ENGINEERING STATEMENT

For Type Certification of

Tekcom Industries Limited

Model No: TP-323
FCC ID: KLLTP-323

I am an Electronics Engineer, a principal in the firm of Hyak Laboratories, Inc., Springfield, Virginia. My education and experience are a matter of record with the Federal Communications Commission.

Hyak Laboratories, Inc. has been authorized by Tekcom Industries, Ltd., to make type certification measurements on the TP-323 transceiver. These tests made by me or under my supervision in our Springfield laboratory.

Test data and documentation required by the FCC for Type Certification are included in this report. The data verifies that the above mentioned transceiver meets FCC requirements and Type Certification is requested.

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Rowland S. Johnson

Dated: July 17, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the TP-323 transceiver in

accordance with Part 2, Subpart J of the FCC Rules.

The TP-323 is a portable, battery operated, UHF, frequency modulated transceiver intended for 12.5 kHz channel family radio service applications in the 462.5625-467.7125 MHz band. It operates from a nominal 6.0 Vdc battery supply. MFR rated output power is 0.5 watts ERP(d).

B. GENERAL INFORMATION REQUIRED FOR TYPE CERTIFICATION (Paragraph 2.983 of the Rules)

1. Name of applicant: Tekcom Industries, Ltd.

2. Identification of equipment: FCC ID: KLLTP-323

   a. The equipment identification label is submitted as a separate exhibit.
   b. Photographs of the equipment are submitted as a separate exhibit.

3. Quantity production is planned.

4. Technical description:

   a. 11k0F3E emission
   b. Frequency range: 462.5625 - 467.7125 MHz.
   c. Operating power of transmitter is fixed at the factory at less than 0.5 W ERP(d).
   d. Maximum power permitted is 0.5 watts, and the TP-323 fully complied with that power limitation.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 5.9 Vdc
      Collector current: 0.29 A

   f. Function of each active semiconductor device: See Appendix 1.
   g. Complete schematic diagram is submitted as a separate exhibit.
   h. A draft instruction manual is submitted as a separate exhibit.
   i. The transmitter tune-up procedure is submitted as a separate exhibit.

   j. A description of circuits for stabilizing frequency is included in Appendix 2.
   k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 3.
   l. Not applicable.

5. Data for 2.985 through 2.997 follow this section.

C. RF Power Output (Paragraph 2.985(a) of the Rules)

The TP-323 has a permanently attached built-in antenna without provisions for a coaxial connector.

Therefore RF power output was measured by substitution. The transmitter was tuned by the factory.

TABLE 1

Operating Freq., MHz	Power watts into a dipole antenna
462.5625	0.49

D. MODULATION CHARACTERISTICS

1. A curve showing frequency response of the transmitter is shown in Figure 1. Reference level was audio signal output from a Boonton 8220 modulation meter with one kHz deviation. Audio output was measured with an Audio Precision System One integrated test system.

2. Modulation limiting curves are shown in Figure 2, using a Boonton 8220 modulation meter. Signal level was established with a Audio Precision System One integrated test system. The curves show compliance with paragraphs 2.987(b).

3. Figure 3 is a graph of the post-limiter low pass filter which provides a roll-off of 60Logf/3 dB where f is audio frequency in kHz. Measurements were made following EIA RS-152B with an Audio Precision System One integrated test system on the Boonton 8220 modulation meter audio output.

4. Occupied Bandwidth
(Paragraphs 2.989(c) of the Rules)

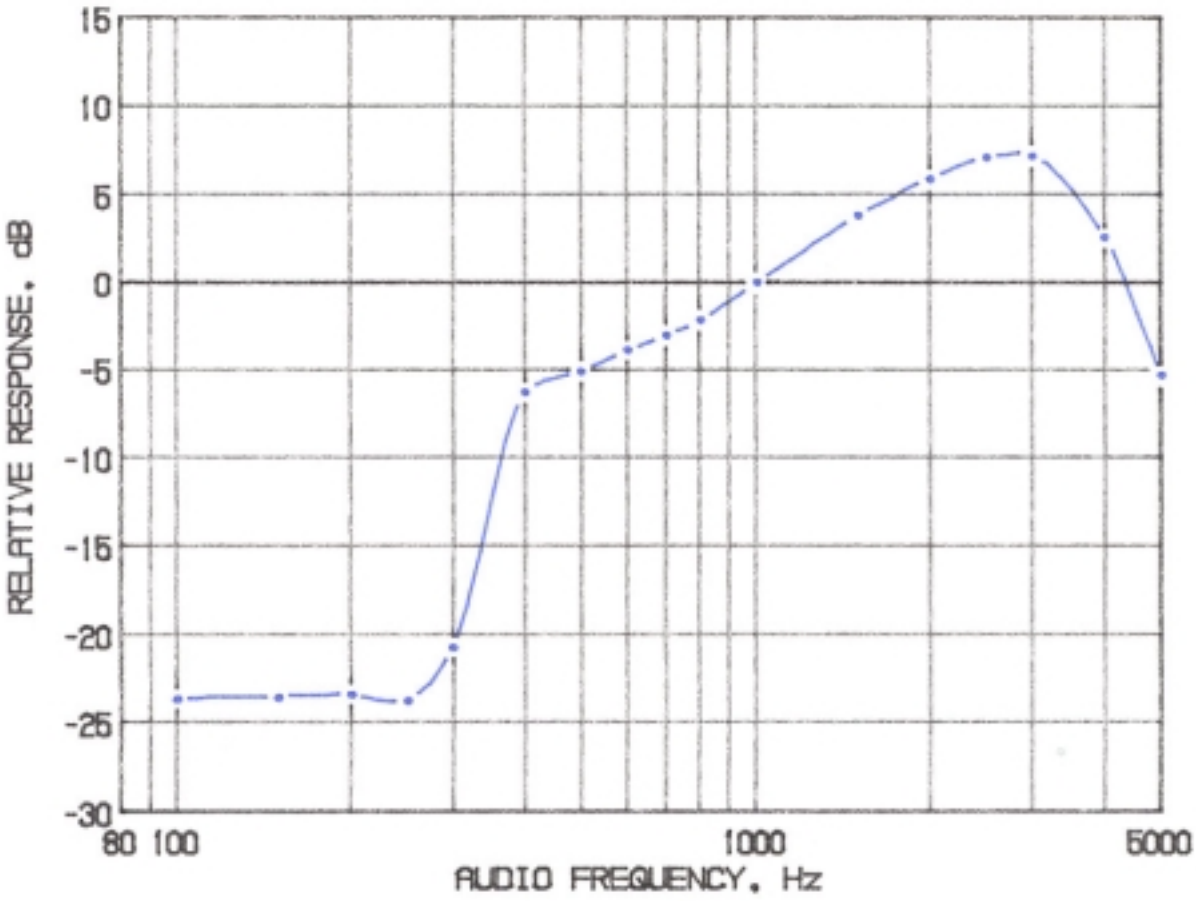
Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2895 Hz, the frequency of maximum response.

Emission designator:

(2M + 2D) (2 x 3 kHz) + (2 x 2.5 kHz) = 11k0F3E

FIGURE 1

MODULATION FREQUENCY RESPONSE



MODULATION FREQUENCY RESPONSE
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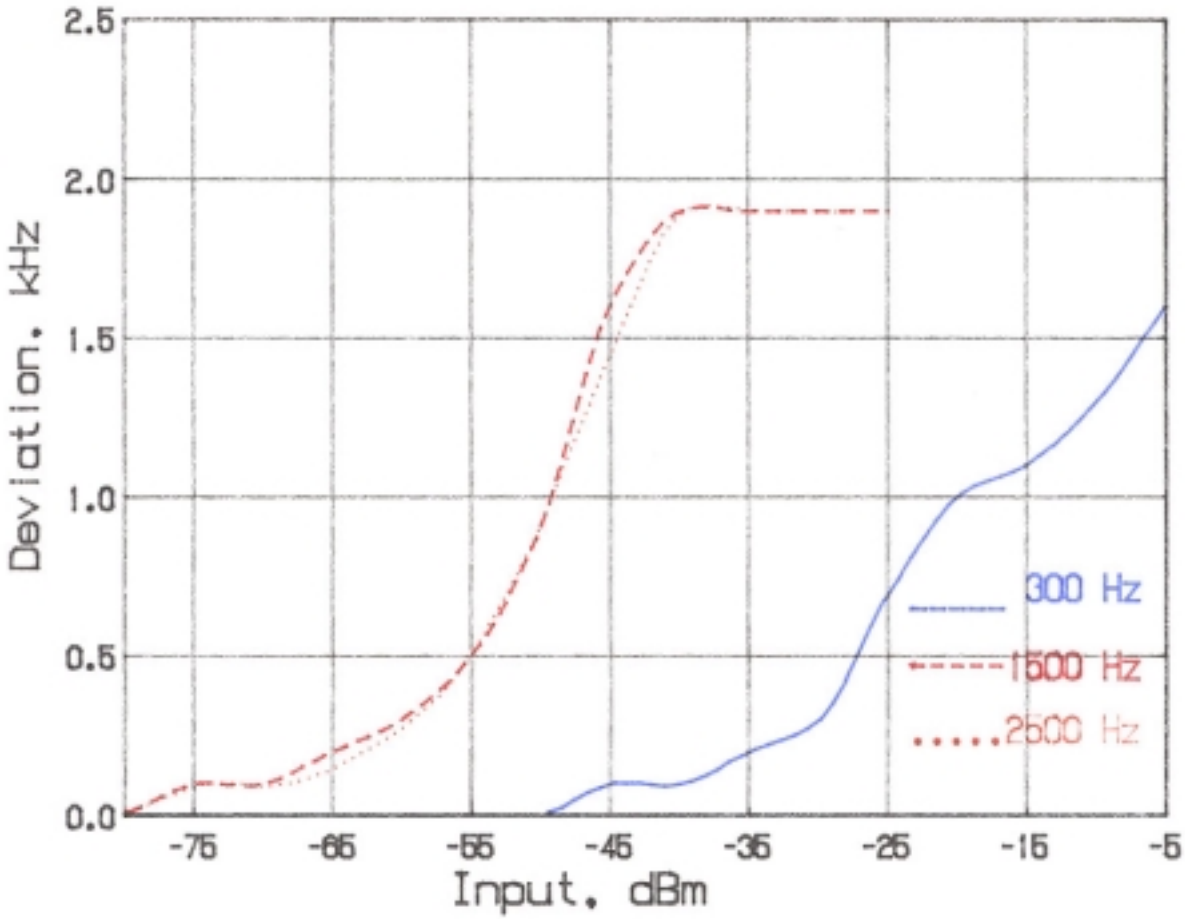
FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS



AUDIO LIMITER CHARACTERISTICS
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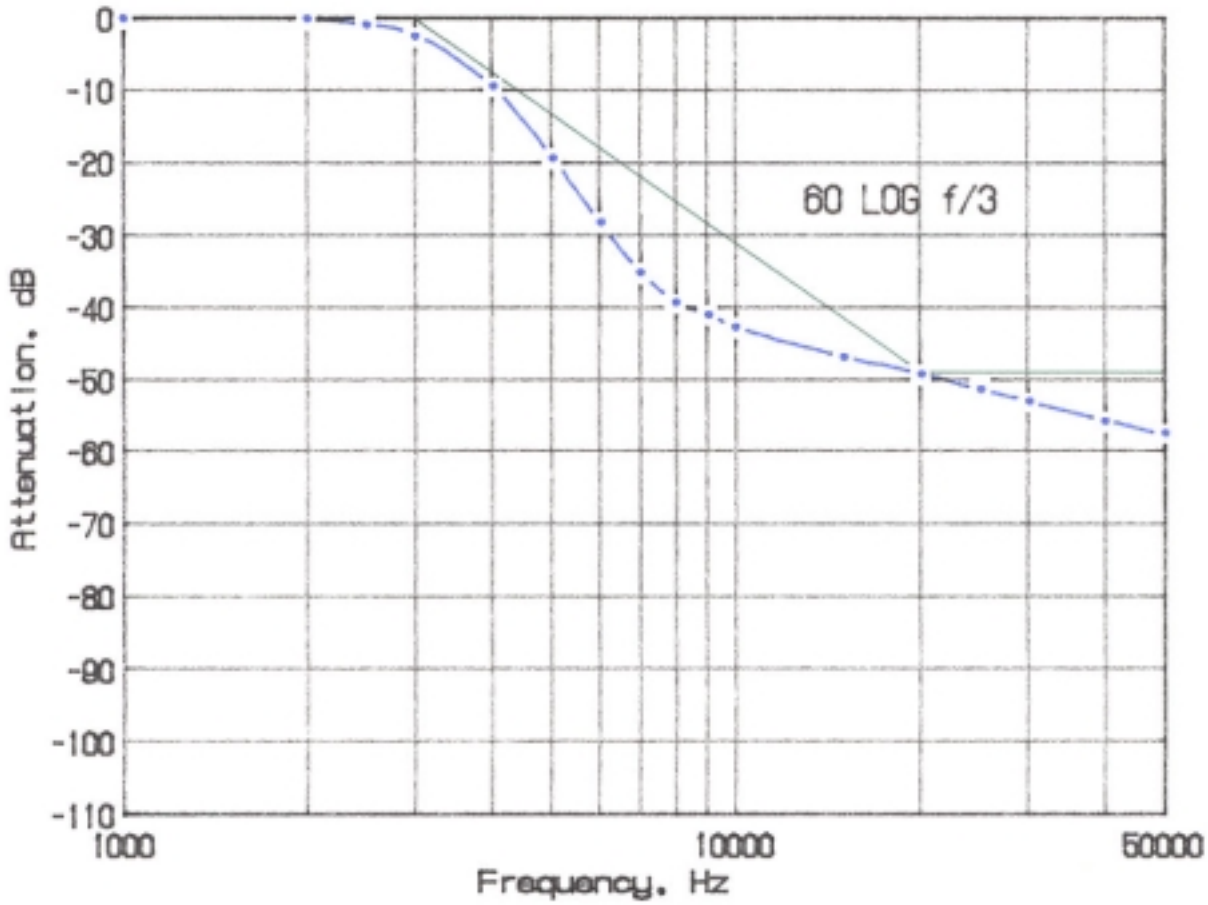
FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE



AUDIO LOW PASS FILTER
RESPONSE
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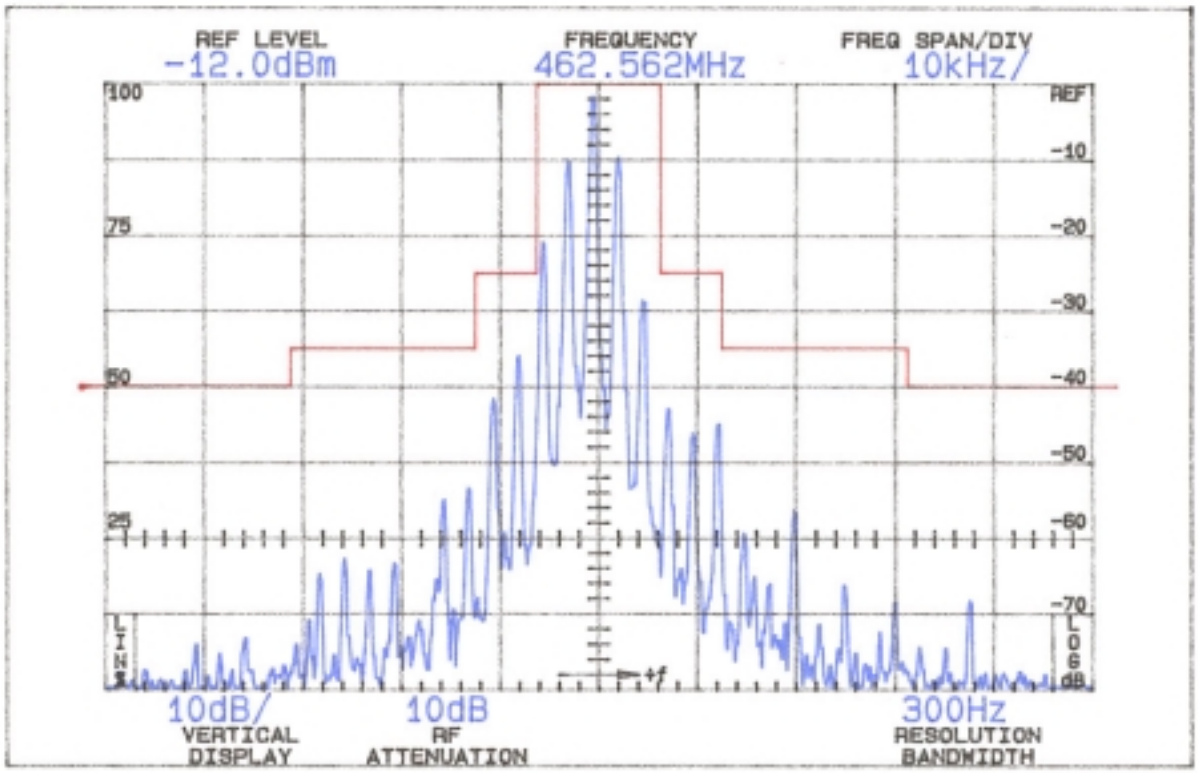
FIGURE 3

FIGURE 4

OCCUPIED BANDWIDTH



	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 12.5 kHz (6.25-12.5 kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (12.5-31.25 kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth (over 31.25 kHz)	43+10LogP = 40 (P = 0.49)

OCCUPIED BANDWIDTH
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FIGURE 4

D. MODULATION CHARACTERISTICS (Continued)

The plots are within FCC limits. The horizontal scale frequency) is 10 kHz per division and the vertical scale amplitude) is a logarithmic presentation equal to 10 dB per division.

E. SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS (Paragraph 2.991 of the Rules)

The TP-323 has a permanently attached antenna. There is no connector for an external antenna. Therefore, no antenna terminal conducted measurements were made.

F. DESCRIPTION OF RADIATED SPURIOUS MEASUREMENT FACILITIES

A description of the Hyak Laboratories' radiation test facility is a matter of record with the FCC. The facility was accepted for radiation measurements from 25 to 1000 MHz on October 1, 1976 and is currently listed as an accepted site.

G. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the TP-323 were made by substitution with a Tektronix 494P spectrum analyzer using Singer DM-105 for the measurements to 1 GHz, and EMCO 3115 horn to 4.8 GHz.

The transmitter was located in an open field 3 meters from the test antenna. Supply voltage was a power supply with a terminal voltage under load of 6.0 Vdc.

The transmitter and test antennae were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed.

The measurement system was capable of detecting signals 100 dB or more below the reference level. Measurements were made from the lowest frequency generated within the unit, to 10 times operating frequency. Data after application of antenna factors and line loss corrections are shown in Table 2.

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS

462.5625 MHz, 6.0 Vdc, 0.49 watts

Spurious Frequency	dB Below Carrier

MHz	Reference[1]
462.563	0
925.125	52V
3700.494	61H
4163.057	59V
Required: 43+10 Log(P) =	40

[1]Worst-case polarization, H-Horizontal, V-Vertical.

All other spurious from 20.95 MHz to the tenth harmonic were 20 dB or more below FCC limit.

H. FREQUENCY STABILITY
(Paragraph 2.995(a)(2))

Measurement of frequency stability versus temperature was made at temperatures from -20°C to +50°C. At each temperature, the unit was exposed to test chamber ambient a minimum of 60 minutes after indicated chamber temperature ambient had stabilized to within ±2° of the desired test temperature. Following the 1 hour soak at each temperature, the unit was turned on, keyed and frequency measured within 2 minutes. Test temperature was sequenced in the order shown in Table 3, starting with -20°C.

A Thermotron S1.2 temperature chamber was used. Temperature was monitored with a Keithley 871 digital thermometer. The

transmitter output stage was terminated in a dummy load. Primary supply was 6.0 volts. Frequency was measured with a HP 5385A frequency counter connected to the transmitter through a power attenuator. Measurements were made at 462.5625 MHz. No transient keying effects were observed.

TABLE 3

FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE
462.5625 MHz, 6.0 Vdc, 0.49 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-19.3	462.562655	0.3
-10.0	462.562710	0.5
- 0.3	462.562821	0.7
9.9	462.562784	0.6
20.1	462.562540	0.1
30.2	462.562357	-0.3
39.6	462.562328	-0.4
49.7	462.562849	0.8

Maximum frequency error: 462.562849
462.562500

+ .000349 MHz

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m.) or a maximum of ±0.001156 MHz, which corresponds to:

High Limit	462.563656 MHz
Low Limit	462.561344 MHz

I. FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE
(Paragraph 2.995(d)(2) of the Rules)

Oscillator frequency as a function of power supply voltage was measured with a HP 5385A frequency counter as supply voltage provided by an HP 6264B variable dc power supply was varied from ±15% above the nominal 6.0 volt rating to below the battery end point. A Fluke 197 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20°C ambient.

TABLE 4

FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE

462.5625 MHz, 6.0 Vdc Nominal; 0.49W

Supply Voltage		Output Frequency, MHz	p.p.m.
6.9	115%	462.562670	0.4
6.6	110%	462.562627	0.3
6.3	105%	462.562582	0.2
6.0	100%	462.562540	0.1
5.7	95%	462.562507	0.0
5.4	90%	462.562481	0.0
5.1	85%	462.562462	-0.1
4.8 *	80%	462.562450	-2.0

Maximum frequency error: 462.562450
462.562500

\- .000919 MHz

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m. or a maximum of ±0.001156 MHz, corresponding to:

High Limit	462.563656 MHz
Low Limit	462.561344 MHz

*Battery end point.

APPENDIX 1

FUNCTION OF DEVICES

Reference	Type	Function

Q101	NE550019	Final Amplifier
Q105	2SC5086	UHF Amplifier
Q106	2SC5086	UHF Amplifier
Q108	2SC5086	Buffer
Q112	2SC5086	VCO
Q114	UPA801T	Driver

IC101	LMX1602	PLL
IC102,IC311	MC3361CD	Audio Detect
IC301	RN5RZ28A	Regular
IC302	NJM2070	Audio Amplifier
IC303	NJM3403	MIC Amplifier/L.P Filter
IC304	NJM324V	H.P Filter
IC305	NJM324V	L.P Filter
IC306	NJM324V	H.P Filter
IC307	AT93C46	Memory
IC308	MC14001BD	CALL
IC309	UPD789406	MCU
IC312	MC74HC4046AD	Fsk. Detect
IC313	NJM2904	B.P Filter
IC314	LM339M	Voltage Comparator
IC315	NJU4053BV	Analog Multiplexers

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

SYNTHESIZER

A phase locked loop (PLL) circuit establishes and stabilizes operating frequency.

The data for producing necessary frequencies is established

by the microcontroller on the digital board.

The frequency stability of the TX/RX is maintained by the TCXO, which generates a stable frequency of 20.95 MHz.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
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APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION
AND LIMIT MODULATION

The modulated signal output from the VCO is pre-amplified by Q114 UPA801T and Q101 NE5500179. The RF output is 0.5W power. The amplified signal then passes through a low-pass filter network, which consists of L115, C143, C149, to be filtered out spurious emission, then arrive at the antenna switching circuit D101. The signal is filtered by another low-pass filter circuit,

which consists of L103, L104, C155, C156 and C148. The low pass filters are necessary to suppress the second and third harmonics.

CIRCUITS TO SUPPRESS SPURIOUS
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APPENDIX 3