

Technical Report
Transmitter Module Model NET-JS72/NET-JS75
FCC ID# BRWNETJS725SYN

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1.0 INTRODUCTION

1.1 Definition

The Model NET-JS72/NET-JS75 is a transmitter Module for the Remote Control(R/C) of models such as airplane, helicopters, cars, boats, etc. and NET-JS72/NET-JS75 is used by plugging into the Transmitter (main body for control).

This Transmitter module is for FM PLL System, available for the PPM(Pulse Position Modulation) and PCM (Pulse Code Modulation). The latest type of Model XP8103 will be utilized for the application of this Transmitter module NET-JS72/NET-JS75. This Transmitter module is a part of the HORIZON HOBBY DISTRIBUTORS, INC. PPM and PCM "family" of Remote Control Transmitters which at this time consists of:

Transmitter Model #	FCC ID #
NET-J72P/NET-J75P	BRWNET72FP
X378	BRWX738
XS3	BRWXS3

Separate Applications for each transmitters and for the receivers are submitted as required by the Commission.

The Manufacturer, Japan Remote Control Company (JR), manufactures all transmitters and receivers.

The PPM and PCM family of R/C systems is exported by JR to the United States of America, and several European and Asian Countries.

The Applicant for this Equipment Authorization, HORIZON HOBBY DISTRIBUTORS, INC. will, following receipt of Grant of Equipment Authorization, import only those versions of these R/C radios which are allowed for use in the USA under the Rules and Regulations of the Federal Communications.

The 72 - 73 MHz , 75 - 76 MHz version of this transmitter is the subject of this Application; these are the units which will be offered for sale to the general public.

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1.2 Application

The Model NET-JS72/NET-JS75 R/C transmitter module utilizes " Phase Locked Loop " and " Frequency Modulation " to convey the PPM and PCM encoded position of its control sticks (joysticks) and toggle switches to its companion R/C receiver, where the PPM and PCM encoded pulse train is demodulated, decoded, and supplied to a number of servo-mechanisms for positioning of control surfaces, throttle etc. on the model.

The Frequency-Shift-Keying of the transmitter carrier takes place in the rhythm of the PPM and PCM pulse train.

Both transmitter and receiver are very narrow band units; they have been designed to comply with the European requirements of 10 KHz channel spacing.

1.3 Construction

The Model NET-JS72/NET-JS75 Transmitter module all consists of a plastic case.

(Reference is made to Fig. 5.1, Transmitter Block Diagram)

- * control sticks and control switches
- * a 9.6V rechargeable (Nicaid) battery
- * an analog-to-digital converter (ADC)
- * a microprocessor to create the PPM and PCM pulse train
- * a modulator driver stage
- * a RF power stage
- * a telescopic antenna

This Transmitter module is to be made available by the importer only on those carrier frequencies in the 72 - 73 MHz , 75 - 76 MHz frequency band which are at present authorized for R/C use.

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2.0 ENCODER THEORY OF OPERATION

Reference is made to Figure 5.1, Transmitter Block Diagram.

The functions of the encoder are to:

- * accept the analog voltages from the control inputs. (Joysticks, toggle switch).
- * process the analog voltages to create control mixing, adding, reversing, etc., as desired by the user.
- * sample these voltages in a cyclic rhythm under control of the system's internal timing generator. (This process is called commutation.)
- * process these analog voltages into binary weighted digital control words by means of an Analog-to-Digital Converter (ADC).
- * store these digital representations of the analog control input into a temporary memory (RAM).
- * supply this serial data stream to a buffer-driver for modulation of the RF Transmitter.
- * provide "housekeeping" of the encoding process by means of a quartz crystal controlled internal clock.
- * provide supply voltages to the RF section ($V_{cc} = 12V$ battery voltage; $V_{reg} = 5.0V$ regulated voltage).

The entire program which controls the timing housekeeping, parallel-to-serial conversion process, and insertion of Synchronization words and error detection codes is governed by a Central Processing Unit (CPU) under control by an internally stored program residing in Read-Only Memory (ROM). The CPU, RAM and ROM are all part of a single-chip microprocessor.

Resolution of the Analog-to-Digital conversion process is ten (10) bits for a control accuracy of $1:2^{10}$.

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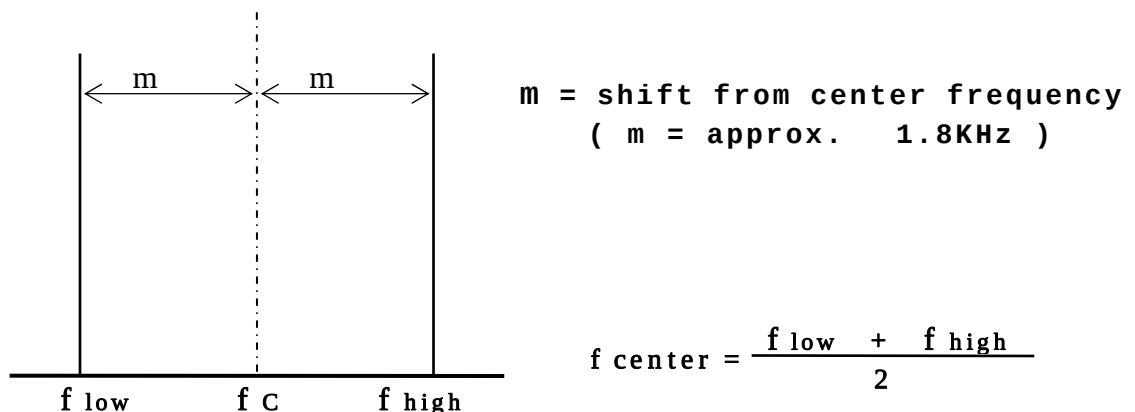
3.0 THEORY OF OPERATION

3.1 General

The RF Transmitter itself is located in a plug-in, hermetically sealed, module.

It operates on any of the R/C frequency (Channels) allowed by the Commission in the 72 - 73 MHz and 75 - 76 MHz frequency band. Selection of the desired RF channel is made by PLL frequency data.

This transmitter employs Frequency-Shift-Keying (FSK) of the carrier frequency, whereby the output frequency is either low or high due to the symmetrical FSK modulation process, the (center) output frequency cannot be directly measured, but must be calculated by taking the average of the high and low frequency states.



The peak-to-peak deviation of the FSK signal is approximately 3.6 KHz ("sliver modulation")

Because of the unfamiliarity of the general public with the term FSK, this modulation technique is commonly named FM.

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3.2 Block Diagram

(Reference is made to Figure 5.1)

The (up to) four control potentiometers are at the upper right side of the schematic drawing.

The control potentiometer, which is mechanically coupled to the control (joy) stick , is supplied with the regulated 5.0V voltage. The wiper on this pot is exactly centered in the neutral control stick position. All analog processing is performed as deviations from this center (reference) voltage.

After the mixing of each channel, control voltage is changed to Pulse Train, through encoder circuit.

The Q11(2SC4519)is an LC-type VCO(Voltage Controlled Oscillator), which is designed to oscillate with about 72.550MHz. Its output is led to amplifying stage for transmitting through a buffer(Q12), while it is also led to the PLL through a buffer(Q13). The pulses generated by the CPU are transferred to the VCO so as to modulate the radio wave. this part is strictly shielded from electric/magnetic noise.

The IC3(BU2630F)is a PLL(phase Lock Loop).

Exact 13.000MHz is generated by an internal crystal oscillator, and divided by 5,200 for 2.5kHz.

VCO wave is also divided by a definite number, which is 29,020 in case of 72.550MHz, for getting 2.5kHz.

Two 2.5kHz's are compared in the phase and the VCO is so controlled that the error gets minimum, while the modulation is so fast that the filter between the PLL and the VCO cancels an error fluctuation.

Frequency data is stored in the IC1(MC68HC908QY1/CPU) as an above-mentioned dividing number, and transferred to the PLL as the serial data while the transmitter is in normal operation mode.

Frequency data can be changed only in system set-up mode with the power of the RF section being cut.

Directly after it has turned on normally, though the CPU starts sending the PLL the data. Then, supply the power to Q1 via Q8(2SC4738) and Q7(2SA1298) to start oscillation.

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the radio wave is still silent because the RF amplifier (Q1,Q2) is not supplied with the power yet. After a while, certain stabilizing time for the PLL, the Q6(2SC4738) and Q4(2SA1298) starts to supply them with the power so that the radio wave is transmitted.

Q2 drives the Power Amplifier (PA). The straight-through PA stage(Q3) is followed by a matching and band pass/low-pass network. This network matches the low PA stage output impedance to the whip antenna.

DC Supply Voltage enter the RF section: 12 Volt "law" battery voltage supplies the PA stage only. PLL stages, and bias current for all stages, including the PA, are derived from the regulated 5.0 Volt.

4.0 FAILURE ANALYSIS

A failure analysis was conducted to ascertain that single-component failure will not result in unauthorized radiation.

It should be noted that component failure would result in return of the unit to the factory, or to an authorized repair station.

(Reference is made to Figure 5.2, Transmitter Schematic Diagram) Failure of any of the transistors (predominant failure mode: emitter-collector short) will result in the unit becoming inoperative: In the case of Q11 oscillator short, RF output will be non-existent.

Q12,Q1,Q2 or Q3 failure will result in very low, if any, output.

Failure of the MOD IN input (latch at 0 or 12 Volt) or modulator transistor Q9, Q10 and variable diode D4 (open or short) will result in carrier frequency.

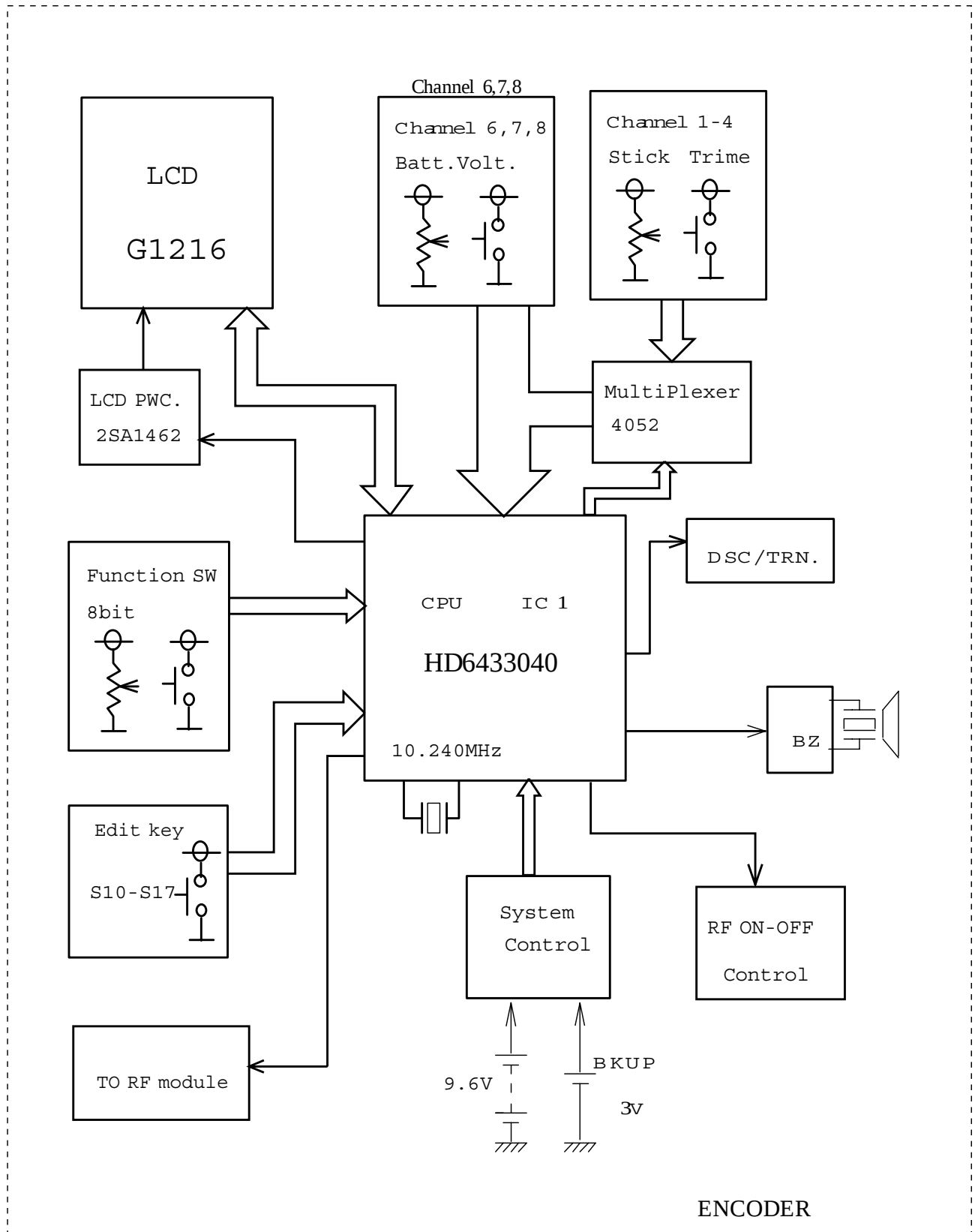
Although this failure would render the unit inoperative, the frequency tolerance would still fall within the channel bandwidth and tolerance requirements of .002% of 75 MHz = 1.50 KHz.

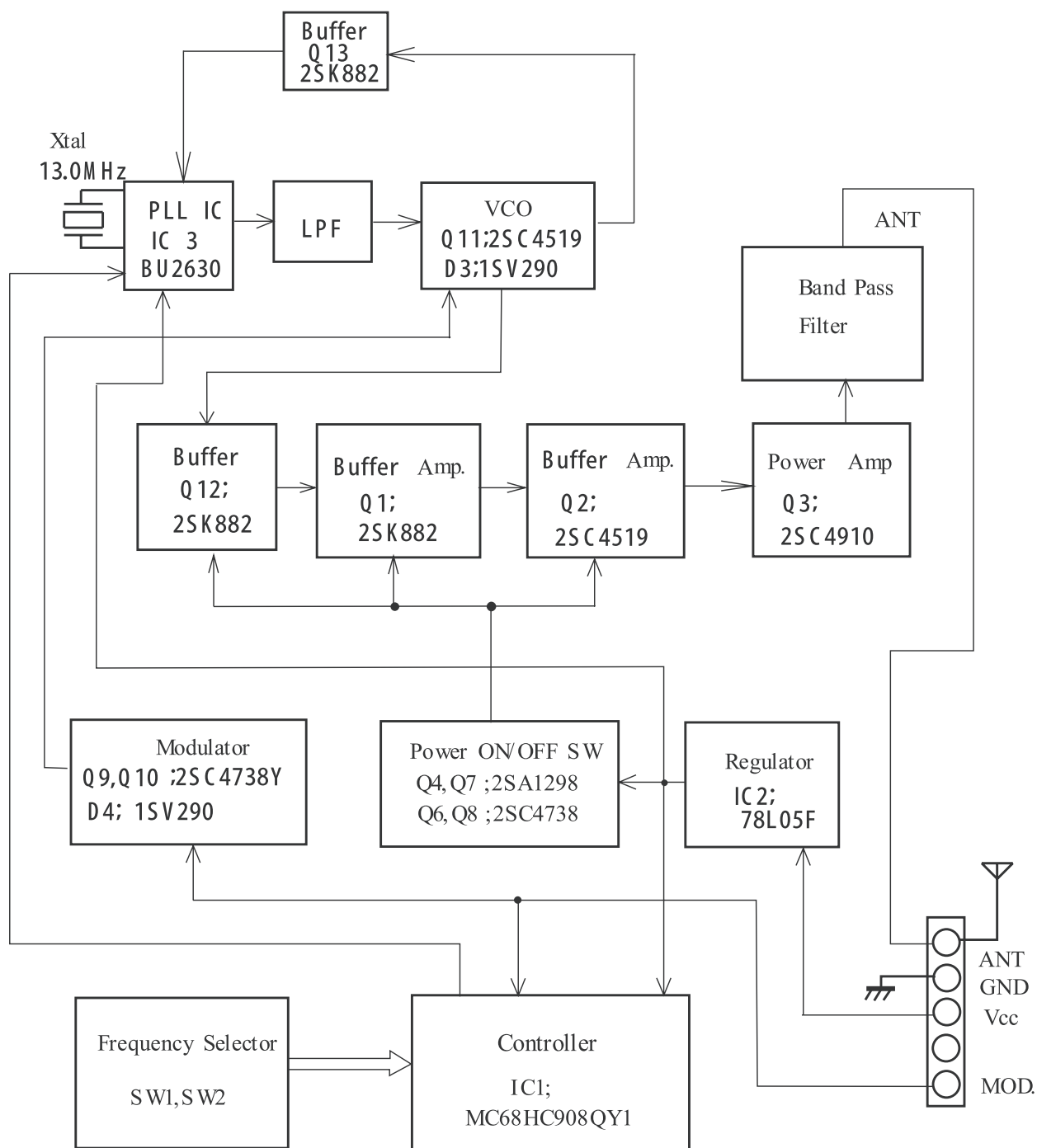
When PLL circuit is broken, for example, crystal X1 break down, or IC101(BU2630) for PLL is broken, PLL will stop functioning.

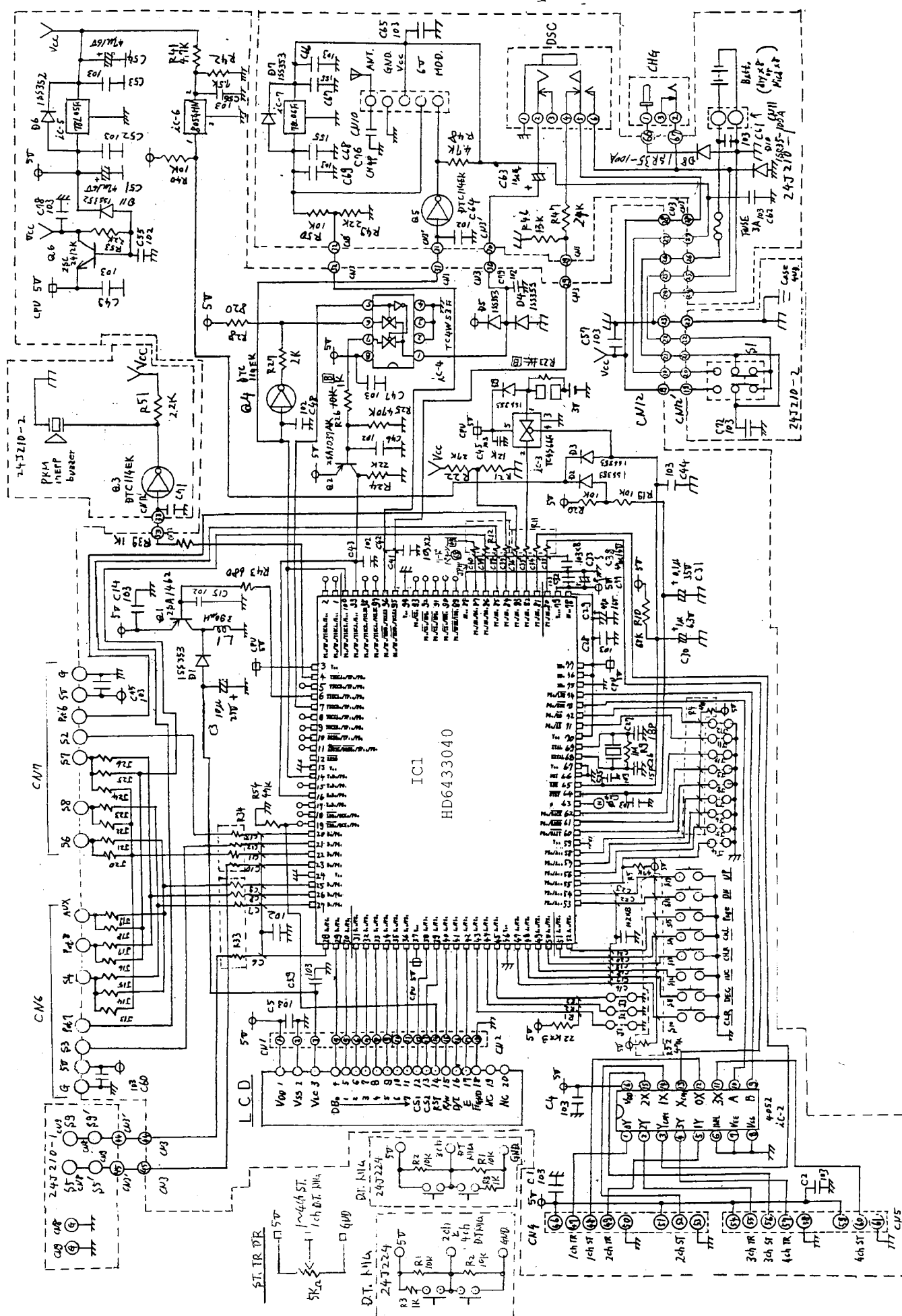
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5.4 Transmitter R.F. Tune-Up Procedure

1. Remove 2 screws from transmitter Module. Remove PC assembly. Put PC assembly on bench, component side up.
2. Refer to transmitter schematic Figure 5.2.2.
Soften bee's wax on cores in L1, L2, L3, L4 ,L5 and L6.
Using oscilloscope with small 50 ohm loop, starting at L1, adjust these cores for maximum oscilloscope reading.
Repeat this tuning sequence until no further increase in oscilloscope reading can be obtained.
3. Extend the aerial, and adjust L1, L2, L4, L5, L6 (in this order) to get maximum output. Try 2 times.
4. Shorten the aerial, and adjust L4 to make the current minimum.
5. Extend the aerial fully, and adjust L5 and L6 to get peak.
6. Adjust the frequency.
First, set up the Spectrum Analyzer.
Level Scale is : Log = 5dB/Div, Center Frequency = 72.550MHz, Span = 5KHz, RBW = 1KHz, VBW = 1KHz.
Then adjust the Amplitude and Attenuator to the right level.
Then, transmit the frequency Band 38 (72.550MHz) from the Standard Transmitter. Then store wave form to the Spectrum Analyzer.
By using VC2 and P2 and p1 in the transmitter, adjust it to make the same wave form.
7. Confirm the power.
8. Using spectrum analyzer with small 50 ohm loop, verify that sub harmonic and harmonic components are at least 50dB below carrier component. Pay special attention to 144MHz components.
9. Remove PCB assembly from Transmitter. Reapply bee's wax to L1, L2, L4 , L5 and L6. Put PCB assembly back into its case, replace the 2 screws.







Transmitter Schematic Diagram

Figure 5.2.2

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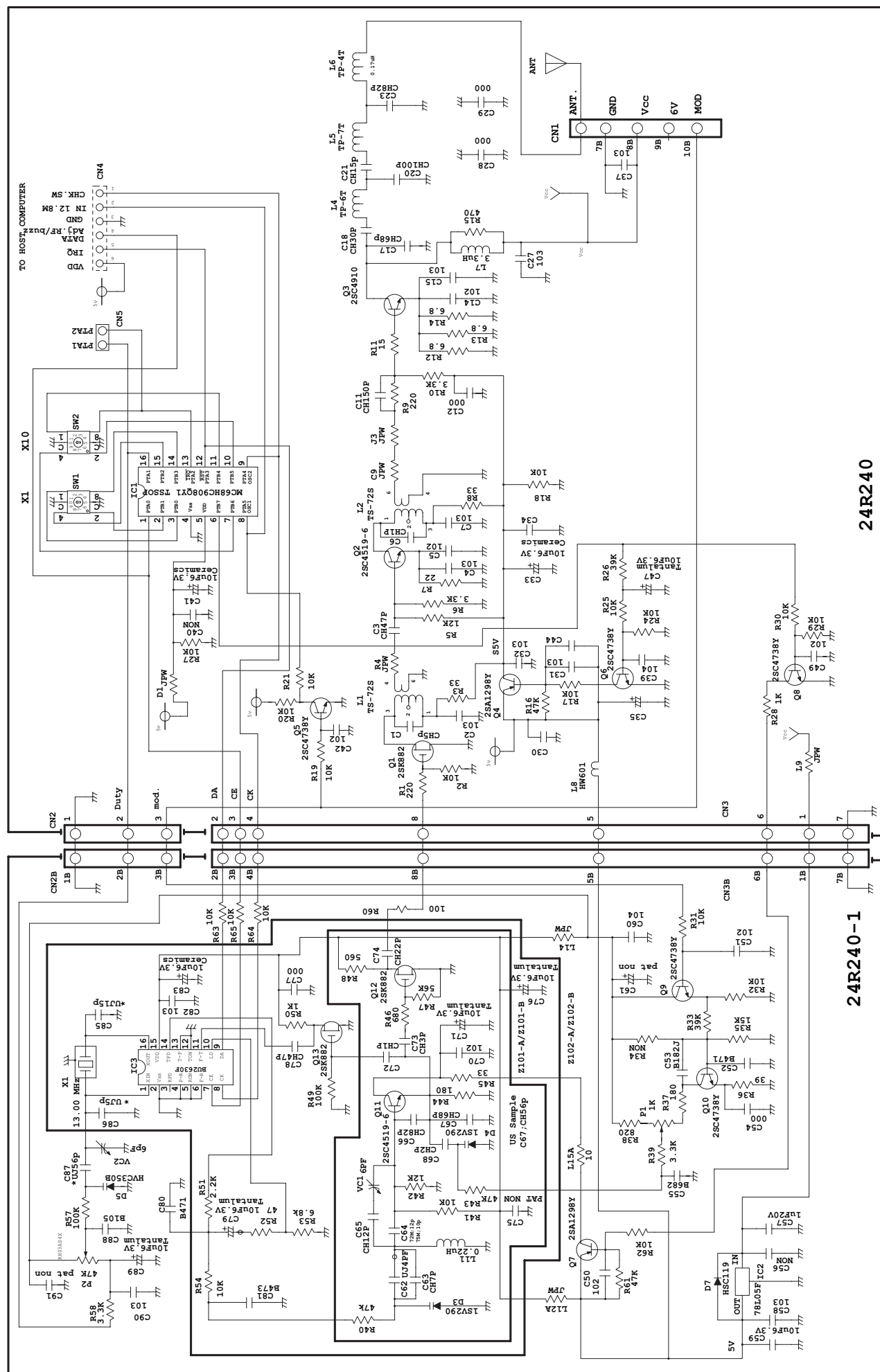


Figure 5.2.2 Transmitter Schematic Diagram

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SPECIFICATION OF CRYSTAL UNIT

1.FREQUENCY	13.000000MHz
2.HOLDER TYPE	SMD SX-2112
3.FREQUENCY TOLERANCE	+/- 20 PPM / +25C
4.EQUIVALENT RESISTANCE	30 OHM MAX / SERIES
5.OPERABLE TEMPERATURE RANGE	-30C ----- +80C
6.TEMPERATURE DRIFT	+/- 10 PPM
7.LOADING CAPACITY	10 PF
8.DRIVE LEVEL	20 uW
9.SHUNT CAPACITY	1.8 PF MAX
10.MODE OF OSCILLATION	FUNDAMENTAL
11.INSULATION RESISTANCE	500M OHMS MIN AT 100V DC
12.SHOCK TEST	
	DROPPING FROM 120cm HIGHT 10 TIMES HARD WOODEN BOARD
	(Drop it onto a hard wooden board (Thickness : 30mm) hor 6 directions (XX'YY'ZZ'),
	This should be 1 cycle)
	VARIATION : FREQUENCY LESS THAN +/-2 PPM
	: RESISTANCE LESS THAN 2 OHM or +/- 15 % (wnichever is lager)
13.VIBRATION TEST	
	FREQUENCY 10 TO 55Hz ; AMPLITUDE 1.5mm P-P 1 MINUTES
	TEST TIME : XYZ each direction 2h
	VARIATION : FREQUENCY LESS THAN +/-2 PPM
	: RESISTANCE LESS T THAN 2 OHM or +/- 15 % (wnichever is lager)
14.AGING	
	+/- 1 PPM max / YEAR

Figure 5.5 Crystal Specification





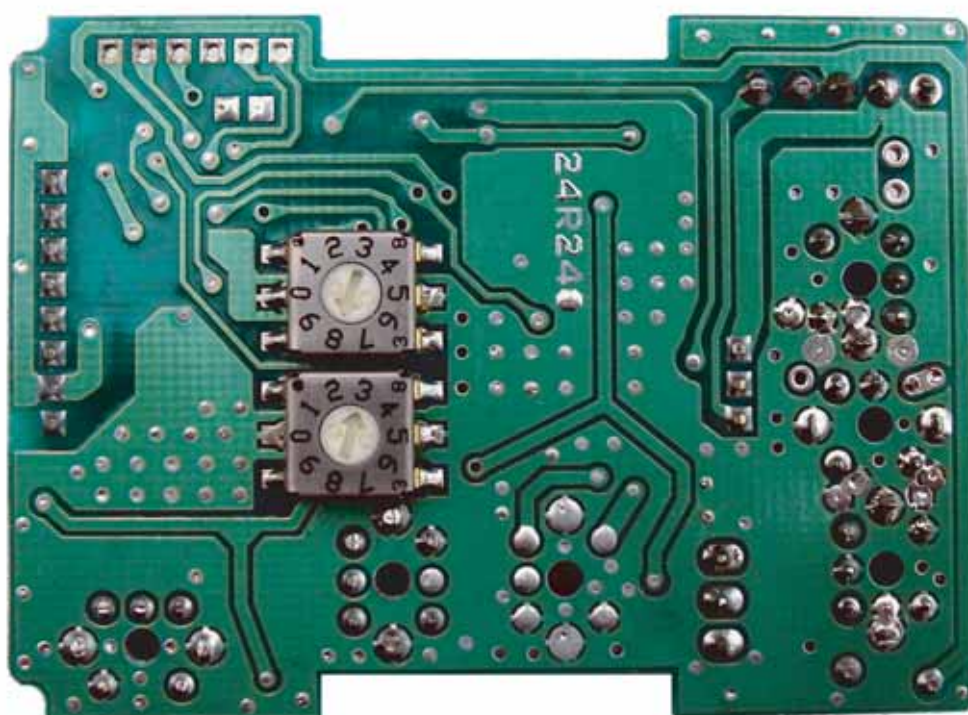
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