
C46	0.1 μ	C111	0.1
C47	470P	C112	0.01
C48	470P	C113	100P
C49	0.018	C115	470P
C50	0.001	C116	220P
C51	0.0082	C117	0.1
C52	0.01	C118	2P
C53	0.01	C120	100P
C54	0.1	C121	0.01
C55	100P	C122	0.1
C56	0.22	C123	0.1
C57	100P	C124	68P
C58	100P	C125	0.01
C59	100P	C126	0.1
C60	0.1	C127	470P

Designator	Component	Designator	Component
C128	27P	C190	470P
C129	2P	C191	470P
C130	0.5P	C192	10P
C132	470P	C193	10P
C133	15P	C194	10P
C134	470P	C195	470P
C135	470P	C196	470P
C136	0.1	C197	5P
C137	470P	C198	0.5P
C138	470P	C199	0.001
C139	82P	C200	7P
C140	3P	C202	5P
C141	470P	C203	5P
C142	47P	C204	4P
C143	2P	C205	10P
C144	0.001	C206	5P
C145	470P	C207	470P
C146	0.1	C208	470P
C147	0.22	C209	0.01
C148	0.01	C210	10P
C149	470P	C211	10P
C150	1 μ	C212	470P
C151	0.01	C213	470P
C152	470P	C214	470P
C153	47P	C215	470P
C154	0.001	C216	0.001
C156	220P	C217	0.001
C157	470P	C218	0.001
C158	100P	C219	6P
C159	0.001	C220	0.5P
C160	2P	C221	24P
C161	5P	C222	7P
C162	0.01	C223	15P
C163	470P	C224	8P
C164	82P	C225	12P
C165	220P	C226	470P
C166	220P	C227	470P
C167	0.01	C228	470P
C168	0.001	C229	470P
C169	0.033	C230	0.1
C170	0.001	C231	12P
C171	470	C232	22P
C172	470P	C233	12P
C173	470P	C234	0.1
C174	47P	C235	10 μ
C175	470P	C236	10 μ
C176	470P	C237	100 μ
C177	0.001	C238	10 μ
C178	470P	C239	10 μ
C179	470P	C240	1 μ
C180	47P	C241	100 μ
C181	47P	C242	10 μ
C182	10P	C243	10 μ
C183	10P	C244	10 μ
C184	470P	C245	1 μ
C185	47P	C247	1 μ
C186	12P	C249	1 μ
C187	10P		
C188	470P		
C189	470P		

Designator	Component
C250	10 µ
C251	10 µ
C252	0.001
C253	10 µ
C254	4.7 µ
C255	33P
C256	4P
C257	0.01
C258	10 µ
C259	22 µ
C260	22 µ
C261	470P
C262	470P
C263	220P
C264	470P
C265	470P
C266	470P
C267	10 µ
C268	470P
C269	470P
C270	470P
C271	470P
C272	470P
C273	470P
C274	100P
C275	470P
C276	470P
C277	470P
C278	0.1
C279	0.1
C280	470P
C281	470P
C282	470P
C283	470P
C284	470P
C285	470P
C286	470P
C287	470P
C287	470P
C288	470P
C289	470P
C290	470P
C291	470P
C292	470P
C293	470P
C294	470P
C295	470P
C296	470P
C297	470P
C298	470P
C299	470P
C300	470P
C301	470P
C302	470P
C303	100P
C304	100P
C305	470P
C306	100P
C307	470P
C308	100P
C309	470P
C310	10 µ
C311	470P
C311	470P
C312	470P
C313	470P
C314	470P
C315	470P
C316	470P
C317	10 µ
C319	470P
C320	470P
C321	470P

Designator	Component
D1	RB706-F40
D2	RB717F
D3	MA77
D4	MA77
D5	MA77
D6	MA77
D7	MA77
D8	MA77
D9	MA77
D10	MA77
D11	MA77
D12	MA77
D13	MA77
D14	GR1608
D15	GR1608
D16	GR1608
D17	GR1608
D18	GR1608
D19	GR1608
D20	GR1608
D21	GR1608
D22	GR1608
D23	1SV214
D24	HVU350
D25	HVU350
D26	HVU350
D27	HVU350
D28	RB706-F40
D29	RB706-F40
D30	W3V

FL1	450E
FL2	21.7MHz
FL3	21.7MHz

Designator	Component
IC1A	NJM2902V
IC1B	NJM2902V
IC1C	NJM2902V
IC1D	NJM2902V
IC2	NJM2902V
IC3	CMX808
IC4	BU4066
IC5	M62363
IC6	HT9170D
IC7	XC6201
IC8	MCU-567
IC9	TA7368F
IC10	HT1621B
IC11	24C08
IC12A	RC4558
IC12B	RC4558
IC13	M64082
IC14	TA31136FN
J1	MIC/SP JACK
J2	OPT JACK
J3	ANT JACK
K1	PTT
K2	UP
K3	DN
K4	MON
K5	FUNC
K6	*
K7	1
K8	2
K9	3
K10	D
K11	4
K12	5
K13	6
K14	C
K15	7
K16	8
K17	9
K18	B
K19	0
K20	#
K21	A
L1	GB1608E102
L2	82nH
L6	L-6T
L7	47nH
L8	0.47μH
L9	27nH
L10	68nH
L11	27nH
L12	27nH
L13	32nH
L14	32nH
L15	68nH
L16	68nH
L17	PB3216-301
L18	6.8nH
L19	47nH
L20	5.6nH
L21	15nH
L22	68nH
L23	12nH
L24	22nH
L25	56nH
L26	2.7μH
L27	32nH
L28	22nH
L29	32nH
L30	GB1608E102
LCD1	V5-LCD
MC1	MIC (-58dB)
Q1	2SA1577
Q2	2SA1577
Q3	2SA1577
Q4	2SA1577
Q5	2SB1132
Q6	DTC143ZU
Q7	DTC144EU
Q8	DTC144EU
Q9	DTC144EU
Q10	DTA144EU
Q11	DTA144EU
Q12	DTA144EU
Q13	2SC4081
Q14	2SC4081
Q16	2SC4081
Q17	2SC4215
Q18	2SC4081
Q19	2SC5085
Q20	2SC4226
Q21	2SC4215
Q22	2SC4215
Q23	2SC4226
Q24	2SC4215
Q25	DTC144EU
Q26	2SK2596
Q27	2SK2595
Q28	3SK320
Q29	3SK293
Q30	DTA144EU

Designator	Component	Designator	Component
R1	2k	R62	10k
R2	15k	R63	82k
R3	100k	R64	120k
R4	180k	R65	47k
R5	22k	R66	33k
R6	470	R67	1.5k
R7	10k	R68	12k
R8	10k	R69	3.9k
R9	470	R70	10k
R10	10k	R71	10k
R11	1.8k	R72	1k
R12	100k	R73	10k
R13	1M	R74	1M
R14	39k	R75	10k
R15	470	R76	100k
R16	15k	R77	1k
R17	82k	R78	1k
R18	3.9k	R79	330
R19	120k	R80	100k
R20	56k	R81	100
R21	120k	R82	100k
R22	680k	R83	100
R23	10k	R84	100
R24	68k	R85	100
R25	100	R86	12k
R26	1M	R87	12k
R27	1k	R88	12k
R28	1k	R89	10k
R29	1k	R90	100k
R30	1k	R91	100k
R31	10k	R93	2.7k
R32	2k	R94	33
R33	10k	R95	10k
R34	2k	R96	3.3k
R35	10k	R97	10
R36	2k	R100	20k*
R37	1M	R102	100k
R38	1k	R103	10
R39	3.9k	R104	4.7k
R40	47k	R105	47k
R41	1M	R106	10k
R42	1M	R107	100
R43	27k	R108	22k
R44	0	R109	10k
R46	100k	R110	10k
R47	470	R111	10k
R48	15k	R112	10k
R49	1.5k	R113	100k
R50	10k	R114	470k
R51	1k	R115	47k
R52	270k	R116	150k
R53	1k	R117	47k
R54	10k	R120	10k
R55	1k	R121	10k
R56	1k	R123	100k
R57	10k	R124	1k
R58	100k	R125	5.6k
R59	1k	R126	33k
R60	1k	R127	220k
R61	220k	R128	180k

Designator	Component
R129	2.2k
R130	1k
R131	100
R132	2.2k
R133	2.2k
R134	47k
R135	1k
R136	0
R137	100k
R138	10k
R139	1k
R140	220
R141	100k
R143	3.9k
R144	470
R145	100k
R146	680
R147	1.5k
R148	1k
R149	47k
R150	470
R151	33k
R152	4.7k
R153	10k
R154	100
R155	100
R156	47
R157	4.7k
R158	18k
R159	33k
R160	220
R161	10k
R162	470
R163	10k
R164	100k
R165	100k
R166	100k
R167	100k
R168	100k
R169	100k
R170	100k
R171	100k
R172	100k
R173	3.9k
R174	330k
R175	10k
R176	330k
R177	180k
R178	2.2k
R179	100
R180	100
R181	100
R182	470
R183	4.7k
R184	68k
R185	68k
R186	100
R187	4.7k
R188	100
R189	33

Designator	Component
R190	100
R191	4.7k
R192	3.3k
R193	39k
R194	22
R195	0
R196	1k
R197	10k
R198	1.2k
R199	68
R200	150
R201	2.2k
R202	2.2k
R203	6.8k
R204	6.8k
R205	100k
R206	0
R207	0
R208	1k
R209	3.3k
R210	22k
R211	22k
R211	1k
SP1	8ohm
W1	10kB
X1	4.0MHz
X2	32.768kHz
X3	3.58MHz
X4	21.25MHz
X5	450C24

MEMO