Engineering Exhibit in Support of Type Acceptance FCC Form 731

For The

DL-3422 Telemetry Transceiver with the DL-3286 Modem

May 4, 1998

Johnson Data Telemetry Corporation
Waseca, Minnesota

AFFIDAVIT

The technical data included in this report has been accumulated through tests that were performed by me or by engineers under my direction. To the best of my knowledge, all of the data is true and correct.

Mark Christensen
Director of Engineering, Johnson Data Telemetry

Johnson Data Telemetry Corporation
Waseca, Minnesota

ENGINEERING STATEMENT OF DARWIN ERICKSON

The application consisting of the attached engineering exhibit and associated FCC form 731, has been prepared in support of a request for Type Acceptance for DL-3422, 132-174 MHz Telemetry Transceiver with The DL-3286 Modem. The transceiver mated with the modem will be identified the Johnson Data Telemetry part number 242-4014-XXX, model number DL-4014. The Transceiver/Modem will be identified by the FCC number NP42424014-001. The transceiver operates pursuant to Part(s) 90 of the Rules and Regulations.

EXISTING CONDITIONS

The units utilized for these type acceptance measurements were obtained from the pilot-production. The transceiver is designed to operate on frequencies ranging from 132.000 MHz to 174.000 MHz. The frequency tolerance of the transceiver is .00025% or 2.5 parts per million. The frequency stability of the transceiver is controlled by a temperature compensated crystal oscillator operating at 17.5 MHz.

PROPOSED CONDITIONS

It is proposed to Type Accept the DL-4014, 132-174 MHz Transceiver/Modem for operation in the band of frequencies previously outlined. The applicant anticipates marketing the device for use in wireless transmission of voice and data.

PERFORMANCE MEASUREMENTS

All Type Acceptance measurements were conducted in accordance with Section 2.983 of 47 CFR 1997 of the Rules and Regulations. Equipment performance measurements were made in the engineering laboratory and on the FCC certified test range at the E.F. Johnson Corporation Operations Center in Waseca, Minnesota. All measurements were made and recorded by myself or under my direction. The performance measurements were made between April 9, 1998 and May 1, 1998.

CONCLUSION

Given the results of the measurements contained herein, the applicant requests that Type Acceptance be granted for the 242-4014-001, 132-174 MHz Transceiver/Modem as tested for data communications.

5/4/98

Darwin Erickson
Senior Engineer, Johnson Data Telemetry

Johnson Data Telemetry Corporation
Waseca, Minnesota

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QUALIFICATIONS OF ENGINEERING PERSONNEL

NAME:	Darwin Erickson
TITLE:	Senior Engineer
TECHNICAL EDUCATION:	BSEE (1991) from North Dakota State University
TECHNICAL EXPERIENCE:	6 years experience in analog and radio frequency software / circuit design.

NAME:	Allen Frederick
TITLE:	Certified Technologist
TECHNICAL EDUCATION:	Bachelor of Science Degree in Electronic Engineering Technology (1998) from Mankato State University.
TECHNICAL EXPERIENCE:	2 years experience in analog and radio frequency communications.

GENERAL INFORMATION

The following report has been generated for FCC Type Acceptance of the Johnson Data Telemetry Transceiver/Modem part number 242-4014-XXX. Unless otherwise noted, all of the measurements were conducted following the procedures set forth in the TIA/EIA-603 standards.

MODEL NUMBER:	DL-4014
PART NUMBER:	242-4014-XXX
MANUFACTURER:	Johnson Data Telemetry Corporation, Waseca, MN 56093
FCC ID NUMBER:	FCC ID: NP42424014-001
FCC RULES AND REGS:	FCC Part (s) 90
FREQUENCY RANGE:	Frequency 132.000 MHz - 174.000 MHz
SERIAL NUMBER (S):	132.000 MHz - 41004 153.000 MHz - 53003 174.000 MHz - 53003

TRANSMITTER

TYPE OF EMISSION:	13K0F1D
MAXIMUM POWER RATING:	5.00 Watts
NUMBER OF CHANNELS:	8 Channel Modem
INPUT IMPEDANCE:	50 ohms, Nominal
VOLTAGE REQUIREMENTS:	13.8 VDC, Nominal

MODEL NUMBER	DESCRIPTION	JDT PART NUMBER
DL-3286	Telemetry Modem	023-3286-330
DL-3422	132-174 MHz Transceiver	242-3422-XXX

DESCRIPTION OF CIRCUITRY

RULE PART NUMBER: 2.983 (d)(10)

THEORY OF OPERATION

1.0 PURPOSE

This report has been prepared to support the application for FCC Type Acceptance PER CODE OF FEDERAL REGULATIONS, TITLE 47, PARTS 2 AND 90 AND for the transmitter subsystem of the JDT Model 242-3422-5xx Transceiver. The report presents necessary information concerning electrical circuit description, measured performance and physical construction and configuration.

2.0 DL-3422 TRANSCEIVER

The main subassemblies of this transceiver are the RF board, VCO board, TCXO and modem assembly. A block diagram of the transceiver is located in Figure 4. The DL-3422 is also available in transmit only and receive only models.

The VCO board is enclosed by a metal shield and soldered directly to the RF board. The VCO is not serviceable.

The DL-3422 has a reference oscillator stability of ±2.5 PPM. The 17.5 MHz TCXO (Temperature Compensated Crystal Oscillator) is soldered directly to the RF board. The TCXO is not serviceable.

2.1 SYNTHESIZER

The synthesizer output signal is produced by a VCO (voltage controlled oscillator). The VCO frequency is controlled by a DC voltage produced by the phase detector in U811. The phase detector senses the phase and frequency of the two input signals and causes the VCO control voltage to increase or decrease if they are not the same. The VCO is then "locked" on frequency.

Programming of the synthesizer provides the data necessary for the internal prescaler and counters. One input signal is the reference frequency. This frequency is produced by the 17.5 MHz reference oscillator (TCXO). The other input signal is the VCO frequency.

VOLTAGE-CONTROLLED OSCILLATOR

Oscillator (Q872)

The VCO is formed by Q872, several capacitors and varactor diodes, and air wound inductor L872. It oscillates at the transmit frequency in transmit mode and first injection frequency in the receive mode (132-150 MHz in transmit and 153.45 - 195.45 MHz in receive).

Biasing of Q872 is provided by R873, R874 and R876. An AC voltage divider formed by C872, C874 and C875 initiates and maintains oscillation and also matches Q872 to the tank circuit. air wound inductor L872 is grounded at one end to provide shunt inductance to the tank circuit.

Frequency Control and Modulation

The VCO frequency is controlled in part by DC voltage across varactor diodes CR852, CR853, and CR854. As voltage across a reverse-biased varactor diode increases, its capacitance decreases. Therefore, VCO frequency increases as the control voltage increases. CR852/CR853 and CR854 are paralleled varactors to divide the capacitance and improve linearity. The varactors CR852/CR853 are biased at -2.0V so the control line voltage can operate closer to ground. CR854 is pin shifted in when transmitting to increase the VCO gain in transmit. The control line is isolated from tank circuit RF by choke L852/L853. The amount of frequency change produced by CR852/CR853/CR854/ is controlled by series capacitor C854.

The -2.0V applied to the VCO is derived from the 17.5 MHz TCXO frequency that is amplified by Q902, rectified by CR902 and filtered by C912, C917, C918 and C920 on the RF board.

The VCO frequency is modulated using a similar method. The transmit audio/data signal from J201, pin 6 is applied across varactor diode CR861 which varies the VCO frequency at an audio rate. Series capacitors C855/C856 set the amount of deviation produced along with CR862 and C865. R863 provides a DC ground on the anodes of CR861/CR862, and isolation is provided by R862, and C863.

The DC voltage across CR862 provides compensation to keep modulation relatively flat over the entire bandwidth of the VCO. This compensation is required because modulation tends to increase as the VCO frequency gets higher (capacitance of CR852/CR853/CR855 gets lower). CR862 also balances the modulation signals applied to the VCO and TCXO. The D/A Converter U911 can be programmed to apply a compensating voltage to CR862 to adjust the modulation sensitivity between the TCXO and VCO.

The DC voltage applied across CR862 comes from the modulation adjust control R827 on the RF board. R826 applies a DC biasing voltage to CR86. C821 provides DC blocking. RF isolation is provided by C865, and R862.

VCO AND REFERENCE OSCILLATOR MODULATION

Both the VCO and reference oscillator (TCXO) are modulated in order to achieve the required frequency response. If only the VCO was modulated, the phase detector in U811 would sense the frequency change and increase or decrease the VCO control voltage to counteract the change (especially at the lower audio frequencies). If only the reference oscillator frequency is modulated, the VCO frequency would not change fast enough (especially at the higher audio frequencies). Modulating both VCO and reference oscillators produces a flat audio response. Potentiometer R827 sets the VCO modulation sensitivity so that it is equal to the reference oscillator modulation sensitivity.

CASCADE AMPLIFIERS/VCO (Q871/Q872)

The output signal on the collector of Q871 is coupled to buffer amplifier Q872 which forms a cascade amplifier. This is a shared-bias amplifier which provides oscillation, amplification and isolation from the stages which follow. The signal is coupled and matched from the collector of Q872 through inductors and capacitors and a T-pad to amplifier Q882.

AMPLIFIER (Q882)

Q882 provides final amplification of the VCO signal. Biasing of Q882 is provided by Q881 and several resistors. Matching to the transmitter and receive first injection is provided by L891 and C892. A 6dB T-pad is used to isolate the transmitter and receive first injection.

VOLTAGE FILTER (Q901)

Q901 on the RF board is a capacitance multiplier to provide filtering of the 8.6V supply to the VCO. R901 provides transistor bias and C901 provides the capacitance that is multiplied. If a noise pulse or other voltage change appears on the collector, the base voltage does not change significantly because of C901. Therefore, base current does not change and transistor current remains constant. CR901 decreases the charge time of C901 when power is turned on. This shortens the startup time of the VCO. C902, and C903 are RF decoupling capacitors.

VCO FREQUENCY SHIFT (Q841)

The VCO must be capable of producing frequencies from 132 - 195.45 MHz to produce the required receive injection and transmit frequencies.
If this large of a shift was achieved by varying the VCO control voltage, the VCO gain would be undesirably high. Therefore, capacitance is switched in and out of the tank circuit to provide a coarse shift in frequency.

This switching is controlled by the T/R pin shift (RX_EN) on J201, pin 4, Q841/Q842 and pin diode CR851. When a pin diode is forward biased, it presents a vary low impedance to RF; and when it is reverse biased, it presents a very high impedance. The capacitive leg is switched in when in transmit and out when in receive.

When J201, pin 4 is high in receive (+5V), Q173 is turned on and the collector voltage goes low. A low on the base of Q172 turns the transistor on and the regulated +9.6V on the emitter is on the collector for the receive circuitry. Q171 applies a low on the base of Q841 the transistor is off and the collector is high. With a high on the base of Q842 and a low on the emitter, this reverse biases CR850 for a high impedance.

The capacitive leg on the VCO is formed by C852, CR851, and C853. When J201, pin 4 is low in transmit, Q842 is turned on and a high is on the emitter, Q171 is turned off and the collector voltage goes high. A low on the base of Q173 turns the transistor off and the regulated +9.6V is removed from the receive circuitry. With a high on the base of Q841 the transistor is on and the collector is low. With a low on the base of Q842 and a high on the emitter, this forward biases CR851 and provides an RF ground through C852 and C853 is effectively connected to the tank circuit. This decreases the resonant frequency of the tank circuit.

2.2 SYNTHESIZER INTEGRATED CIRCUIT (U811)

Introduction

This device contains the following circuits: R (reference), Fractional-N, NM1 and NM2; phase and lock detectors, prescaler and counter programming circuitry.

Channel Programming

Frequencies are selected by programming the R, Fractional-N, NM1 and NM2 in U811 to divide by a certain number. These counters are programmed by Loader board or a user supplied programming circuit.

As previously stated, the counter divide numbers are chosen so that when the VCO is oscillating on the correct frequency, the VCO-derived input to the phase detector is the same frequency as the reference oscillator-derived frequency.

The VCO frequency is divided by the internal prescaler and the main divider to produce the input to the phase detector.

LOCK DETECT

When the synthesizer is locked on frequency, the SYNTH LOCK output of U811, pin 18 (J201, pin 7) is a high voltage. Then when the synthesizer is unlocked, the output is a low voltage. Lock is defined as a phase difference of less than 1 cycle of the TCXO.

2.3 RECEIVER CIRCUIT DESCRIPTION

PRESELECTOR FILTER, RF AMPLIFIER (Q202)

Capacitor C201 couples the receive signal from the antenna switch to the LC preselector filter composed of L201, L202, L203, CR281, CR282, C202, C203, C204, C205, C206, and C207. (The antenna switch is described in later.) The preselector filter is a two pole discrete LC varactor tuned bandpass filter adjusted to pass only a narrow band of frequencies to the receiver. This attenuates the image and other unwanted spurious frequencies. The preselector filter is tuned in frequency by varying the reverse bias voltage of the varactors CR 281 and CR 282. The filter control voltage is generated by Digital to Analog Converter (DAC) U911 and amplified by U831 to generate a higher voltage swing to the varactors and minimize filter loss. R206 and capacitors C281 through C285 filter the varactor voltage and provide RF isolation.

Impedance matching between the preselector filter and RF amplifier Q202 is provided by C207 and L204. CR201 protects the base-emitter junction of Q202 from excessive negative voltages that may occur during high signal conditions. Q201 is a switched constant current source which provides a base bias for Q202. Q201 base bias is provided by R202/R203. Current flows through R201 so that the voltage across it equals the voltage across R202 (minus the base/emitter drop of Q201). In the transmit mode the receive +9.6V is removed and Q201 is off. This removes the bias from Q202 and disables the RF amplifier in transmit mode. This prevents noise and RF from being amplified by Q202 and fed back on the first injection line.

Additional filtering of the receive signal is provided by a three pole discrete LC varactor tuned bandpass filter composed of filter L212, L213, L214, L221, L222, L223, L224, CR283, CR284, CR285, C214, C215, C216, C217, C221, C222, and C223. L211 and C213 provide impedance matching between Q202 and this filter. Resistor R205 is used to lower the Q of L211 to make it less frequency selective. The same control voltage that adjusts to two pole filter on frequency adjusts this filter as well. The inductors are factory tuned to align the filter tracking and should not be adjusted.

MIXER (Q232)

First mixer Q232 mixes the receive frequency with the first injection frequency to produce the 21.45 MHz first IF. Since high-side injection is used, the injection frequency is 21.45 MHz above the receive frequency. Q231 biases Q 232 in similar fashion to Q201 described above. The RF signal is coupled to the mixer through C233. R226 attenuates high voltage excursions on the base of Q232. The LO injection is proved across L232 and R236 on the emitter of Q232. Emitter injection is used to provide isolation between the LO port and the RF port. L233 and C238 provide a low impedance on the emitter at the IF frequency improving noise performance and conversion gain.

FIRST L.O. AMPLIFIER/BUFFER (Q301, Q302)

The first L.O. amplifier provides amplification and buffering of the receive first injection. R305, R306, and R307 form a 3dB 50 ohm pad C303 couples the signal to C304 and L301 which match Q302 to 50 ohms L302 and C307 match Q302 to the mixer Q232. Q301, R301, R302, R303, and R304 provide biasing for Q302 R308 enhances the stability of Q302. C302 and C306 provide RF decoupling.

CRYSTAL FILTER (Z231/Z232)

The output of Q232 is matched to the crystal filter, Z231 and Z232 by L231, C234, and C237. This filter presents a low impedance to 21.45 MHz and attenuates the receive, injection, and other frequencies outside the 21.45 MHz passband.

Z221 and Z222 form a 2-section, 4-pole crystal filter with a center frequency of 21.45 MHz and a -3 dB passband of 8 KHz (12.5 KHz BW) or 15 KHz (25 KHz BW). This filter establishes the receiver selectivity by attenuating the adjacent channel and other signals close to the receive frequency. C241 and C242 adjust the coupling of the filter. L242, C244, C245 and R243 provide impedance matching between the filter and 241.

SECOND LO OSCILLATOR (U241), BUFFER (Q251)

The second LO oscillator is built into U241 which provides the base and emitter connections for an internal oscillator transistor. The oscillator tank circuit consists of L251, C253, and CR251. Oscillator feedback is provided by C254, C256 and C257. The oscillator frequency is adjusted by applying a control voltage across R253 to CR251. The control voltage is provided by the charge pump of the auxiliary synthesizer in U811. The emitter of the oscillator transistor is connected to the common collector buffer amplifier Q251 by C251. R257, R258, R259 and R254 provided bias for Q251. R254 additionally provides an RF load to decrease the buffer level. C258, C259, and L252 filter the unwanted harmonics from the oscillator output. The output of Q251 is coupled to the auxiliary synthesizer phase detector by C814. The oscillator is phase locked at 21.9 MHz with L251 adjusted to center the control voltage.

SECOND MIXER/DETECTOR (U241)

Oscillator and Mixer

U241 contains the second oscillator, second mixer, limiter, detector, and squelch circuitry. The 21.45 MHz IF signal is mixed with a 21.9 MHz signal produced by second LO amplifier Q401 from TCXO Y801.

Second IF Filter

The output of the internal double-balanced mixer is the difference between 21.45 MHz and 21.9 MHz which is 450 KHz. This 450 KHz signal is fed out on pin 3 and applied to second IF filters Z241 and Z242. These filters have passbands of 9 KHz (12.5 KHz BW), or 20 KHz (25 KHz BW) at the -6 dB points and are
used to attenuate wideband noise.

Limiter-Amplifier

The output of Z241/Z242 is applied to a limiter-amplifier circuit in U241. This circuit amplifies the 450 KHz signal and any noise present; then limits this signal to a specific value. When the 450 KHz signal level is high, noise pulses tend to get clipped off by the limiter; however, when the 450 KHz signal level is low, the noise passes through the limiter. C275/C276 decouple the 450 KHz signal.

Quadrature Detector

From the limiter stage the signal is fed to the quadrature detector. An external phase-shift network connected to pin 8 shifts the phase of one of the detector inputs 90× at 450 KHz (all other inputs are unshifted in phase). When modulation occurs, the frequency of the IF signal changes at an audio rate as does the phase of the shifted input. The detector, which has no output with a 90× phase shift, converts this phase shift into an audio signal. L253 is tuned to provide maximum undistorted output from the detector.

R255 is used to lower the Q of L253. From the detector the audio and data signal is fed out on pin 9. The audio/data output of U241, pin 9 is applied to J201, pin 13.

Receive Signal Strength Indicator (RSSI)

U241, pin 5 is an output for the RSSI circuit which provides a current proportional to the strength of the 450 KHz IF signal. The voltage developed across R275 is applied to J201, pin 12.

2.4 TRANSMITTER CIRCUIT DESCRIPTION

BUFFER (Q501)

The VCO RF output signal is applied to R892, R893 and R894 that form a resistive splitter for the receive first local oscillator and the transmitter. The VCO signal is then applied to a 50 ohm pad formed by R501, R502, and R503. This pad provides attenuation and isolation. Q501 provides amplification and additional isolation between the VCO and transmitter. Biasing for this stage is provided by R504 and R505, and decoupling of RF signals is provided by C503 . Impedance matching to the predriver is provided by L511 and C512.

PRE-DRIVER (Q511)

Pre-driver Q511 is biased class A by R511 and R512 and R515. L513, Q517 and C518 match Q511 to U531. R514 provides a resistive feedback path to stabilize Q511 and C515 provides DC blocking. C516 bypasses RF from the DC line, and R513 provides supply voltage isolation and ties the +9V transmit supply to the circuit.

FINAL (U531), COMPARATOR (U111C)

RF module U531 has an RF output of 1 to 5W and operates on an input voltage from 10-16V.

Power control is provided by U581, U111, Q531 and a stripline directional coupler. The power is adjust by Power Set Control R535 that provides a reference voltage to U111C. U111C drives Q531 and PA module U531.

One end of the balun directional coupler is connected to a forward RF peak detector formed by R591, CR591, C591 and U581A. The other end of the stripline directional coupler is connected to a reverse RF peak detector formed by R593, CR592, C593 and U581B.

If the power output of U531 decreases due to temperature variations, etc., the forward peak detector voltage drops. This detector voltage drop is buffered by U581A and applied to inverting amplifier U111C which increases the forward bias on Q531. The increase on Q531 increases the power output level of U531. If the power output of U531 increases, the forward peak detector voltage increases and U111C decreases the forward bias on Q531. The decrease on Q531 decreases the output power of U531.

The output of CR591 and CR592 are fed to U581A/B respectively. If the output of either buffer increases, the increase is applied to the inverting input of U111C. The output of U111C then decreases and Q531 decreases the input voltage to U531 to lower the power. The control voltage is isolated from RF by ferrite bead EP532 and C531 decouples RF.

The forward/reverse power voltages from U581A/B are also applied to U913/U912 for diagnostics outputs on J201.

The low-pass filter consists of L551, C552, L552, C553, L553, C555, L554 and C856. The filter attenuates spurious frequencies occurring above the transmit frequency band. The transmit signal is then fed through the antenna switch to antenna jack J501.

ANTENNA SWITCH (CR561, CR562)

The antenna switching circuit switches the antenna to the receiver in the receive mode and the transmitter in the transmit mode.
In the transmit mode, +9V is applied to L555 and current flows through diode CR561, L561, diode CR562, and R561. When a diode is forward biased, it presents a low impedance to the RF signal; conversely, when it is reverse biased (or not conducting), it presents a high impedance (small capacitance). Therefore, when CR561 is forward biased, the transmit signal has a low-impedance path to the antenna through coupling capacitor C562.

L561, and C564 form a discrete quarter- wave line. When CR561 is forward biased, this quarter-wave line is effectively AC grounded on one end by C564. When a quarter-wave line is grounded on one end, the other end presents a high impedance to the quarter-wave frequency. This blocks the transmit signal from the receiver. C561 and C563 matches the antenna to 50 ohms in transmit and receive.

TRANSMITTER KEY-UP CONTROL

Q121, Q122, and Q123 act as switches which turn on with the RX_EN line. When the line goes low the Q121 is turned of which turns Q122 on turning Q123 on. This applies 13.6V to U111 before the TX_EN line goes high. U111A/B provides the key-up and key-down conditioning circuit. C116 and R117 provide a ramp up and ramp down of the 9.0TX during key-up and key-down which reduces load pull of the VCO during key-up. The conditioning provides a stable 5.5V output by balancing the 5.5V reference with the 5.5V regulated supply. The output on U111B, pin 7 is applied to comparator U111D, pin 12, the non-inverting input. The output of U111D, pin 14 is applied to the base of current source Q124. The output of Q124 is on the emitter and is applied back to the inverting input of comparator U111D, pin 13. A decrease or increase at U111D, pin 13 causes a correction by U111D to stabilize the 9V transmit output. R125/R126 establish the reference voltage on U111D, pin 13. C123 provides RF bypass, C124 provides RF decoupling and C125 stabilizes the output. The 9V transmit voltage is then distributed to the circuits.

2.5 VOLTAGE REGULATORS

+9.6V REGULATED

The 5V applied on J201, pin 5 is applied to the base of Q131 turning the transistor on. This causes the collector to go low and applies a low to the control line of U141, pin 1 and R131 is a pull up resistor. The 13.6V from J201, pin 2 is on U141, pin 6 to produce a +9.6V reference output on U141, pin 4. C145 stabilizes the voltage and C146 provides RF decoupling. C144 provides RF bypass and C118 provides RF decoupling. C137 provides is a bypass capacitor for U131.
+5.5 REGULATED

When 5.0V is applied to J201, pin 5 it is applied to the base of Q131 turning the transistor on. This causes the collector to go low and applies a low to the control line of U131, pin 1. C136 decouples RF and R131 is a pull up resistor. The 13.6V from J201, pin 2 is on U131, pin 6 to produce a +5.5V regulated output on U131, pin 4. C135 stabilizes the voltage and C136 provides RF decoupling. C137 provides is a bypass capacitor for U131.

3.0 DL-3286 MODEM

3.1 GENERAL

The Modem board, Part No. 023-3286-330, is a plug-in circuit board. The three main functions of the modem board include, loading the synthesizer, providing the baseband modulating signal for the transmitter and demodulating receive audio signals. The modem board is programmed by a personal computer and software. The modem board connects to the radio through 14-pin connector J100. Programming channels and other operating parameters is provided through DB9 connector. A block diagram of the modem is shown at the end of this section.

3.2 TRANSMIT DATA

Transmit Data from the RS-232 port is level-shifted to TTL levels by U216. The MX919B modem, U210 takes the digital data stream and modulates the analog baseband signal using a 4 Level Root Raised Cosine FSK modulation scheme, which is then filtered by U502 then applied to MOD_IN (pin 6) of J100.

The MX919B modem IC is a custom MX-COM 4-level FSK packet data modem operating from 4800 bps to 19.2 kbps. The modem IC adds forward error correction (FEC) and data correction (CRC) information. After adding symbol and frame synchronization codewords, the data packet is converted into filtered 4-level analog signals for modulation the radio. Potentiometer R508 sets the transmit deviation.

3.2 RECEIVE DATA

Received signals are filtered by band-pass filter U402-3 and the gain is adjusted with R410 to set the correct analog levels for the modem IC. The detected audio is fed to the input of the modem IC and also to a symbol synchronization band-pass filter U402-1. From U402-1 the audio passes through a peak detector and amplifier U402-4, then to the processor where a symbol sync pattern is searched for. Once this symbol sync pattern is found the processor enables the Modem to start accepting the data from low-pass filter U402-3. The modem IC takes the analog signals, removes the overhead bits, and performs the error correcting.

3.3 SYNTHESIZER PROGRAMMING

The processor loads the synthesizer on power up, wake up, or receive or transmit transitions. The synthesizer load is sent on the SPI bus with RF_SYNTH_ENABLE, pin 8 of J100, asserted. The radio synthesizer generates a lock detect signal to show when it is on frequency. This signal enters the loader on pin 7 of J100 where it is buffered by U300. If the synthesizer is out of lock the processor will remove the TX enable (if present) and reload the synthesizer until lock is again regained. Eight channel frequency select is provided DIP switches 1, 2, and 3 of S1.

3.4 POWER SUPPLIES

Voltage Regulator U800 provides 8 volt V_SRC for the 3474 Module. Ferrite bead EP 800 is placed when the regulator is in use. To bypass the regulator when an externally-regulated 8 volt supply is used, or when the 3412/3422/3492 RF modules which operate on 12.5 v are being used, EP 800 is removed and EP 700 is placed instead. U604 provides 5.5 V for the receiver 5.5REG and analog modem circuitry, while U602 provides 5V for the CPU and other digital logic.

MOSFET Q806 controls the rise and fall time of RF_TX_EN to eliminate keying transients with the DL3474. This KEY UP CIRCUITRY is only placed on the (-002) boards for use with the 3474.

3.5 MISCELLANEOUS FUNCTIONS

An error condition, when the logic voltage regulator goes out of regulation, resets the processor. U606 is a temperature sensor used by the firmware to compensate for variations in RSSI.

The RF module's RSSI_OUT, J100 pin 12, is read by an analog input on the CPU, which implements a squelch threshold in software. Various internal voltages (F_B+, analog VCC, RX5V, TX5V, SWB+) are read and the diagnostics can be displayed using the available software.

Switch S102 puts the CPU in programming mode in which the CPU accepts new boot code from the software.

NAME OF TEST: Transmitter Rated Power Output

RULE PART NUMBER: 2.983 (d)(5), 2.985 (a)

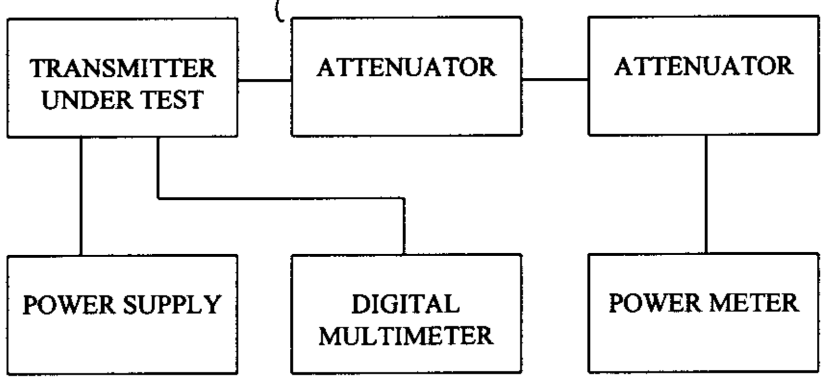
TEST RESULTS: See results below

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT: Attenuator, BIRD Model / 9715 / 50-A-MFN-06 / 6 dB / 50 Watt
Attenuator, BIRD Model / 9716 / 25-A-MFN-20 / 20 dB / 25 Watt
Digital Voltmeter, Fluke Model 8012A
DC Power Source, Model HP6284A
Power Meter, Hewlett Packard 436A

PERFORMED BY: Allen Frederick DATE: 4/9/98

TEST SET-UP:

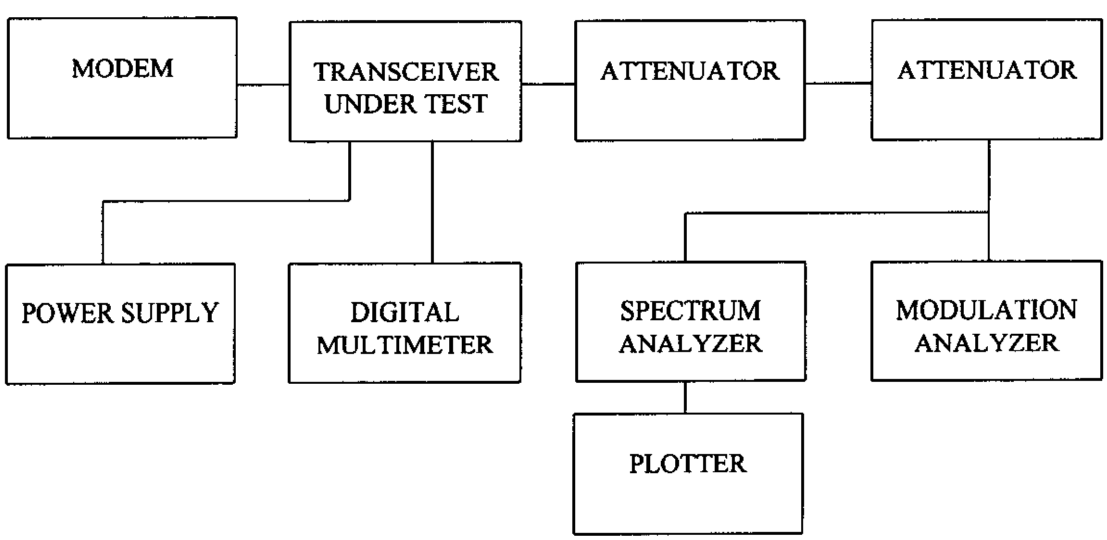


TEST RESULTS:

Frequency (MHz)	DC Voltage at Final (Vdc)	DC Current into Final (Adc)	DC Power into Final (W)	RF Power Output (W)
132.000	13.3	1.21	16.09	5.0

NAME OF TEST:	Transmitter Occupied Bandwidth DL-3286 Modem at 9600 bps (4800 BAUD) In Support of Emission Designator 13K0F1D
RULE PART NUMBER:	2.201, 2.202, 2.989 (h), 90.209 (b)(5), 90.210 (d)
MINIMUM STANDARD:	Mask D Sidebands and Spurious [Rule 90.210 (d), P = 5 Watts] Authorized Bandwidth = 11.25 KHz [Rule 90.209(b) (5)] From Fo to 5.625 KHz, down 0 dB. Greater than 5.625 KHz to 12.5 KHz, down 7.27(f_d-2.88kHz) dB. Greater than 12.5 KHz, at least 50+10$\log_{10}$(P) or 70 dB, whichever is the lesser of the attenuation. Attenuation = 0 db at Fo to 5.625 KHz Attenuation = 20 dB at 5.625 KHz and 70 dB at 12.5 KHz Attenuation = 57 dB at > 12.5 KHz
TEST RESULTS:	Meets minimum standard (see data on the following pages)
TEST CONDITIONS:	Standard Test Conditions, 25 C
TEST EQUIPMENT:	Attenuator, BIRD Model / 9715 / 50-A-MFN-06 / 6 dB / 50 Watt Attenuator, BIRD Model / 9716 / 25-A-MFN-20 / 20 dB / 25 Watt Digital Voltmeter, Fluke Model 8012A DC Power Source, Model HP6284A Modulation Analyzer, Model HP8901A Spectrum Analyzer, Model HP8563E Plotter, HP7470A
PERFORMED BY:	Allen Frederick DATE: 4/14/98

TEST SET-UP:



NAME OF TEST: Transmitter Occupied Bandwidth (Continued)
DL-3286 Modem at 4800 BAUD (9600 bps)
In Support of Emission Designator 13K0F1D

MODULATION SOURCE DESCRIPTION:

The DL-3286 modem was used as the modulating source for this test configuration.
The deviation was set to +/- 4.1 KHz . A random test pattern was generated by the modem. The baud rate was set to 4800 Symbols/sec which corresponds to a bit rate of 9600bps. In this mode, the highest resulting modulating frequency is 2400 Hz.

The modem uses a random number generator to produce random binary numbers from 0-255 decimal to be used as random data to modulate the transceiver. A Symbol Synchronization Code, Frame Synchronization and Header Block is added to the beginning of the frame. (see figure below) From the time the modem keys the transmitter there is a 3 mS delay before the Symbol Synchronization Code begins.

Transmit Frame Structure

Symbol Synchronization 1.2 KHz SineWave Tone 25 mS	Frame Synch. 5 mS	Header Block 14 mS	Data including FEC

Transmit Data from the RS-232 port is level-shifted to TTL levels by U216. The MX919B modem, U210 takes the digital data stream and modulates the analog baseband signal using a 4 Level Root Raised Cosine FSK modulation scheme, which is then filtered by U502. The modem IC adds forward error correction (FEC) and data correction (CRC) information. After adding Symbol Synchronization Code, Frame Synchronization and A Header Block, the data packet is converted into filtered 4-level analog signals for modulating the radio.

<u>NECESSARY BANDWIDTH (Bn) CALCULATION</u>

Bn = 2M + 2DK

M= 2400 Hz. This is the highest modulating frequency corresponding to 4800 baud (9600bps).

D = 4100 Hz. This is the maximum deviation.

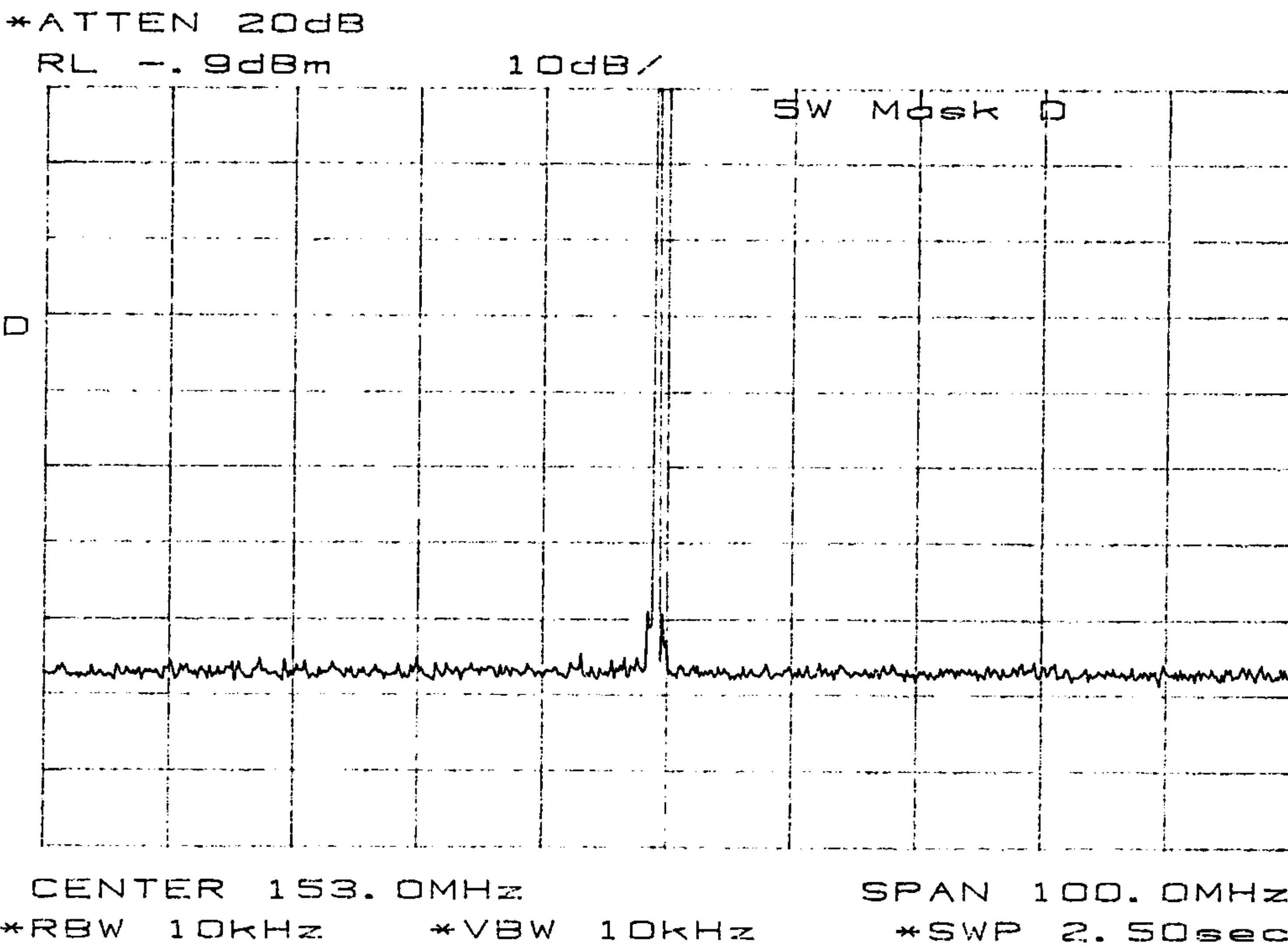
K = 1.0

Bn = 2(2400) + 2(4100)(1.0) = 13,000 Hz.

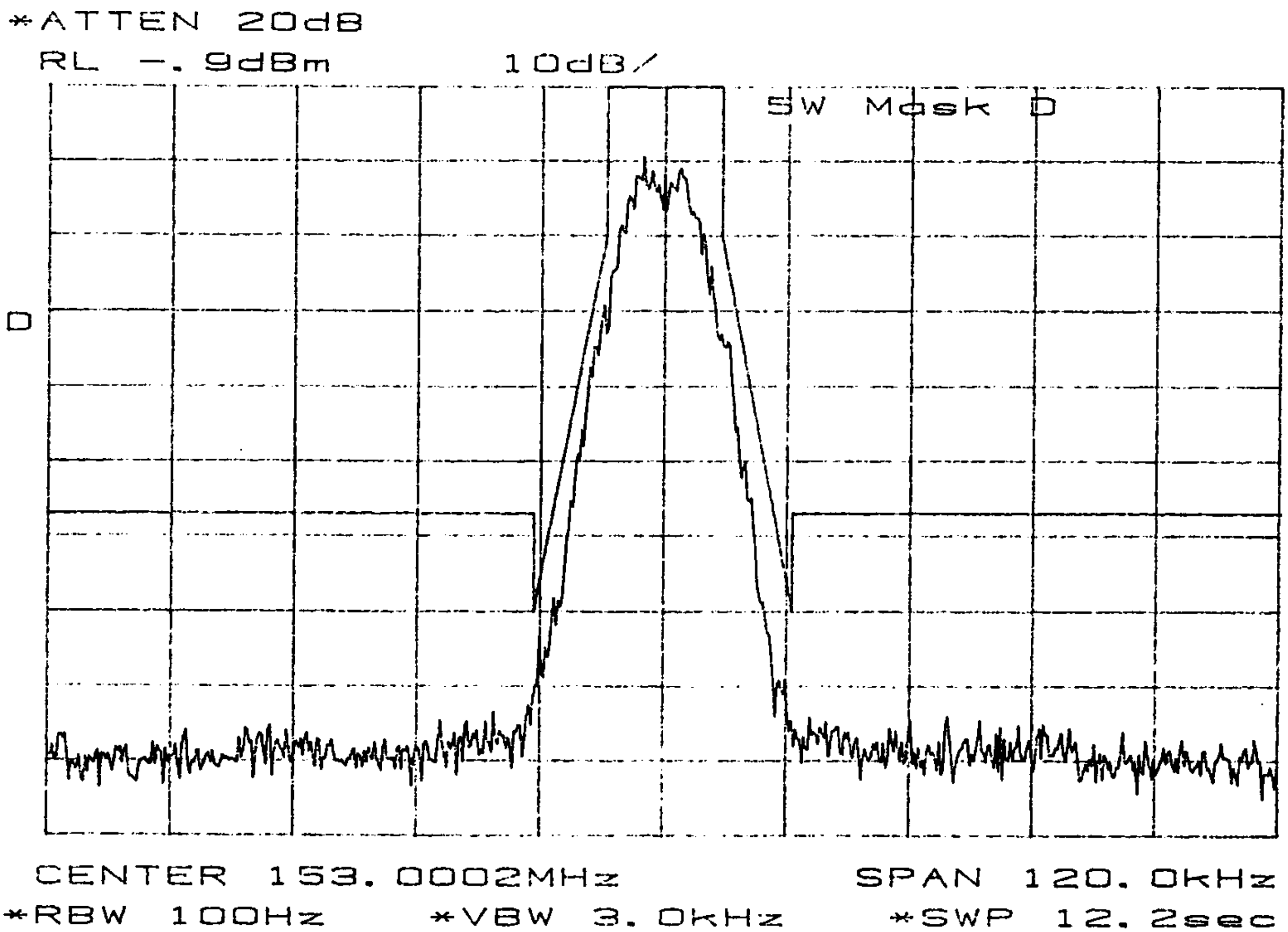
The corresponding emission designator prefix for necessary bandwidth = **13K0.**

TEST DATA: Refer to Following Graphs:

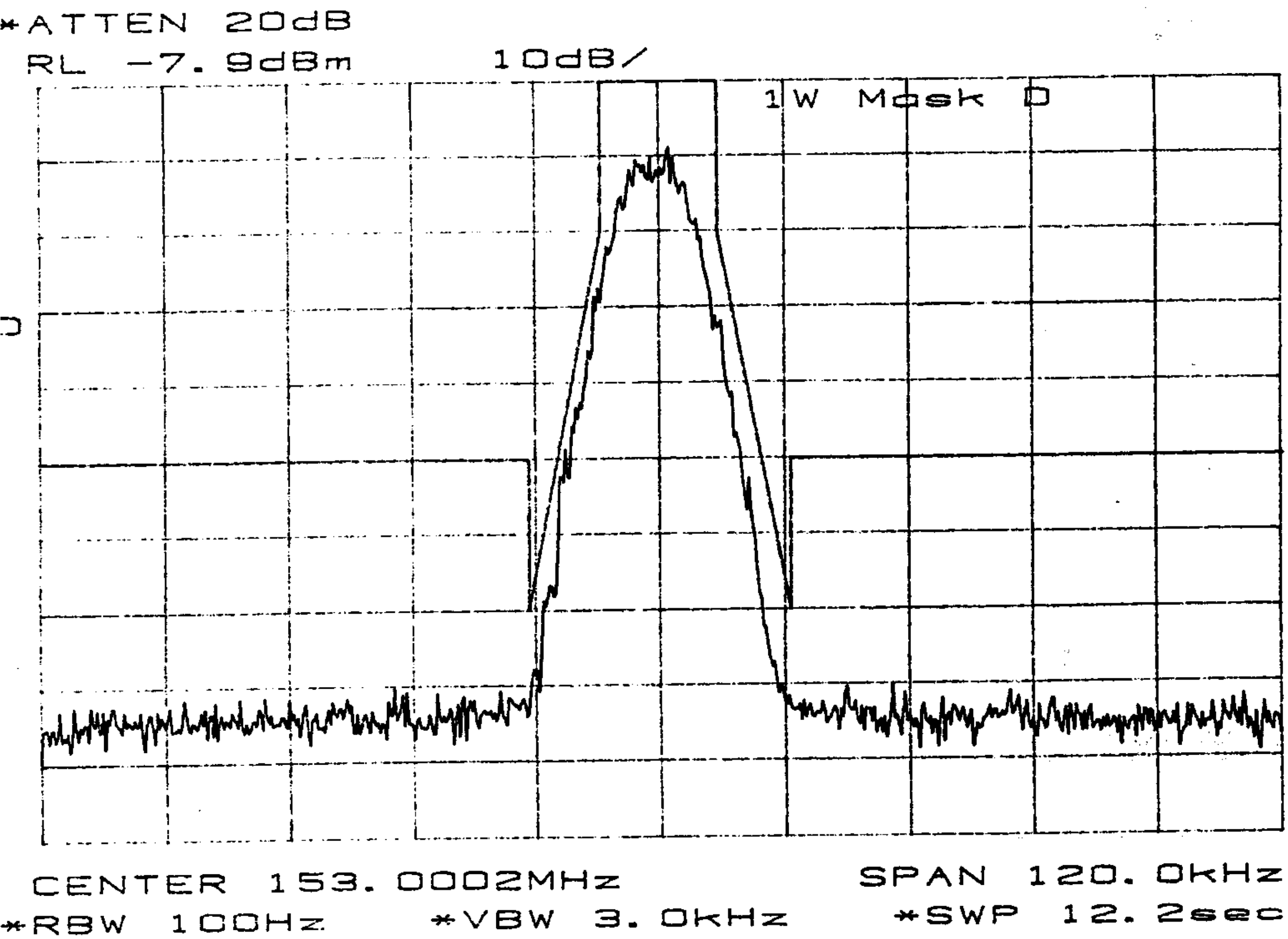
GRAPH: 13K0F1D
SPECTRUM FOR EMISSION 13K0F1D
OUTPUT POWER: 5 Watts
4800 BAUD (9600 bps)
PEAK DEVIATION = 4100 Hz
SPAN = ± 50 MHz



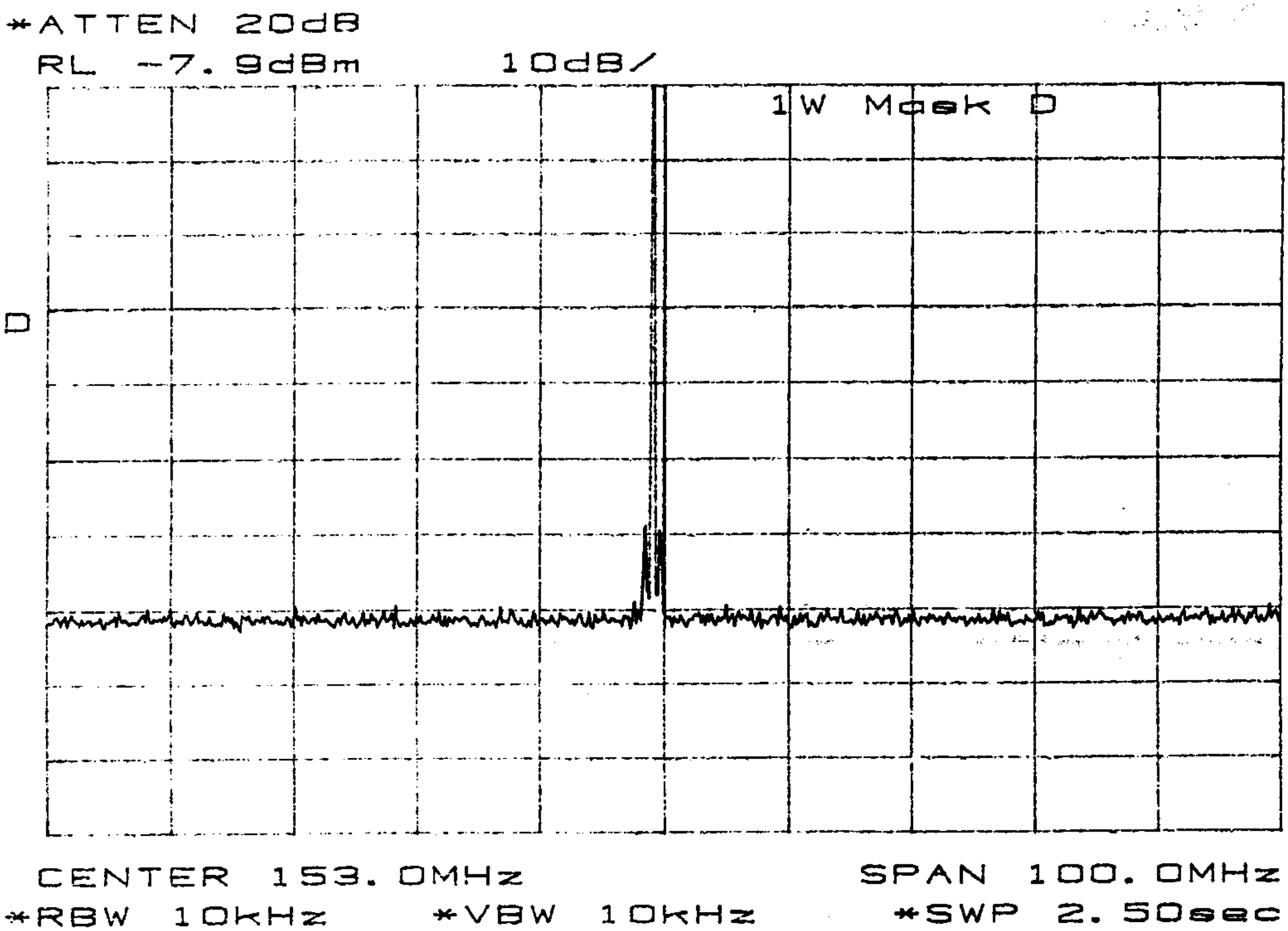
GRAPH: 13K0F1D
SPECTRUM FOR EMISSION 13K0F1D
OUTPUT POWER: 5 Watts
4800 BAUD (9600 bps)
PEAK DEVIATION = 4100 Hz
SPAN = ± 60 KHz



GRAPH: 13K0F1D
SPECTRUM FOR EMISSION 13K0F1D
OUTPUT POWER: 1 Watts
4800 BAUD (9600 bps)
PEAK DEVIATION = 4100 Hz
SPAN = ± 60 KHz

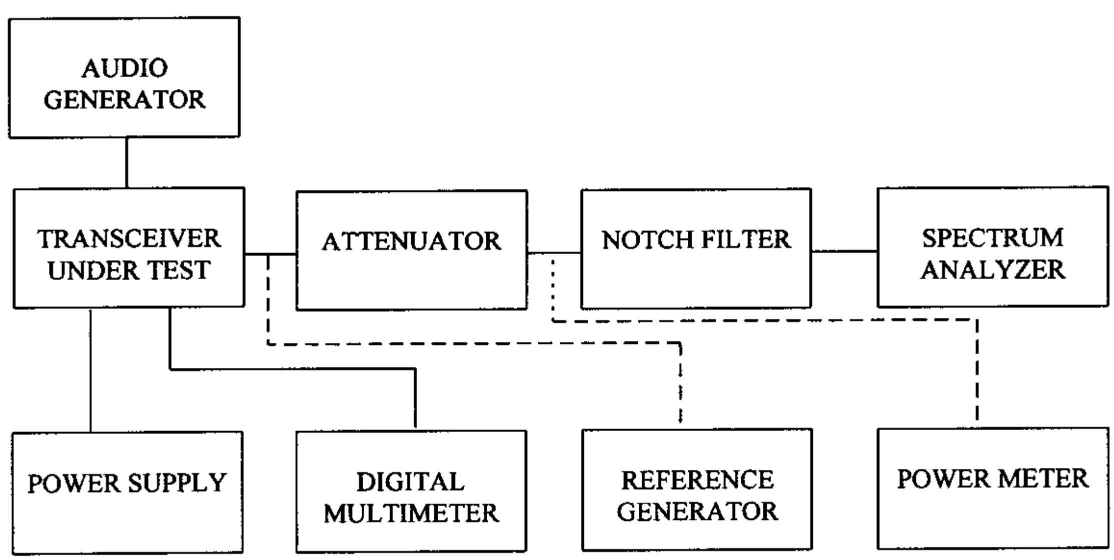


GRAPH: 13K0F1D
SPECTRUM FOR EMISSION 13K0F1D
OUTPUT POWER: 1 Watts
4800 BAUD (9600 bps)
PEAK DEVIATION = 4100 Hz
SPAN = ± 50 MHz



NAME OF TEST:	Transmitter Spurious and Harmonic Outputs
RULE PART NUMBER:	2.991, 90.210 (d)(3)
MINIMUM STANDARD:	For 5 Watt; $50+10\text{Log}_{10}(5\text{ Watts}) = -57$ dBc or -70 dBc whichever is the lesser attenuation.
TEST RESULTS:	Meets minimum standard (see data on the following page)
TEST CONDITIONS:	Standard Test Conditions, 25 C RF voltage measured at antenna terminals
TEST PROCEDURE:	TIA/EIA - 603, 2.2.13
TEST EQUIPMENT:	Attenuator, BIRD Model / 9715 / 50-A-MFN-06 / 6 dB / 50 Watt Attenuator, BIRD Model / 9716 / 25-A-MFN-20 / 20 dB / 25 Watt Digital Voltmeter, Fluke Model 8012A DC Power Source, Model HP6284A Modulation Analyzer, Model HP8901A Spectrum Analyzer, Model HP8563E Plotter, HP7470A Reference Generator, Model HP83732B Power Meter, Model HP436A Audio Generator, Model HP8903B
PERFORMED BY:	Allen Frederick (signature) Date:4/27/98

TEST SET-UP:



NAME OF TEST: Transmitter Spurious and Harmonic Outputs (Continued)

MEASUREMENT PROCEDURE:

1. The transmitter carrier output frequency is 132.000, 153.000 and 174.000 MHz. The reference oscillator frequency is 17.5000 MHz.

2. After carrier reference was established on spectrum analyzer, the notch filter was adjusted to null the carrier Fc to extend the range of the spectrum analyzer for harmonic measurements.

3. At each spurious frequency, Generator substitution was used to establish the true spurious level.

4. The spectrum was scanned to the 10th harmonic.

TEST DATA:

F_o = 132.000 MHz

5 Watts = 37dBm Transmitter Spurious and Harmonics

Frequency (MHz)	Relation	Level (dBm)	Level Relative To Carrier (dBc)
264	2 Fo	-39	-76
396	3 Fo	-46	-83
528	4 Fo	-60	-97
660	5 Fo	-54	-91
792	6 Fo	-53	-90
924	7 Fo	-71	-108
1056	8 Fo	-70	-107
1188	9 Fo	-71	-108
1320	10 Fo	-69	-106

F_o = 153.000 MHz

5 Watts = 37dBm Transmitter Spurious and Harmonics

Frequency (MHz)	Relation	Level (dBm)	Level Relative To Carrier (dBc)
306	2 Fo	-46	-83
459	3 Fo	-69	-106
612	4 Fo	-54	-91
765	5 Fo	-66	-103
918	6 Fo	-59	-96
1071	7 Fo	-71	-108
1224	8 Fo	-71	-108
1377	9 Fo	-62	-99
1530	10 Fo	-78	-115

NAME OF TEST: Transmitter Spurious and Harmonic Outputs (Continued)

F_o = 174.000 MHz

5 Watts = 37dBm Transmitter Spurious and Harmonics

Frequency (MHz)	Relation	Level (dBm)	Level Relative To Carrier (dBc)
348	2 Fo	-52	-89
522	3 Fo	-68	-105
696	4 Fo	-62	-99
870	5 Fo	-51	-88
1044	6 Fo	-83	-120
1218	7 Fo	-72	-109
1392	8 Fo	-52	-89
1566	9 Fo	-73	-110
1740	10 Fo	-70	-107

F_o = 132.000 MHz

1 Watts = 30 dBm Transmitter Spurious and Harmonics

Frequency (MHz)	Relation	Level (dBm)	Level Relative To Carrier (dBc)
264	2 Fo	-55	-92
396	3 Fo	-68	-105
528	4 Fo	-67	-104
660	5 Fo	-60	-97
792	6 Fo	-61	-98
924	7 Fo	-71	-108
1056	8 Fo	-79	-116
1188	9 Fo	-74	-111
1320	10 Fo	-60	-97

NAME OF TEST: Transmitter Spurious and Harmonic Outputs (Continued)

F_o = 153.000 MHz

1 Watts = 30 dBm Transmitter Spurious and Harmonics

Frequency (MHz)	Relation	Level (dBm)	Level Relative To Carrier (dBc)
306	2 Fo	-48	-85
459	3 Fo	-70	-107
612	4 Fo	-59	-96
765	5 Fo	-71	-108
918	6 Fo	-63	-100
1071	7 Fo	-82	-119
1224	8 Fo	-68	-105
1377	9 Fo	-62	-99
1530	10 Fo	-72	-109

F_o = 174.000 MHz

1 Watts = 30 dBm Transmitter Spurious and Harmonics

Frequency (MHz)	Relation	Level (dBm)	Level Relative To Carrier (dBc)
348	2 Fo	-62	-99
522	3 Fo	-73	-110
696	4 Fo	-80	-117
870	5 Fo	-62	-99
1044	6 Fo	-80	-117
1218	7 Fo	-75	-112
1392	8 Fo	-52	-89
1566	9 Fo	-76	-113
1740	10 Fo	-82	-119

NAME OF TEST: Field Strength of Spurious Radiation

RULE PART NUMBER: 2.993, 90.210 (d)(3)

MINIMUM STANDARD: For 5 Watts; $50+10Log_{10}(5) = -57$ dBc

TEST RESULTS: Meets minimum standard (see data on the following page)

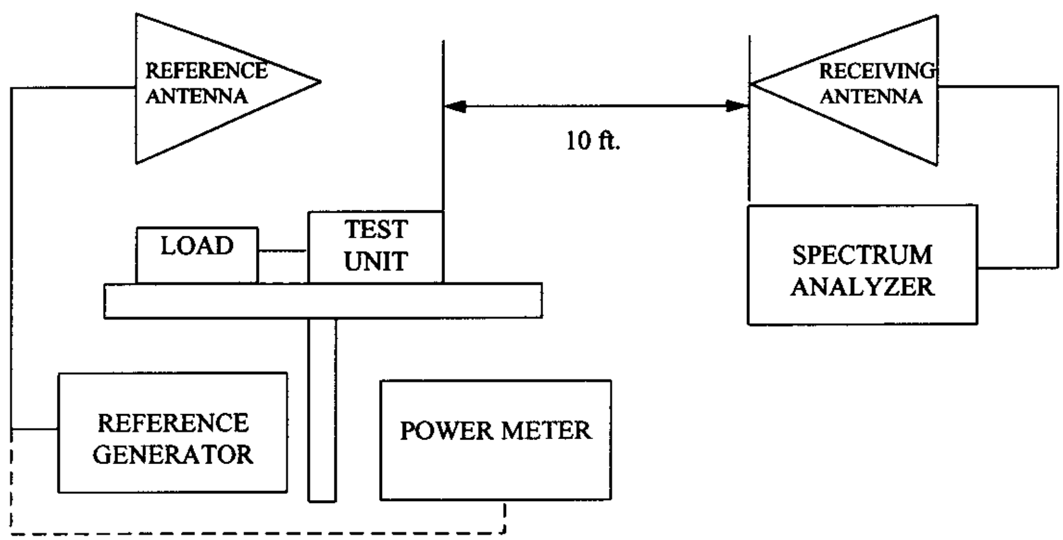
TEST CONDITIONS: Standard Test Conditions, 25 C

TEST PROCEDURE: TIA/EIA - 603, 2.2.12

Test Equipment: Dipole Antenna Kit, Electro-Mechanics Model 3121C
Load, Tenuline Model 8340-200 (20 dB)
Spectrum Analyzer, HP 8563E
Reference Generator, HP83732A
Power Meter, HP437A

MEASUREMENT PROCEDURE: Radiated spurious attenuation was measured according to TIA/EIA Standard 603 Section 2.2.12

TEST SET-UP:



PERFORMED BY: Allen Frederick DATE: 5/1/98

NAME OF TEST: Spurious Radiation Attenuation (Continued)

Frequency: 132 MHz
Power: 5 Watts
37 dBm

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Antenna Gain (dBd)	Circular Polarization Correction (dB)	Spurious Attenuation dBc
264	H	-64.5	-25.3	-0.85	0.0	-63.2
	V	-66.7	-26.7	-0.85	0.0	-64.6
396	H	-75.8	-41.5	-0.35	0.0	-78.9
	V	-76.2	-42.7	-0.35	0.0	-80.1
528	H	-77.5	-45.8	-1.15	0.0	-84.0
	V	-86.8	-44.8	-1.15	0.0	-83.0
660	H	-79.5	-38.8	-1.15	0.0	-77.0
	V	-80.8	-44.7	-1.15	0.0	-82.9
792	H	-71.8	-32.8	-2.05	0.0	-71.9
	V	-70.3	-31.5	-2.05	0.0	-70.6
924	H	-79.2	-41.7	-1.65	0.0	-80.4
	V	-82.4	-39.0	-1.65	0.0	-77.7
1056	H	-71.5	-31.7	1.20	3.0	-70.5
	V	-73.4	-37.5	1.20	3.0	-76.3
1188	H	-94.2	-54.3	1.20	3.0	-93.1
	V	-93.4	-56.2	1.20	3.0	-95.0
1320	H	-92.5	-56.8	1.20	3.0	-95.6
	V	-93.5	-56.5	1.20	3.0	-95.3

Frequency: 153 MHz
Power: 5 Watts
37 dBm

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Antenna Gain (dBd)	Circular Polarization Correction (dB)	Spurious Attenuation dBc
306	H	-64.2	-33.7	-0.85	0.0	-71.6
	V	-68.0	-40.7	-0.85	0.0	-78.6
459	H	-69.8	-35.8	0.15	0.0	-72.7
	V	-77.2	-35.7	0.15	0.0	-72.6
612	H	-79.0	-45.7	-1.15	0.0	-83.9
	V	-87.0	-47.7	-1.15	0.0	-85.9
765	H	-78.8	-34.5	-1.45	0.0	-73.0
	V	-77.3	-37.5	-1.45	0.0	-76.0
918	H	-73.0	-35.0	-1.15	0.0	-73.2
	V	-79.0	-35.0	-1.15	0.0	-73.2
1071	H	-83.3	-42.5	1.20	3.0	-81.3
	V	-84.8	-48.0	1.20	3.0	-86.8
1224	H	-73.8	-32.8	1.20	3.0	-71.6
	V	-72.5	-35.5	1.20	3.0	-74.3
1377	H	-90.8	-44.0	1.20	3.0	-82.8
	V	-90.6	-49.0	1.20	3.0	-87.8
1530	H	-91.0	-56.3	1.20	3.0	-95.1
	V	-91.3	-54.3	1.20	3.0	-93.1

NAME OF TEST: Spurious Radiation Attenuation (Continued)

Frequency: 174 MHz
Power: 5 Watts
37 dBm

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Antenna Gain (dBd)	Circular Polarization Correction (dB)	Spurious Attenuation dBc
348	H	-71.3	-34.8	-0.25	0.0	-72.1
	V	-75.5	-44.8	-0.25	0.0	-82.1
522	H	-68.0	-36.0	-1.15	0.0	-74.2
	V	-76.1	-38.8	-1.15	0.0	-77.0
696	H	-71.2	-22.7	-1.85	0.0	-61.6
	V	-70.8	-34.2	-1.85	0.0	-73.1
870	H	-71.7	-35.3	-0.85	0.0	-73.2
	V	-74.7	-28.7	-0.85	0.0	-66.6
1044	H	-75.3	-32.2	1.20	3.0	-71.0
	V	-78.8	-44.0	1.20	3.0	-82.8
1218	H	-77.5	-35.7	1.20	3.0	-74.5
	V	-78.0	-40.2	1.20	3.0	-79.0
1392	H	-88.3	-42.0	1.20	3.0	-80.8
	V	-84.5	-39.5	1.20	3.0	-78.3
1566	H	-93.7	-54.3	1.20	3.0	-93.1
	V	-92.3	-54.3	1.20	3.0	-93.1
1740	H	-92.8	-53.7	1.20	3.0	-92.5
	V	-89.7	-49.6	1.20	3.0	-88.4

CALCULATIONS FOR FIELD STRENGTH OF SPURIOUS RADIATION TESTS:

The transmitter carrier frequencies were 132.000 MHz, 153.000 MHz, and 174.000 MHz. The reference oscillator frequency of all of the transceivers is 17.50 MHz. The output of the transceivers were searched from 17.50 MHz to the tenth harmonic of each of the carrier frequencies. The tests were conducted with the transceiver and modem inside of the enclosure.

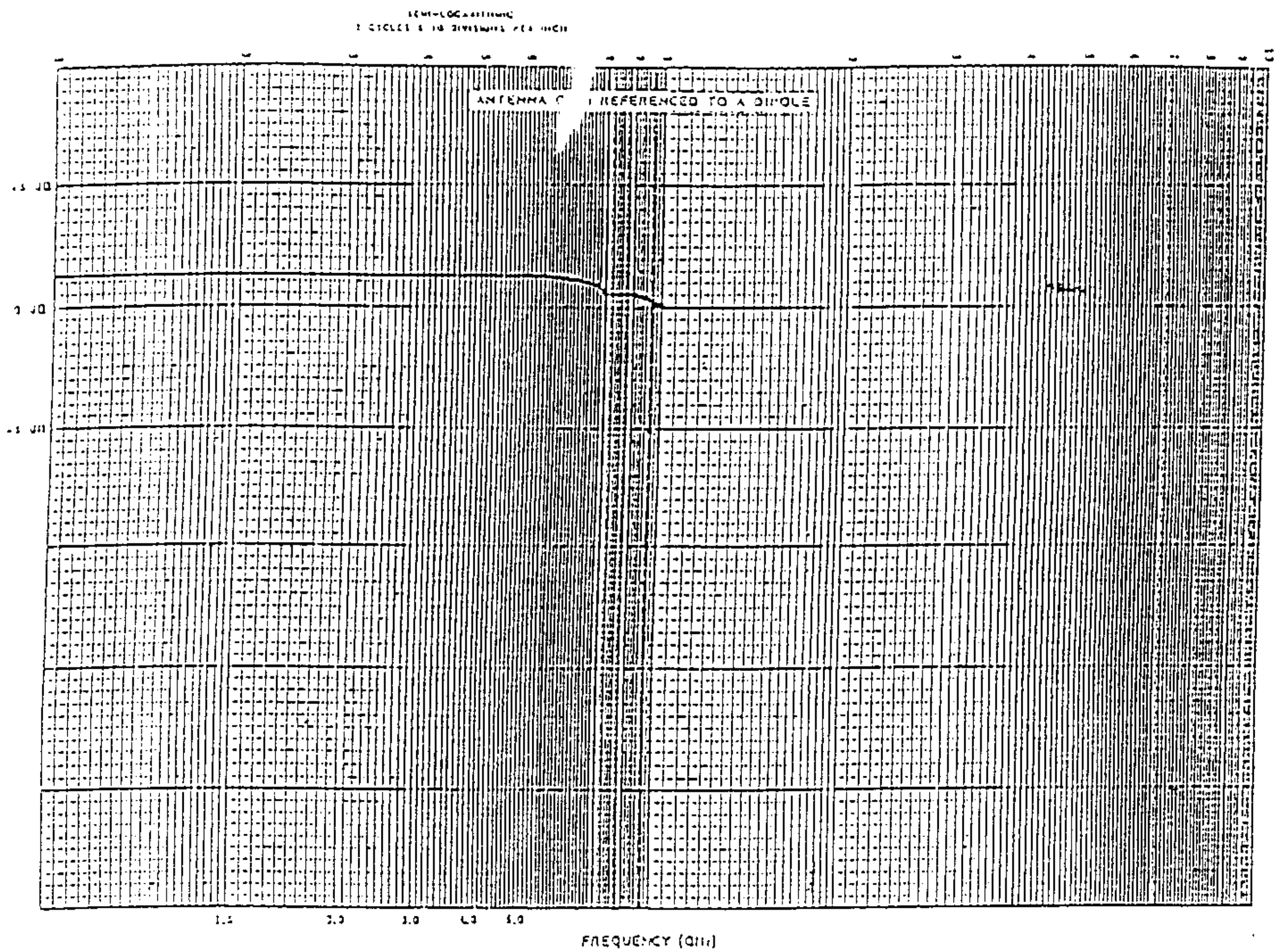
Because the antennas used for the measurements recorded above 1 GHz were not flat in gain and differed from a dipole, the generator output was corrected for gain at each spurious frequency. The power was measured directly at the reference antenna and therefore requires no coaxial cable loss correction. An additional 3 dB correction also made to the spurious responses measured above 1 GHz to correct for the 3 dB polarization loss in the reference path.

Example: At 1056.000 MHz

R - Substitution Generator (dBm)
A - Antenna Gain (dB)
P - Polarization Correction Factor
Po - Carrier Power Output (dBm)

Spurious Attenuation = R + A - P - Po = -31.7 + 1.2 - 3.0 - 37 = -70.5 dB

The test was conducted per section 2.2.12 of the TIA/EIA-603 method of measurement procedure.



ANTENNA GAIN GRAPH

NAME OF TEST: Frequency Stability with Variation in Ambient Temperature

RULE PART NUMBER: 2.995 (a)(1), 90.213 (a) (7)

MINIMUM STANDARD: Shall not exceed ± 0.000250% from test frequency, or 2.50 ppm

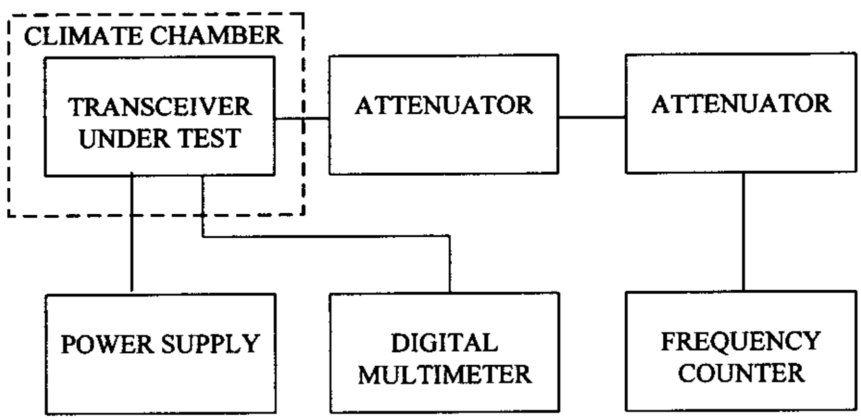
TEST RESULTS: Meets minimum standard, see data on following page

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT:
Attenuator, BIRD Model / 9715 / 50-A-MFN-06 / 6 dB / 50 Watt
Attenuator, BIRD Model / 9716 / 25-A-MFN-20 / 20 dB / 25 Watt
Frequency Counter, Fluke Model 1920A
Digital Voltmeter, Fluke Model 8012A
DC Power Source, Model HP6284A
Climate Chamber, TempGard III, Tenney Jr.

PERFORMED BY: [signature] Allen Frederick DATE: 4/13/98

TEST SET-UP:



(Test data on next page)

NAME OF TEST: Frequency Stability with Variation in Ambient Temperature (Continued)

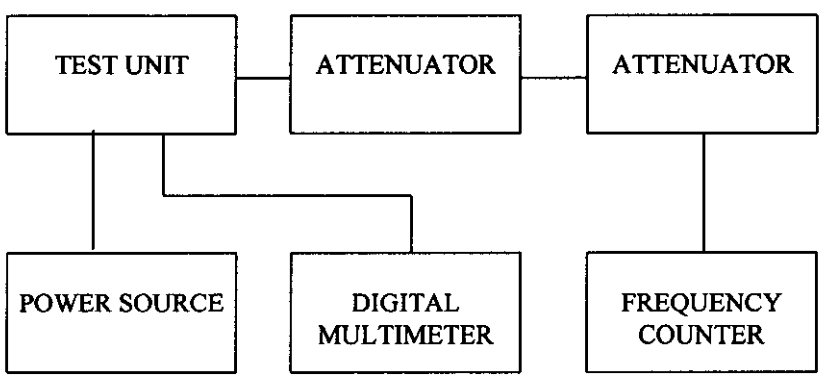
Frequency Reference Set at 25° C: 153000163 Hz
Tolerance Requirement: 2.5 ppm
Highest Variation (ppm): 1.340 ppm

TEMP ° C	FREQUENCY MHz	FREQ DELTA Hz	ppm from assigned frequency
-30	153000320	157	1.026
-20	153000368	205	1.340
-10	153000336	173	1.131
0	153000368	205	1.340
10	153000216	53	0.346
20	153000214	51	0.333
25	**153000163**	**0**	**0.000**
30	153000095	-68	0.444
40	153000008	-155	1.013
50	153000043	-120	0.784
60	153000099	-64	0.418

NAME OF TEST:	Frequency Stability with Variation in Supply Voltage
RULE PART NUMBER:	2.995 (d)
MINIMUM STANDARD:	Shall not exceed ± 0.000250% from test frequency, 2.50 ppm for ±15% change in supply voltage
TEST RESULTS:	Meets minimum standard, see data on following page
TEST CONDITIONS:	Standard Test Conditions, 25 C
TEST EQUIPMENT:	Attenuator, BIRD Model / 9715 / 50-A-MFN-06 / 6 dB / 50 Watt Attenuator, BIRD Model / 9716 / 25-A-MFN-20 / 20 dB / 25 Watt Frequency Counter, Fluke Model 1920A Digital Voltmeter, Fluke Model 8012A DC Power Source, Model HP6284A

PERFORMED BY: Allen Frederick DATE: 4/13/98

TEST SET-UP:



TEST SET-UP

(Test data on next page)

NAME OF TEST: Frequency Stability with Variation in Supply Voltage (Continued)

MEASUREMENTS TAKEN:

2.5 ppm Reference Oscillator

Frequency Reference Set at 25° C: 153000163 Hz
Tolerance Requirement: 0.00025 %
Highest Variation (%): 0.00000003 %
Highest Variation (ppm): 0.033 ppm

SUPPLY VDC	FREQUENCY MHz	DELTA FREQ % of assigned f	SPEC LIMIT % of assigned f	ppm from assigned frequency
10	153000168	0.00000003	0.00025	0.033
13	**153000163**	0.00000000	0.00025	0.000
16	153000165	0.00000001	0.00025	0.013

NAME OF TEST: Transient Frequency Behavior

RULE PART NUMBER: 90.214

TEST CONDITIONS: Transient tests were conducted with the DL-3286 modem modulating the transmitter at 9600 bps (4800 baud), 4.1 KHZ deviation

MINIMUM STANDARD: **12.5 KHZ channel** (used worst case numbers from 403 to 512 MHz)

TIME INTERVAL	MAXIMUM FREQUENCY DIFFERENCE (KHZ)	TIME (mS)
T1	+/- 12.5	5
T2	+/- 6.25	20
T3	+/- 12.5	5

TEST RESULTS: Meets minimum standards, see data on following pages

TEST CONDITIONS: RF Power Level = 5 Watts
Standard Test Conditions, 25 C

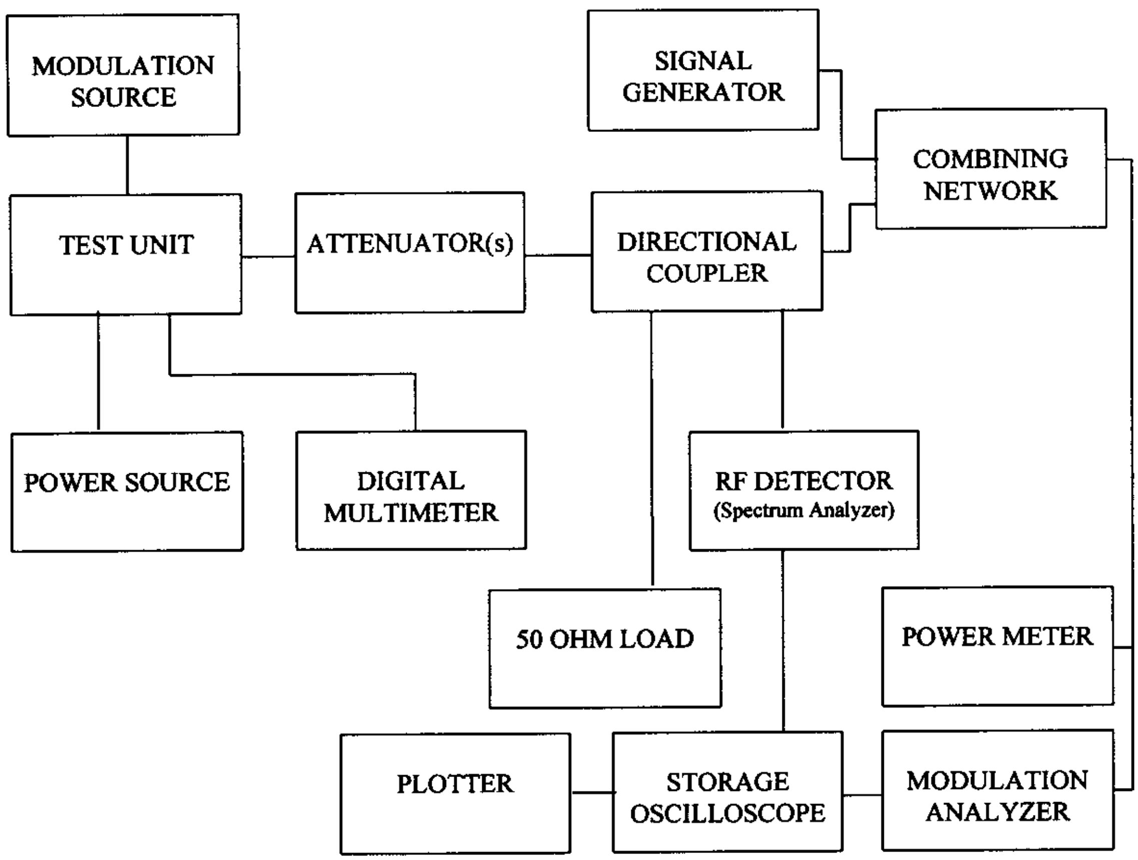
TEST PROCEDURE: TIA/EIA - 603, 2.2.19

TEST EQUIPMENT: Attenuator, BIRD Model / 9716 / 25-A-MFN-20 / 20 dB / 25 Watt
Digital Voltmeter, Fluke Model 8012A
DC Power Source, Model HP6284A
Modulation Analyzer, Model HP8901A
RF Detector (Spectrum Analyzer), Model HP8563E
Plotter, Model HP2671G
Reference Generator, Fluke Model 6071A
Power Meter, Model HP436A
Power Combiner, Model MCL ZFSC-4-1
Oscilloscope, Model HP54503A
Directional Coupler, Model HP778D

PERFORMED BY: Allen Frederick Date:4/28/98
Allen Frederick

NAME OF TEST: Transient Frequency Behavior (Continued)

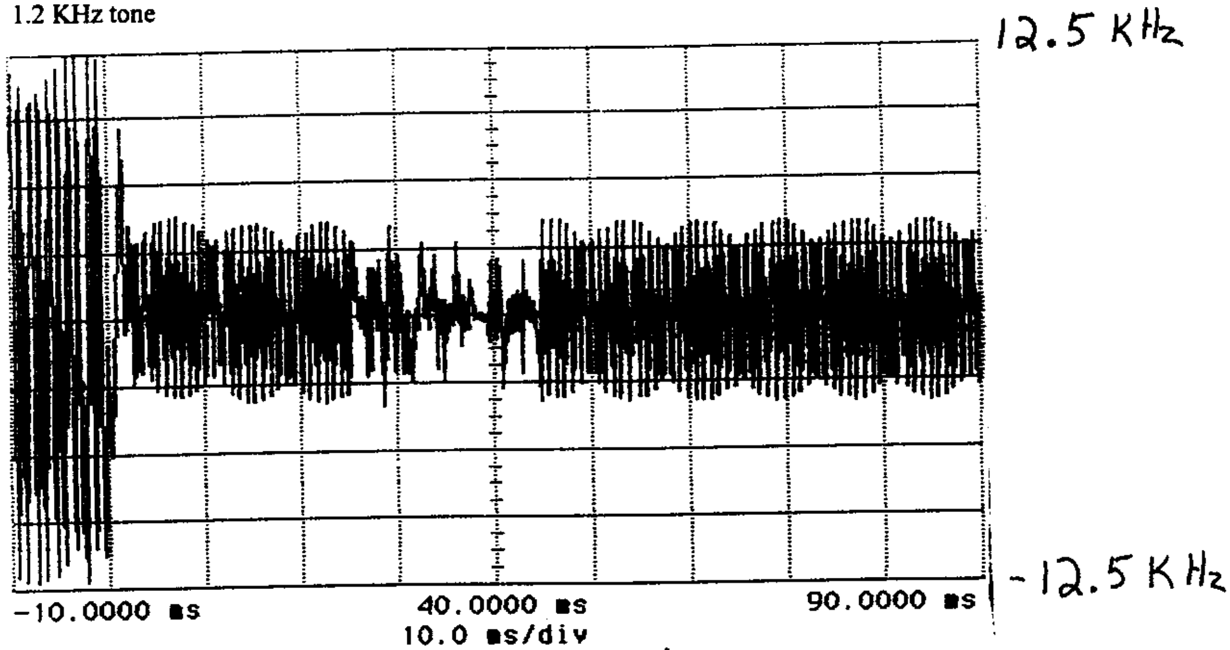
TEST SET-UP:



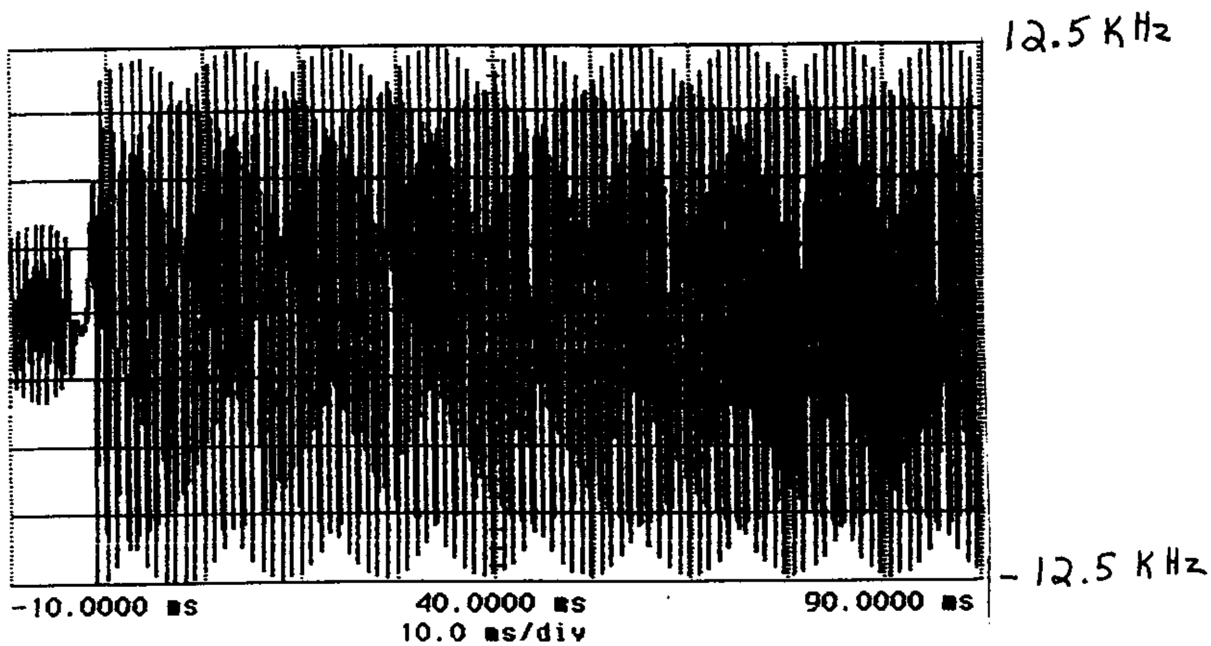
TRANSIENT FREQUENCY RESPONSE
TRANSCEIVER MODULATED BY DL-3286 MODEM, 1.2 KHz TONE , 4.1 KHz DEVIATION

The DL 3286 Modem was used to modulate the DL-3422 for this test, modulation format is shown below. The modem delays 3 mS from the time the transmitter is enabled until the 1.2 KHz tone is sent.

1.2 KHz tone	25 mS
Frame Synchronization Bit Pattern	5 mS
Header	14 mS
1.2 KHz tone	

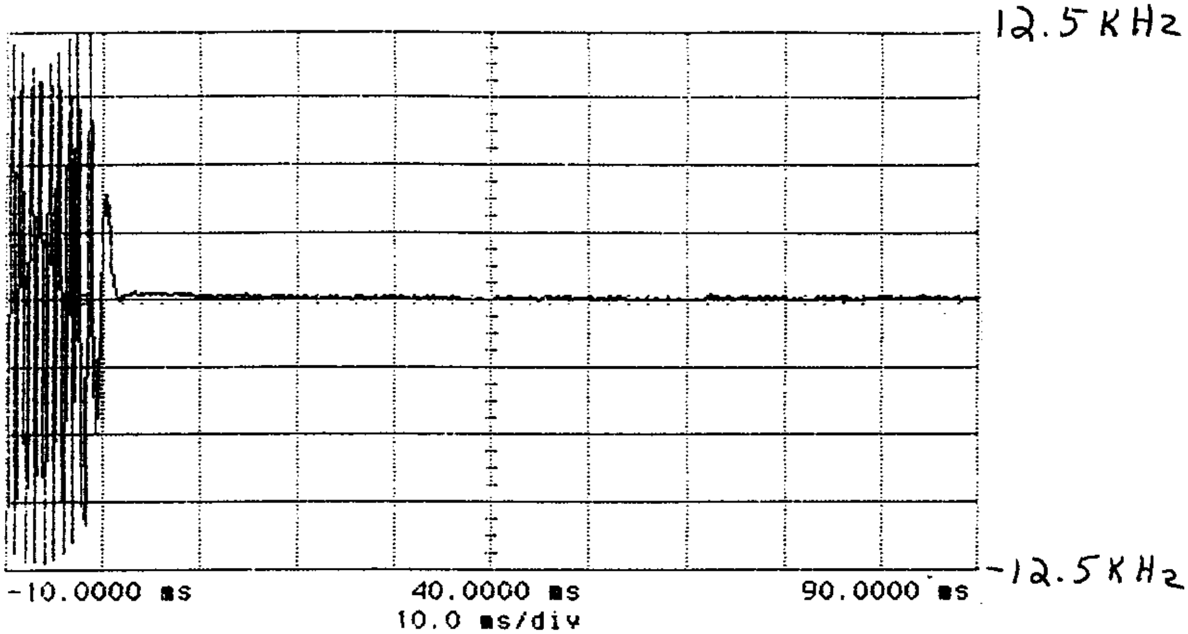


KEY UP

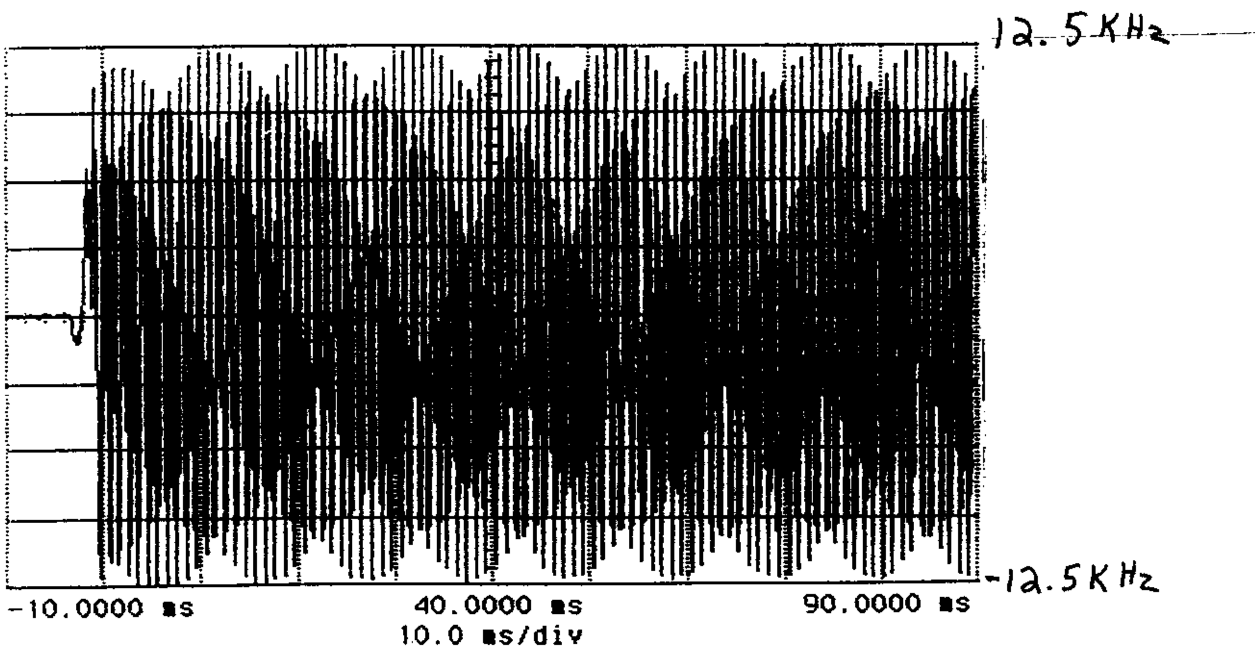


KEY DOWN

TRANSIENT FREQUENCY RESPONSE
TRANSCEIVER UNMODULATED



KEY UP



KEY DOWN

FCC LABEL:

RULE PART NUMBER: 2.983 (f)