SYNTHESIZED VHF TELEMETRY UNIT
PART NO. 242-3422-XYZ

The Johnson Data Telemetry Corporation designs and manufactures radios and radio modems to serve a wide variety of data communication needs. The Johnson Data Telemetry Corporation produces equipment for the fixed data market including SCADA systems for utilities, petrochemical, waste and fresh water management markets and RF boards for OEM applications in the Radio Frequency Data Capture market. In addition, the Johnson Data Telemetry Corporation provides wireless communication solutions to the mobile data market serving public safety, utilities and industrial users.

DATA TELEMETRY PRODUCT WARRANTY

The manufacturer's warranty statement for this product is available from your product supplier or from the Johnson Data Telemetry Corporation, 299 Johnson Avenue, PO Box 1733, Waseca, MN 56093-0833. Phone (507) 835-8819.

WARNING

This device complies with Part 15 of the FCC rules. Operation is subject to the condition that this device does not cause harmful interference. In addition, changes or modification to this equipment not expressly approved by Johnson Data Telemetry Corporation could void the user's authority to operate this equipment (FCC rules, 47CFR Part 15.19).

DO NOT allow the antenna to come close to or touch, the eyes, face, or any exposed body parts while the radio is transmitting.

DO NOT operate the radio near electrical blasting caps or in an explosive atmosphere.

DO NOT operate the radio unless all the radio frequency connectors are secure and any open connectors are properly terminated.

DO NOT allow children to operate transmitter equipped radio equipment.

SAFETY INFORMATION

Proper operation of this radio will result in user exposure below the Occupational Safety and Health Act and Federal Communication Commission limits.

The information in this document is subject to change without notice.

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TABLE OF CONTENTS

SECTION 1 GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This service manual contains alignment and service information for the Johnson DM3422 VHF Synthesized Telemetry Unit.

1.2 EQUIPMENT DESCRIPTION

1.2.1 GENERAL

The Johnson DM3422 is a synthesized data transceiver (transmitter and receiver) which operates in the 132-174 MHz VHF frequency range. Transmitter power output is 1-5 watts, 5W at 13.3V nominal, and operation is simplex or half duplex.

Versions of the 3422 covered in this manual are indicated in Section 1.5. The 3422 has a frequency stability of ± 2.5 PPM (see Section 3) and is available with or without the Loader board.

The number of channels that can be selected with the DM3422 model is determined by the customer supplied synthesizer loading circuitry. DL3422 model is supplied with the Loader board that has one or two channels that can be programmed.

1.2.2 DL3422 WITH LOADER BOARD

The DL3422 (Part No. 023-3240-001) includes the 8-channel Loader board (Part No. 023-3240-330), which performs synthesizer loading through an RS-232 DB-9 interface. In addition, this board has circuitry which provides electronic control of the following:

Transmit/Receive data conditioning and gating
Carrier Detect
Power Control
Preselector Tracking
Modulation Flatness
Audio/Data Filtering
Sleep/Wake-up to minimize current consumption
Diagnostics that includes:
- Input Voltage Sense
- Input Current Sense
- Ambient Temperature Sense
- RSSI Indicator (RSSI Sense)
- Forward/Reverse Power Sense.

The gating circuits allow the type of data filtering to be selected (standard or wide band) and also pre-emphasis/de-emphasis to be enabled or disabled.

This board is programmed using an IBM® PC or compatible computer and the Johnson Data Telemetry programming software. Programming information is stored by an EEPROM on the Loader board. Refer to Section 3.3 for programming information.

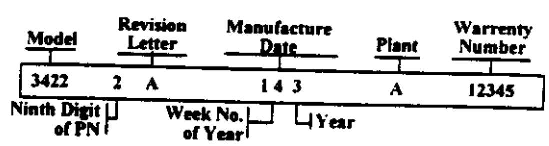
NOTE: The synthesizer must be loaded each time power is turned on. Therefore, one loader board or customer supplied programming circuit is required for each data transceiver.

1.2.3 DM3422 SYNTHESIZER PROGRAMMING

The DM3422 requires customer supplied circuitry to load the synthesizer with channel information. The protocol that this circuitry must follow is described in Section 3.

1.3 TRANSCEIVER IDENTIFICATION

The transceiver identification number is printed on a label that is affixed to the PC board. The following information is contained in that number:



1.4 ACCESSORIES

Accessories available for the 3422 data transceiver are listed in Table 1-1.

Table 1-1 ACCESSORIES

Accessory	Part No.
DM3422 Receive Test Filter	023-3472-040

5 PART NUMBER BREAKDOWN

The following is a breakdown of the part number ed to identify this transceiver:

242-3422 - X Y Z

- Z: 0 = Base; 2 = Portable
- Y: 1 = 15 kHz BW; 3 = 30 kHz BW
- X: 4 = 132-150 MHz; 5 = 150-174 MHz

FACTORY CUSTOMER SERVICE

The Customer Service Department of the nson Data Telemetry Corporation provides cus- ner assistance on technical problems and the avail- lity of local and factory repair facilities. Customer vice hours are 7:30 a.m. - 4:30 p.m. Central Time, nday - Friday. There is also a 24-hour emergency nnical support telephone number. From within the tinental United States, the Customer Service partment can be reached at this toll-free number

1-800-992-7774

When your call is answered at the Johnson Data emetry Corporation, you will hear a brief message rming you of numbers that can be entered to reach ous departments. This number may be entered ing or after the message using a tone-type tele- ne. If you have a pulse-type telephone, wait until message is finished and an operator will come on line to assist you. When you enter a first number 3", another number is requested to further catego- the type of information you need. You may also r the 4-digit extension number of the person that want to reach if you know what it is.

(Machine - Sales	(507) 835-6485
(Machine - Cust Serv	(507) 835-6969

If you are calling from outside the continental ed States, the Customer Service telephone num- are as follows:

omer Service Department - (507) 835-6911
omer Service FAX Machine - (507) 835-6969

You may also contact the Customer Service Department by mail. Please include all information that may be helpful in solving your problem. The mailing address is as follows:

Johnson Data Telemetry Corporation
Customer Service Department
299 Johnson Avenue
P.O. Box 1733
Waseca, MN 56093-0833

1.7 PRODUCT WARRANTY

The warranty statement for this transceiver is available from your product supplier or from the Warranty Department, Johnson Data Telemetry Corporation, 299 Johnson Avenue, PO Box 1733, Waseca, MN 56093-0833. This information may also be requested by phone from the Warranty Department. The Warranty Department may also be contacted for Warranty Service Reports, claim forms, or any questions concerning warranties or warranty service by dialing (507) 835-6970.

1.8 REPLACEMENT PARTS

Replacement parts can be ordered directly from the Service Parts Department. To order parts by phone, dial the toll-free number and then enter "3" as described in Section 1.6. When ordering, please supply the part number and quantity of each part ordered. Johnson Data Telemetry dealers also need to give their account number.

If there is uncertainty about the part number, include the designator (C112, for example) and the model number of the equipment the part is from (refer to Section 1.3).

You may also send your order by mail or FAX. The mailing address is as follows and the FAX number is shown in Section 1.6.

Johnson Data Telemetry Corporation
Service Parts Department
299 Johnson Avenue
PO Box 1733
Waseca, MN 56093-0833

1.9 FACTORY RETURNS

Repair service is normally available through local authorized Johnson Data Telemetry Land Mobile Radio Service Centers. If local service is not available, the equipment can be returned to the factory for repair. However, it is recommended that you contact the Field Service Department before returning equipment. A service representative may be able to suggest a solution to the problem so that return of the equipment would not be necessary. If using the toll-free number in the preceding section, enter "3".

Be sure to fill out a Factory Repair Request Form #271 for each unit to be repaired, whether it is in or out of warranty. These forms are available free of charge by calling the repair lab (see Section 1.6) or by requesting them when you send a unit in for repair. Clearly describe the difficulty experienced in the space provided and also note any prior physical damage to the equipment. Include a form in the shipping container with each unit. Your phone number and contact name are very important because there are times when the technicians have specific questions that need to be answered in order to completely identify and repair a problem.

When returning equipment for repair, it is also a good idea to use a PO number or some other reference number on your paperwork in case you need to call the repair lab about your unit. These numbers are referenced on the repair order to make it easier and faster to locate your unit in the lab.

Return Authorization (RA) numbers are not necessary unless you have been given one by the Field Service Department. They require RA numbers for exchange units or if they want to be aware of a specific problem. If you have been given an RA number, reference this number on the Factory Repair Request Form sent with the unit. The repair lab will then contact the Field Service Department when the unit arrives.

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3422 UHF SYNTHESIZED TELEMETRY UNIT SPECIFICATIONS

The following are general specifications intended for use in testing and servicing this transceiver. For current advertised specifications, refer to the specification sheet available from the Marketing Department. Specifications are subject to change without notice.

GENERAL

Frequency Range	132-150 MHz/150-174 MHz
Frequency Control	Synthesized
Channel Spacing	15/30 kHz
Mode of Operation	Simplex or Half Duplex
Operating Voltage	+13.3V DC nominal (10-16V DC operational)
Regulated Supply Voltages	+5V DC ±5%
Transmit Enable	3-16V DC at 400 μA max
Receive Enable	3-16V DC ±5% at 400 μA nominal (400 μA during receive)
Transceiver Enable	3-16V DC at less than 400 μA
Power and Data Connector	14-pin in-line socket (Dupont 76308-14)
RF Input/Output	SMA Jack (female)
Operating Temperature	-30°C to +60°C (-22°F to +140°F)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Humidity	95% maximum RH at 40°C, non-condensing
Maximum Dimensions	4.585" L, 3.25" W, 2.212" H
FCC Compliance	Part 90, Part 15
DM3422	Customer must apply

RECEIVER

Bandwidth	132-150 MHz: 18 MHz with electronic tuning 6 MHz without retuning from 132-150 MHz 150-174 MHz: 24 MHz with electronic tuning 6 MHz without retuning from 150-174 MHz
Frequency Stability	±2.5 PPM from -30°C to +60°C (-22°F to +140°F)
Sensitivity - 12 dB SINAD	≤ 0.35 μV, -116 dBm psophometrically weighted
RF Input Impedance	50 ohms
Selectivity	-70 dB/-60 dB (tN/t/E) for 30 kHz, 60 dB/50 dB (tN/t/E) for 15 kHz
Spurious and Image Rejection	-70 dB
Conducted Spurious Emissions	< -57 dBm
Intermodulation	-70 dB
FM Hum and Noise	-45 dB, 30 kHz channels psophometrically weighted -40 dB, 15 kHz channels psophometrically weighted
Receive Attack Time	< 5 ms
Total Receive On Time	7 ms maximum
Audio	
Distortion	< 3% psophometrically weighted
Buffered Output Level	150 mV RMS nominal at 2.5V DC bias
Discriminator Output	+1/-3 dB from DC to 5 kHz (reference to 1 kHz)
Output Bias	2.5V DC ±20%
Output Impedance	>10k ohms
Data Characteristics	4800/9600 BPS NRZ
RSSI	0.75V to 2.0V DC output from -120 to -60 dBm, attack time < 2 ms

RANSMITTER

equency Stability	±2.5 PPM from -30°C to +60°C (-22°F to +140°F)
ndwidth	132-150 MHz, 18 MHz without tuning 150-174 MHz, 24 MHz without tuning
aximum System Deviation	5 kHz (30 kHz), 2.5 kHz (15 kHz)
odulation	FM/DC coupled
nput Bias	2.5V DC ±1% temperature compensated to ±100 mV. Supplied in Tx/Rx.
nput Impedance	>40k ohms
istortion	< 3% at 60% of maximum system deviation, 1 kHz tone
apability	1.8V P-P ±2 dB produces ±5 kHz deviation with a 1 kHz tone
latness	±2 dB, DC-5 kHz at 1 kHz (Programmable to ±0.5 dB with diagnostic DAC)
Power Output	1-5W ±20% adjustable (5W at 13.3V nominal)
viation Symmetry	5%
Output Impedance	50 ohms
ty Cycle	50% (30 sec. max transmit)
nsmitter Adjacent Power	-70 dB
ermodulation Attenuation	-40 dB
rious and Harmonic FM	-20 dBm max.
Hum and Noise	-45 dB 30 kHz, -40 dB 15 kHz

SECTION 2 INSTALLATION

2.1 PRE-INSTALLATION CHECKS

Field alignment should not be required before the 3422 is installed. However, it is still good practice to check the performance to ensure that no damage occurred during shipment. Performance tests are located in Section 6.2.

2.2 INTERFACING WITH DATA EQUIPMENT

2.2.1 DM3422 ONLY

Connector J201 on the data transceiver PC board provides the interface with the data equipment. This is a 14-pin female connector with .025" square pins on 0.1" centers (Dupont 76308-114). An interface cable diagram and pin designations are shown in Figure 2-1. This cable is not included with the data transceiver.

The following is a general description of the various P101 input and output signals.

Pin 1 (Ground) - Chassis ground.

Pin 2 (+13.3V DC Continuous) - This voltage should be stabilized near +13.3V DC. Variations from +10V to +16V can change power output as much as 6 dB.

Pin 3 (Tx Enable) - This input should be +3V to 13V DC in transmit mode only.

Pin 4 (+3-16V DC Receive Enable Line) - This input should be +3-16V DC in the receive mode only, ≤ 0.3 V DC in Tx. input impedance ≥ 10k ohms.

Pin 5 (Shutdown) - This voltage should be +3-16V DC ±5%.

Pin 6 (Tx Data Input) - Provides a response of ±2 dB from DC to 5 kHz across the RF band (referenced to 1 kHz). It also is programmable to ±0.5 dB with the diagnostic DAC. The modulation capability is 1.8V P-P ±2 dB that produces ±5 kHz deviation with a 1 kHz tone. When this input is used, a temperature compensated 2.5V DC bias is required because variations in voltage cause the frequency to change. In addition, the transceiver regulatory compliance must be applied for with the customer supplied modulation limiting/filter circuit and chassis.

Pin 7 (Synthesizer Lock) - Output from synthesizer lock detect circuit. Low = unlocked, high = locked.

Pin 8 (Synthesizer Enable) - Latch enable signal. A rising edge on this input latches the data loaded into synthesizer IC U811.

Pin 9 (Synthesizer Data) - Serial data line used for programming synthesizer IC U811.

Pin 10 (Synthesizer Clock) - Software generated serial clock. Data is valid on the rising edge of this signal.

Pin 11 (Diagnostic Enable) - This pin enables U911 and U912.

Pin 12 (RSSI Output) - The Receive Signal Strength Indicator output provides a voltage that increases in proportion to the strength of the RF input signal.

Pin 13 (Rx Output) - The data output level is 150 mV RMS with a modulation signal of 1 kHz at 60% of maximum deviation. The output is DC coupled and referenced to +2.5V DC. Load impedance should be >10k ohms.

Pin 14 (Diagnostic) - This pin is enabled by pin 11. When the Loader board is used it has the capability to test the operating environment through diagnostics. The diagnostic capabilities are in Section 1.2.2

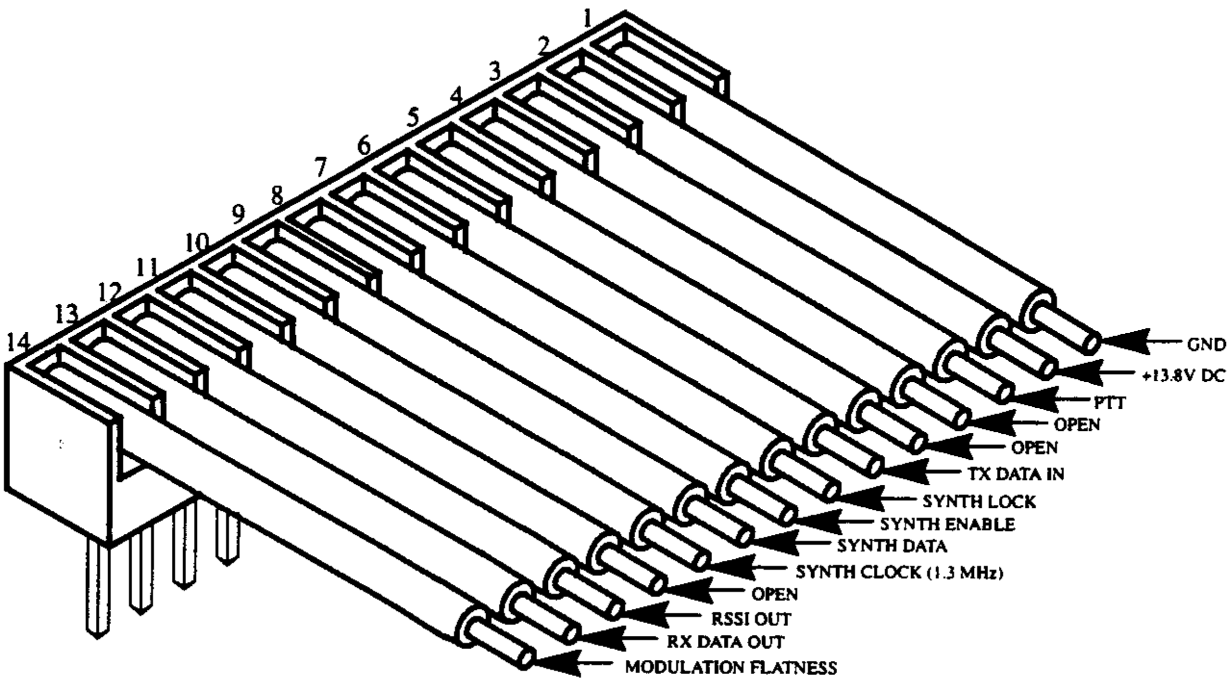

Figure 2-1 DM3422 INTERFACE CABLE

SECTION 3 PROGRAMMING

3.1 INTRODUCTION

DM3422 - The information in Section 3.2 describes synthesizer programming protocol. This information can be used as a basis for designing the synthesizer programming hardware and software required.

3.2 DM3422 SYNTHESIZER DATA PROTOCOL

Programming of the dividers and the charge pumps are performed on a 3-line bus; SYNTH ENABLE, SYNTH DATA, AND SYNTH CLK. On initial power up four 24-bit words are required to load the 3422 Data Transceiver. After the initial load, one 32-bit word can be used to change channels.

The SA7025 Synthesizer IC uses four address words; D, C, B and A (see Figure 3-4). The 24- and 32-bit words contain one or four address bits, depending on the address bits, the data is latched into registers. When the A-word is loaded, the data of these temporary registers is loaded together with the A-word into the work registers.

3.2.1 D-WORD

Refer to Figure 3-1.

TCXO Reference Frequency is 14.85 MHz.
Loop Reference Frequency is 25, 37.5 and 50 kHz.
Reference Divide (NR) =

NR (5 kHz channels)	= 14.85 MHz ÷ 25 kHz
	= 594 (decimal
	= 001001010010 (binary)
NR (6.25 kHz channels)	= 14.85 MHz ÷ 50 kHz
	= 297 (decimal)
	= 000100101001 (binary)
NR (7.5 kHz channels)	= 14.85 MHz ÷ 37.5 kHz
	= 396 (decimal)
	= 000110001100 (binary)

The 3422 has frequency resolution of 5 kHz, 6.25 kHz or 7.5 kHz. When programming 6.25 kHz frequency resolution use FMOD=8. When programming 5 kHz or 7.5 kHz frequency resolution use FMOD=5.

Example:

(FCM) ÷ FMOD = 25 kHz ÷ 5 = 5 kHz
(FCM) ÷ FMOD = 50 kHz ÷ 8 = 6.25 kHz
(FCM) ÷ FMOD = 37.5 kHz ÷ 5 = 7.5 kHz

Where:
FCM = Loop Reference Frequency
FMOD = Fractional N Modulus

3.2.2 C-WORD

Aux Freq is 21.9 MHz
Loop Ref Freq = 50 kHz for 6.25 kHz channels
= 37.5 kHz for 7.5 kHz channels
= 25 kHz for 5 kHz channels
NA (aux divide) = (Aux Freq ÷ FCM) ÷ 1

NA 6.25 kHz	= 21.9 ÷ 0.05 ÷ 1	= 438 (decimal)
		= 000110110110
NA 25 kHz	= 21.9 ÷ 0.0375 ÷ 1	= 584 (decimal)
		= 001001001000
NA 5 kHz	= 21.9 ÷ 0.025 ÷ 1	= 876 (decimal)
		= 001101101100

3.2.3 B-WORD

The B-Word is 24-bits long (see Figure 3-2). It contains the Address, Charge Pump setting factor (CN), Binary Acceleration factors (CK, CL), and Prescaler Type (PR).

The Charge Pump Current setting (CN) could be changed on a channel-by-channel basis for ultimate rejection of the Fraction N spurious responses close into the carrier frequency. The 3422 synthesizer has an adjust (R823) for the fractional compensation current. The factory preset value will allow CN to be set to the following ranges:

Frequency in a Band	CN
Lowest TX	78
Highest TX	88
Lowest RX	91
Highest RX	101

The value of CN should be interpolated for fre-
iencies between the band edges. With these recom-
ended values of CN, the transceiver should have the
ictional spurs minimized far below the levels needed
make 70 dB adjacent channel RX or TX
ecifications.

ample:

odel 3422-530 is a 150-174 MHz transceiver.

2 MHz TX CN = 83	01010011 Binary
2 MHz RX CN = 96	01100000 Binary

.4 A-WORD

The A-Word must be sent last (see Figure 3-3).
e A-Word contains new data for the loop dividers
l is programmed for every channel. The A-Word
ı be a 24-bit or 32-bit word depending on the state
the flag LONG in the D-Word. The 24-bit word
)) is sent if LONG=0 and the 32-bit word (A1) is
t if LONG=1. It is recommended to send the D, B,
nd A0 words always. The extra 8-bits in A1 are
CN charge pump settings. Upon power up the D-,
and A-Words must be sent, but after that only the
word may be sent.

The Fractional-N increment (NF) is a 3-bit word
: is channel dependent. NF is used to program the
-channels below the Loop Reference frequency.
M = 50 kHz and if FMOD = 8, then the Fractional-
ıcrement is: 50 kHz ÷ 8 = 6.25 kHz.

program an 18.75 kHz channel:

= 18.75 kHz ÷ 6.25 kHz
= 3

NM1, NM2 and NM3 are calculated as follows:

$$N = (NM1 + 2) \times 64 + NM2 \times 65 + (NM3 + 1) \times 72$$

Where:
N = total division ratio
NM1 = Number of main divider cycles when prescaler modulus equals 64
NM2 = Number of main divider cycles when prescaler modulus equals 65
NM3 = Number of main divider cycles when prescaler modulus equals 72

Example:

Calculate NM1, NM2 and NM3 to Rx 162.150 MHz.

LO = 162.15 + 21.45 = 183.6 MHz
(21.45 MHz IF with High Side Injection)

N = RX LO ÷ FCM = 183.6 ÷ 0.0375 = 4896
(FCM = Loop Reference Frequency)

NM3 = (INT(64 x FRAC [N ÷ 64]) ÷ 8) - 1
= (INT(64 x 0.5) ÷ 8) - 1
= (32 ÷ 8) - 1
= 4 - 1
= 3

NM2 = 8 x FRAC [N ÷ 8]
= 8 x 0
= 0

NM1 = INTEGER [N ÷ 64] - NM2 - NM3 - 3
= 76 - 0 - 3 - 3
= 70

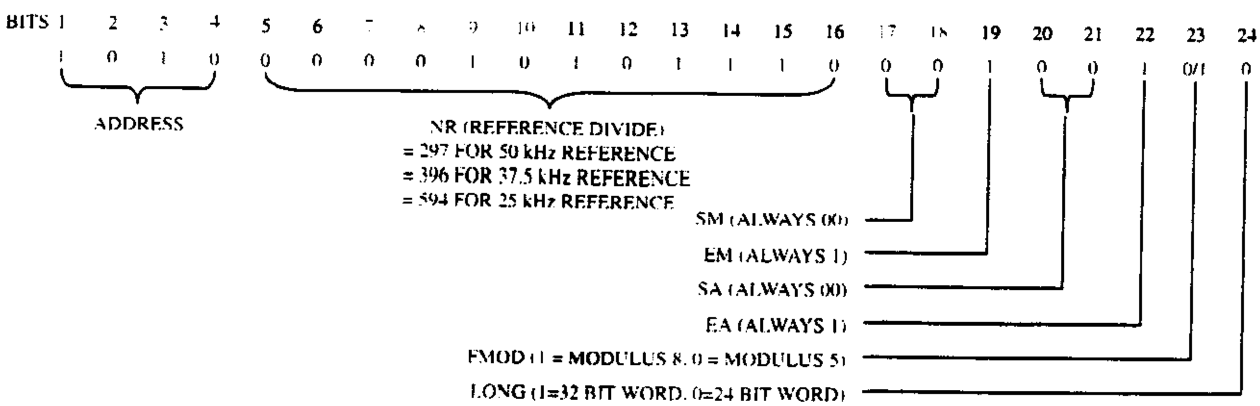

Figure 3-1 D-WORD

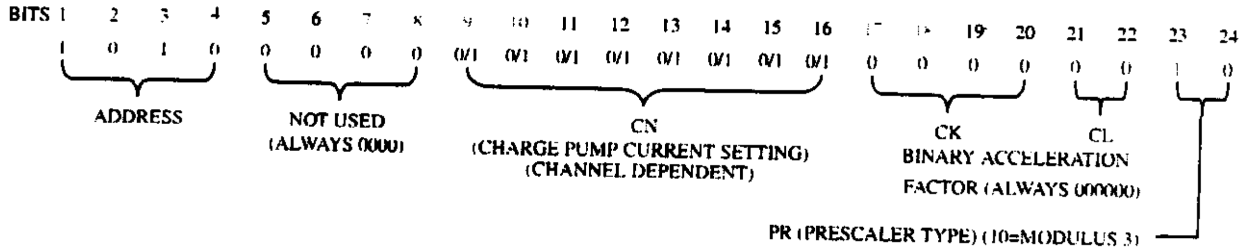

Figure 3-2 B-WORD

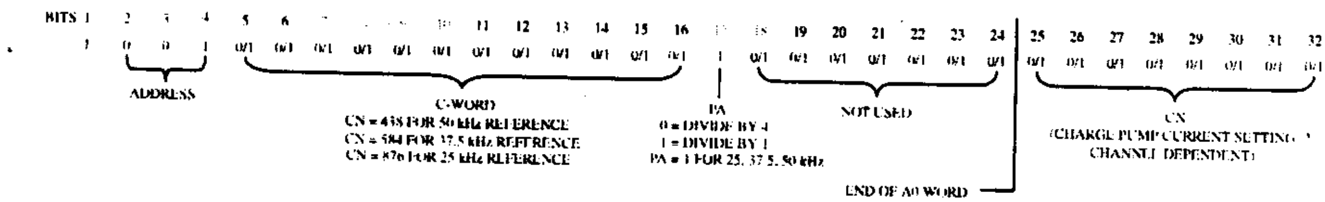

Figure 3-3 A-WORD

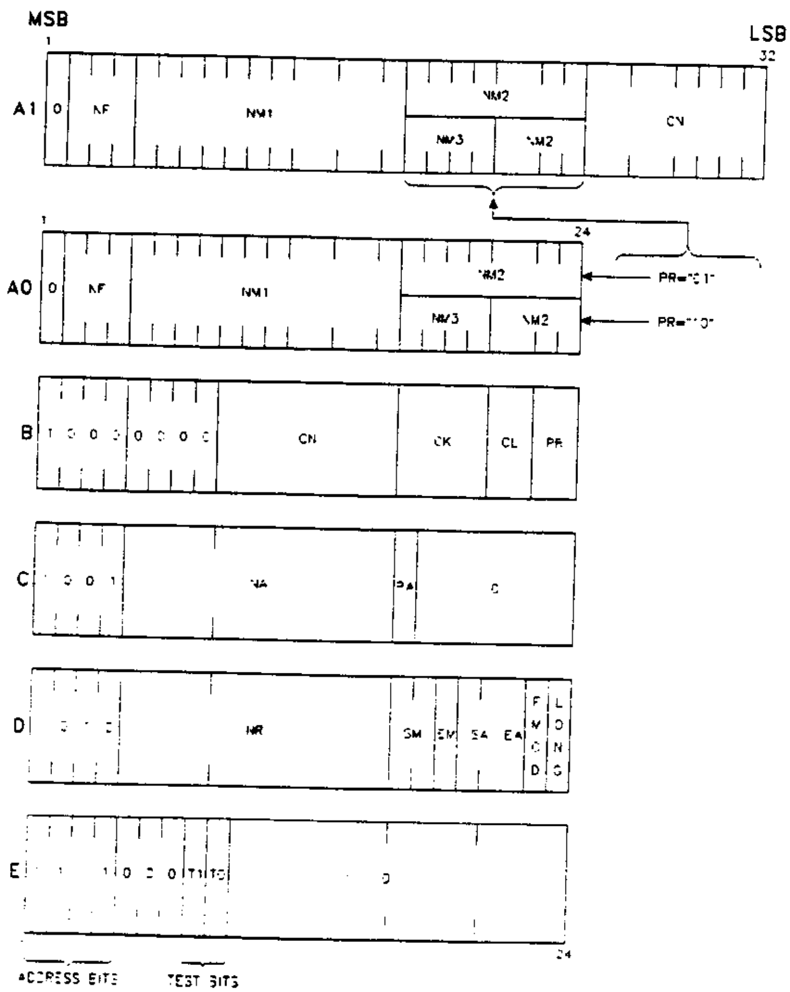

Figure 3-4 SERIAL INPUT WORD FORMAT

3 RECEIVE TO TRANSMIT SEQUENCE

Synthesizer is loaded (B and A 24-Bit words or one long 32-bit A-Word). Refer to Figure 3-5.

The state of the RX_EN line does not have to be changed until the last bit is sent. However, RX will cease as soon as it is changed.

The SYNTH ENABLE line should be held HIGH for 2 to 3 milliseconds after the last word is sent. This puts the frequency synthesizer in a SPEEDUP MODE and slightly improves lock times.

After the last word is strobed in, 7 milliseconds (worst case) should elapse before TX_EN is turned ON. This allows the synthesizer to come within 1 kHz of the desired frequency.

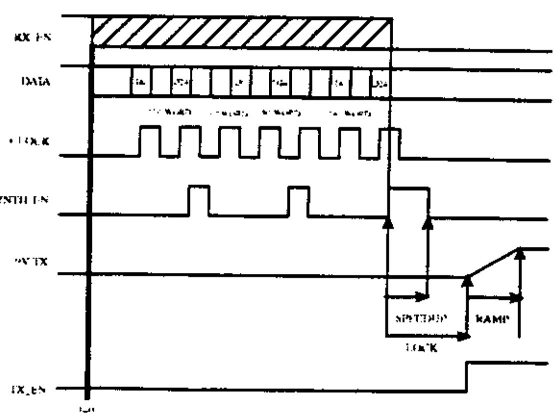

Figure 3-5 RX TO TX TIMING DIAGRAM

Dekey is a length of time to allow the TX to
er down while the synthesizer is still in lock. This
eded to meet ETSI (European Telecommunica-
s Standards Institute) adjacent power specifica-
s. Dekey is approximately 3 ms in length. The
TX should be ramped or optimally filtered in such
y as to reduce the Sinx/x power spreading.
edup will slightly improve lock times and is 1 to
s.

3.4 TRANSMIT TO RECEIVE SEQUENCE

1. TX_EN is turned OFF. For best TX adjacent channel power performance this could be shaped. Refer to Figure 3-6.

2. The synthesizer load process could begin slightly before, but when the last bit is strobed in the synthesizer it will become unlocked. For ETSI specs, the TX should be turned OFF "on-frequency".

3. The RX_EN line should switch from low to high AFTER the TX_EN is switched. The RX_EN not only turns the RX circuits on but also Pin Shifts the VCO.

4. For quickest lock times the SYNTH ENABLE line on the last load word should be held high for 2 to 3 milliseconds. It MUST NOT be left high as the synthesizer in the SPEEDUP mode has poor noise performance and would degrade the RX performance.

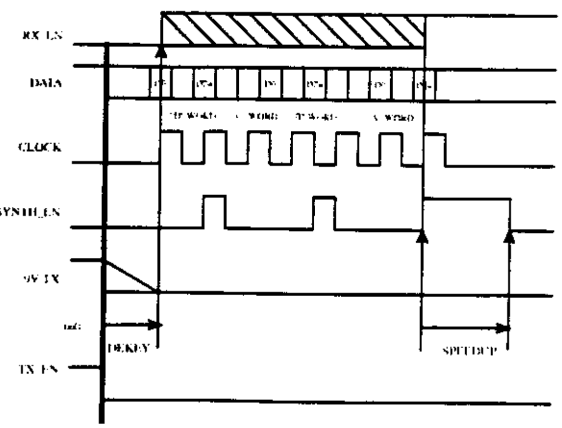

Figure 3-6 TX TO RX TIMING DIAGRAM

Speedup is 2 to 3 ms
Lock is approximately 7 ms
Ramp is approximately 3 ms
Dekey is approximately 3 ms

The Dekey and Ramp functions are not user programmable: they are part of the 9VTX voltage regulator on the 3422. The Dekey and Ramp functions minimize transmit load pull and transmit adjacent channel power.

SECTION 4 CIRCUIT DESCRIPTION

4.1 GENERAL

4.1.1 INTRODUCTION

The main subassemblies of this transceiver are the RF board, VCO board, TCXO and Loader board. A block diagram of the transceiver is located in Figure 4-1. The 3422 is also available in Transmit only and Receive only models.

The 3422 is available with a reference oscillator stability of ±2.5 PPM. The 14.85 MHz TCXO (Temperature Compensated Crystal Oscillator) is soldered directly to the RF board. The TCXO is not serviceable.

4.1.2 SYNTHESIZER

The VCO (voltage-controlled oscillator) output signal is the receiver first injection frequency in the Receive mode and the transmit frequency in the Transmit mode. The first injection frequency is 21.45 MHz above the receive frequency. The frequency of this oscillator is controlled by a DC voltage produced by the phase detector in synthesizer chip U811.

Channels are selected by programming counters in U811 to divide by a certain number. This programming is performed over a serial bus formed by the Synth Clock, Synth Enable, and Synth Data pins of J201. This programming is performed by the Loader board or user supplied hardware and software (see Section 3).

The frequency stability of the synthesizer in both the receive and transmit modes is established by the stability of the reference oscillator described in the preceding section. These oscillators are stable over a temperature range of -30° to +60° C (-22° to +140° F).

4.1.3 RECEIVER

The receiver is a double-conversion type with intermediate frequencies of 21.45 MHz / 450 kHz. Varactor tuned LC bandpass filters reject the image, half IF, injection, and other unwanted frequencies. A four-pole crystal filter enhances receiver selectivity.

4.1.4 TRANSMITTER

The transmitter produces a nominal RF power output of 5W at 13.3V DC, adjustable down to 1W. Frequency modulation of the transmit signal occurs in the synthesizer. Transmit audio processing circuitry is contained in the Loader board or customer-supplied equipment.

4.1.5 LOADER BOARD

The Loader board, Part No. 023-3240-330, is a plug-in circuit board used to load the synthesizer with a desired frequency and filters data/audio to and from the user interface connector. The Loader board is programmed by a personal computer and software.

4.2 SYNTHESIZER

A block diagram of the synthesizer is shown in Figure 4-1 and a block diagram of Synthesizer IC U811 is shown in Figure 4-2. As stated previously, 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 14.85 MHz reference oscillator (TCXO). The other input signal is the VCO frequency.

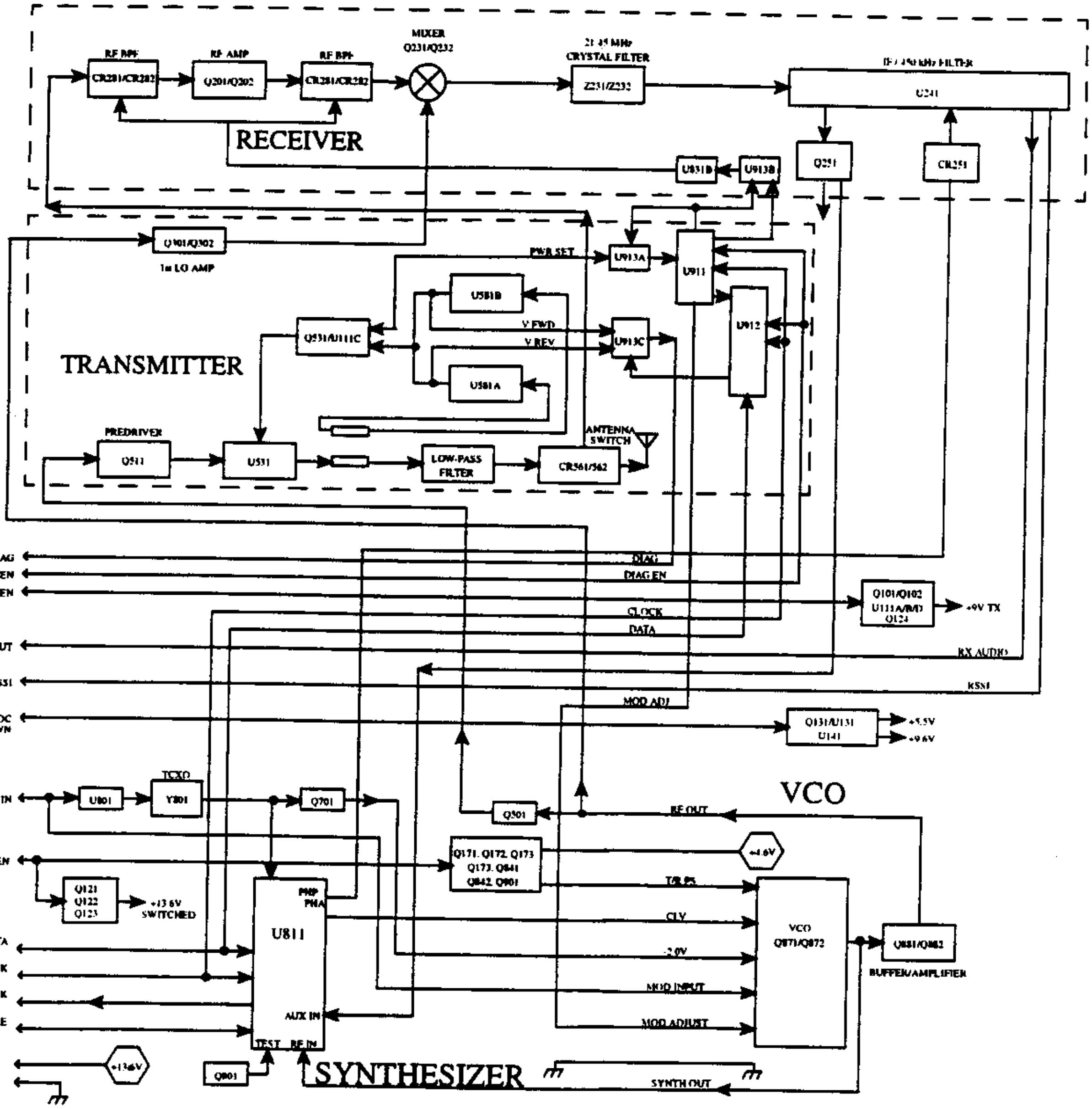

Figure 4-1 TRANSCEIVER BLOCK DIAGRAM

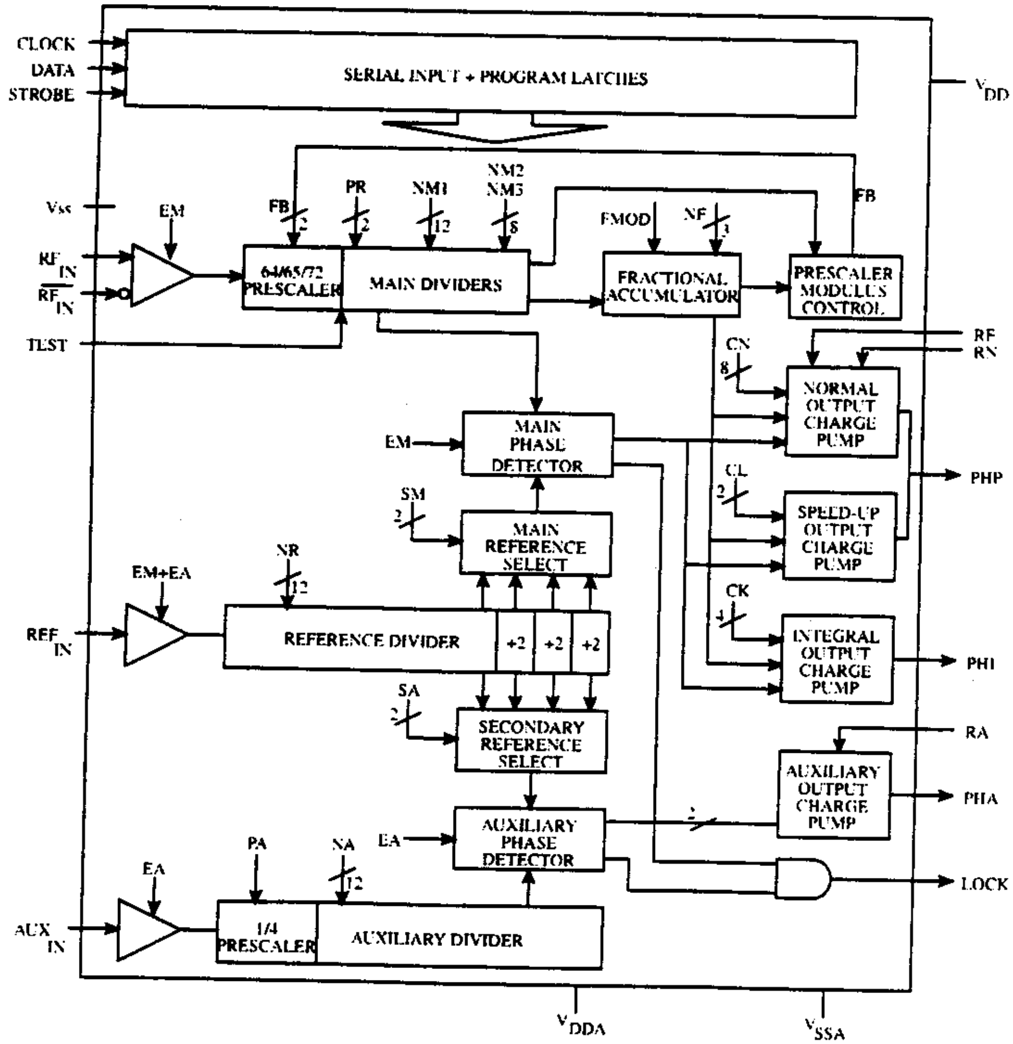

Figure 4-2 U811 SYNTHESIZER BLOCK DIAGRAM

4.2.1 VOLTAGE-CONTROLLED OSCILLATOR

Oscillator (Q872)

The VCO is formed by Q872, several capacitors and varactor diodes, and ceramic resonator L872. It oscillates at the transmit frequency in transmit mode and first injection frequency in the receive mode (132-174 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 ıe 14.85 MHz TCXO frequency that is amplified by)902, rectified by CR902 and filtered by C912, C917, :918 and C920 on the RF board.

The VCO frequency is modulated using a similar ıethod. The transmit audio/data signal from J201, in 6 is applied across varactor diode CR861 which aries the VCO frequency at an audio rate. Series ıpacitors C855/C856 set the amount of deviation roduced along with CR862 and C865. R863 prodes a DC ground on the anodes of CR861/CR862, ıd isolation is provided by R862 and C863.

The DC voltage across CR862 provides compen-tion to keep modulation relatively flat over the ıtire bandwidth of the VCO. This compensation is quired because modulation tends to increase as the CO frequency gets higher (capacitance of CR852/ R853/CR855 gets lower). CR862 also balances the odulation signals applied to the VCO and TCXO. ıe D/A Converter U911 can be programmed to apply :ompensating voltage to CR862 to adjust the modu-:ion sensitivity between the TCXO and VCO.

The DC voltage applied across CR862 comes ım the modulation adjust control R827 on the RF ard. R826 applies a DC biasing voltage to CR862; :21 provides DC blocking. RF isolation is provided C865 and R862.

:.2 VCO AND REFERENCE OSCILLATOR MODULATION

Both the VCO and reference oscillator (TCXO) modulated in order to achieve the required fre-ency response. If only the VCO was modulated, the ıse detector in U811 would sense the frequency ınge and increase or decrease the VCO control volt-: to counteract the change (especially at the lower lio frequencies).

If only the reference oscillator frequency is mod-ted. the VCO frequency would not change fast ugh (especially at the higher audio frequencies). dulating both VCO and reference oscillators pro-es a flat audio response. Potentiometers R825 and :7 set the VCO modulation sensitivity so that it is al to the reference oscillator modulation sitivity.

4.2.3 CASCODE 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 amplification and also isolation from the stages that follow. The signal is coupled and matched from the collector of Q872 through inductors and capacitors and a T-pad to amplifier Q882.

4.2.4 AMPLIFIER (Q882)

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

4.2.5 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 start-up time of the VCO. C902 and C903 are RF decoupling capacitors.

4.2.6 VCO FREQUENCY SHIFT (Q841)

The VCO must be capable of producing frequencies from approximately 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 very 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 CR851 for a high impedance.

The capacitive leg on the VCO board 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 collector 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.

4.2.7 SYNTHESIZER INTEGRATED CIRCUIT (U801)

Introduction

Synthesizer chip U811 is shown in Figure 4-2. This device contains the following circuits: R (reference), Fractional-N, NM1, NM2 and NM3; phase and lock detectors, prescaler and counter programming circuitry. The basic operation was described in Section 4.2.1.

Channel Programming

Frequencies are selected by programming the R, Fractional-N, NM1, NM2 and NM3 in U811 to divide by a certain number. These counters are programmed by Loader board or a user supplied programming circuit. More information on programming is located in Section 3.

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.

4.2.8 LOCK DETECT

When the synthesizer is locked on frequency, the SYNTH LOCK output of U811, pin 18 (J201, pin 7) is a high voltage. 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.

4.3 RECEIVER CIRCUIT DESCRIPTION

4.3.1 PRESELECTOR FILTER, RF AMPLIFIER (Q202)

Capacitor C201 couples the receive signal from the antenna switch to the LC preselector filter composed of L201-L203, CR281, CR282, C202-C207. (The antenna switch is described in Section 4.4.4.) The preselector filter is a 2-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 varactors CR281/CR282. The filter control voltage is either generated by Digital to Analog Converter (DAC) U911 or R920 and amplified by U831 to generate a higher voltage swing to the varactors and minimize filter loss. R206 and capacitors C281-C285 filter the varactor voltage and provide RF isolation. The control voltage source is chosen by U913.

Impedance matching between the helical 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 pro-
ided by a three pole discrete LC varactor tuned band-
ass filter composed of filter L212-L214, L221-L224,
R283-CR285, C214-C217, C221-C223. L211 and
213 provide impedance matching between Q202 and
is filter. Resistor R205 is used to lower the Q of
211 to make it less frequency selective. The same
ontrol voltage that adjusts to two pole filter on fre-
uency adjusts this filter as well. The inductors are
ctory tuned to align the filter tracking and should not
adjusted.

3.2 MIXER (Q232)

First mixer U232 mixes the receive frequency
ith the first injection frequency to produce the
.45 MHz first IF. Since high-side injection is used,
e injection frequency is 21.45 MHz above the
ceive frequency. Q231 biases Q232 in similar fash-
n to Q201 described above. The RF signal is cou-
ed to the mixer through C233. R226 attenuates high
ltage excursions on the base of Q232. The LO
jection is proved across L232 and R236 on the emit-
r of Q232. Emitter injection is used to provide isola-
on between the LO port and the RF port. L233 and
238 provide a low impedance on the emitter at the IF
equency improving noise performance and conver-
on gain.

3.3 FIRST LO AMPLIFIER/BUFFER (Q301,
Q302)

The first LO amplifier provides amplification and
ffering of the receive first injection. R305-R307
m a 3 dB 50 ohm pad. C303 couples the signal to
04 and L301 which match Q302 to 50 ohms. L302
d C307 match Q302 to the mixer Q232. Q301,
01-R304 provide biasing for Q302. R308 enhances
stability of Q302. C302 and C306 provide RF
coupling.

.4 CRYSTAL FILTER (Z231/Z232)

The output of Q232 is matched to the crystal fil-
. Z231/Z232 by L231, C234 and C237. This filter
sents a low impedance to 21.45 MHz and attenu-
s the receive, injection and other frequencies out-
e 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 (15 kHz BW) or 15 kHz (30 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 U241.

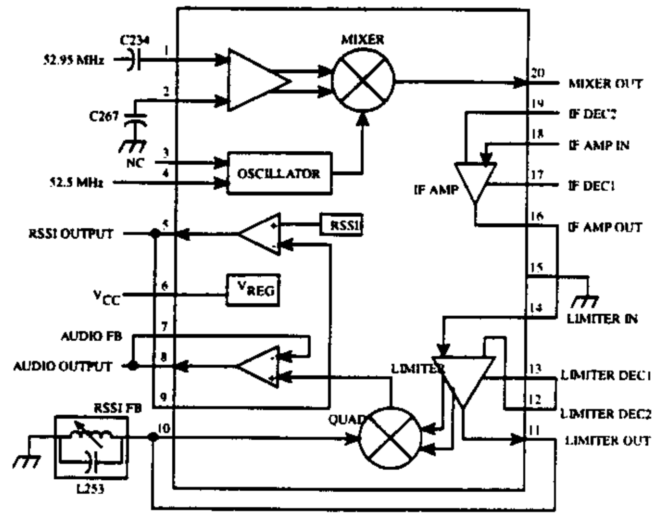

Figure 4-3 U241 BLOCK DIAGRAM

4.3.5 FM IF (U241)

Second LO Oscillator, Buffer (Q251)

As shown in Figure 4-3, U241 contains the second oscillator, second mixer, limiter, detector, and squelch circuitry. 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-R259 and R254 provide 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 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 (15 kHz BW), or 20 kHz (30 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.

4.4 TRANSMITTER CIRCUIT DESCRIPTION

4.4.1 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.

4.4.2 PRE-DRIVER (Q511)

Pre-driver Q511 is biased Class A by R511 and R512 and R515. L513, C517 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.

4.4.3 FINAL (U531), COMPARATOR (U111C)

RF module U531 has an RF output of 1W 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 adjusted 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 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 icrease on Q531 increases the power output level of 531. If the power output of U531 increases, the forard peak detector voltage increases and U111C ecreases the forward bias on Q531. The decrease on 531 decreases the output power of U531.

The output of CR591/CR592 is fed to U581A/B spectively. If the output of either buffer increases, e increase is applied to the inverting input of 111C. The output of U111C then decreases and 531 decreases the input voltage to U531 to lower the wer. The control voltage is isolated from RF by fere bead EP532 and C531 decouples RF.

The forward/reverse power voltages from 581A/B are also applied to U913/U912 for outputs J201.

The low-pass filter consists of L551-L554, 552, C553, C555 and C856. The filter attenuates urious frequencies occurring above the transmit freency band. The transmit signal is then fed through antenna switch to antenna jack J501.

.4 ANTENNA SWITCH (CR561, CR562)

The antenna switching circuit switches the tenna to the receiver in the receive mode and the nsmitter in the transmit mode. In the transmit de, +9V is applied to L555 and current flows ough diode CR561, L561, diode CR562, and 61. When a diode is forward biased, it presents a impedance to the RF signal; conversely, when it is erse biased (or not conducting), it presents a high edance (small capacitance). Therefore, when 561 is forward biased, the transmit signal has a -impedance path to the antenna through coupling acitor C562.

L561 and C564 form a discrete quarter-wave . When CR561 is forward biased, this quarterre line is effectively AC grounded on one end by 64. When a quarter-wave line is grounded on one the other end presents a high impedance to the rter-wave frequency. This blocks the transmit sigfrom the receiver. C561/C563 match the antenna 0 ohms in transmit and receive.

4.4.5 TRANSMITTER KEY-UP CONTROL

Q121, Q122 and Q123 act as switches which turn on with the RX_EN line. When the line goes low Q121 is turned off, which turns Q122 on, turning Q123 on. This applies 13.6V to U111 before the TX_EN line goes high.

U111A/B provide the key-up and key-down conditioning circuit. C116 and R117 provide a ramp-up and ramp-down of the 9V transmit supply during keyup 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 b ase 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 on 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.

4.5 VOLTAGE REGULATORS

4.5.1 +9.6 AND +5.5V 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 is a bypass capacitor for U131.

The low from the collector of Q131 is also applied 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 output on U131, pin 4. C135 stabilizes the voltage and C136 provides RF decoupling. C137 is a bypass capacitor for U131.

SECTION 5 SERVICING

5.1 GENERAL

5.1.1 PERIODIC CHECKS

This transceiver should be put on a regular maintenance schedule and an accurate performance record maintained. Important checks are receiver sensitivity and transmitter frequency, modulation, and power output. A procedure for these and other tests is located in Section 6. It is recommended that transceiver performance be checked annually even though periodic checks are not required by the FCC. During the first year, make an additional check or two to ensure no TCXO frequency drifting has occurred.

5.1.2 SURFACE-MOUNTED COMPONENTS

A large number of the components used on the transceiver board are the surface-mounted type. Since these components are relatively small in size and are soldered directly to the PC board, care must be used when they are replaced to prevent damage to the component or PC board. Surface-mounted components should not be reused because they may be damaged by the unsoldering process.

5.1.3 SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

Schematic diagrams and component layouts of the PC boards used in this transceiver are located in Section 8. A component locator guide is also provided to aid in component location.

5.1.4 REPLACEMENT PARTS LIST

A replacement parts list with all the parts used in this transceiver is located in Section 7. Parts are listed alphanumerically according to designator. For information on ordering parts, refer to Section 1.8.

5.1.5 TCXO MODULE NOT SERVICEABLE

The ±2.5 PPM TCXO module is not field serviceable. Part changes require a factory recalibration to ensure that the oscillator stays within its ±2.5 PPM tolerance.

5.2 SYNTHESIZER SERVICING

5.2.1 INTRODUCTION

When there is a synthesizer malfunction, the VCO is not locked on frequency. When an unlocked VCO is detected by the lock detector circuit, U811, pin 18 goes low (0V).

NOTE: The user-supplied circuitry must disable the transmitter and receiver when an out-of-lock condition is indicated.

When the VCO is unlocked, the f_R and f_V inputs to the phase detector are usually not in phase (see Section 4.1.2). The phase detector in U811 then causes the VCO control voltage to go to the high or low end of its operating range. This in turn causes the VCO to oscillate at the high or low end of its frequency range.

As shown in Figure 4-1, a loop is formed by VCO Q872, amplifier Q871, and the RF IN of U811. Therefore, if any of these components begin to malfunction, improper signals appear throughout the loop. However, correct operation of the counters can still be verified by measuring the input and output frequencies to check the divide number.

Proceed as follows to check the synthesizer I/O signals to determine if it is operating properly.

5.2.2 REFERENCE OSCILLATOR

Check the signal at U811, pin 8. It should be 14.85 MHz at a level of approximately 0.5V P-P. If the TCXO module is defective, it is not serviceable and must be replaced with a new module as described in Section 5.1.5.

5.2.3 VCO

Output Level

The output level of Q882 can be measured with an RF voltmeter or some other type of high impedance meter. The minimum level after a power splitter at R851 should be -3 dBm.

'ontrol Voltage

Check the DC voltage at C815 with a channel ear the center of the band. If the VCO is locked on equency, this should be a steady DC voltage near V. If it is not locked on frequency, it should be near e lower or upper end of its range (0V or 5.5V).

utput Frequency

Check the VCO frequency at R851. If the VCO locked on frequency, it should be stable on the ansmit channel frequency. If the VCO is not locked 1 frequency, the VCO control voltage is probably ear 0V or 5.5V.

2.4 SYNTHESIZER (U811)

ock Detector

When the VCO is locked on frequency, the lock tect output on J201, pin 7 should be high.

3 RECEIVER SERVICING

To isolate a receiver problem to a specific secon, refer to the troubleshooting flowchart in Figure 1. Tests referenced in the flowchart are described in e following information.

OTE: Supply voltages are provided by the user.

3.1 SUPPLY VOLTAGES AND CURRENT

Measure the supply voltages on the following is at interface connector J201:

in 4 - 5.0V DC Receive
in 5 - 5.0V DC

Place a DC ammeter in the supply line to the nsceiver and the following maximum currents ould be measured:

in 4 - 400 μA
in 5 - 400 μA

5.3.2 MIXER/DETECTOR (U201)

Data Output

Using a .01 μF coupling capacitor, inject a 21.45 MHz, 1 mV signal, modulated with 1 kHz at ±3 kHz deviation at U241, pin 1. The signal output at U241, pin 8 should be approximately 150 mV P-P.

NOTE: This signal consists of the 1 kHz modulation and harmonics of 450 kHz.

RSSI Output

The RSSI output on J201, pin 12 should be <900 mV DC with no signal applied, and >1.8V DC with a 1 mV input signal.

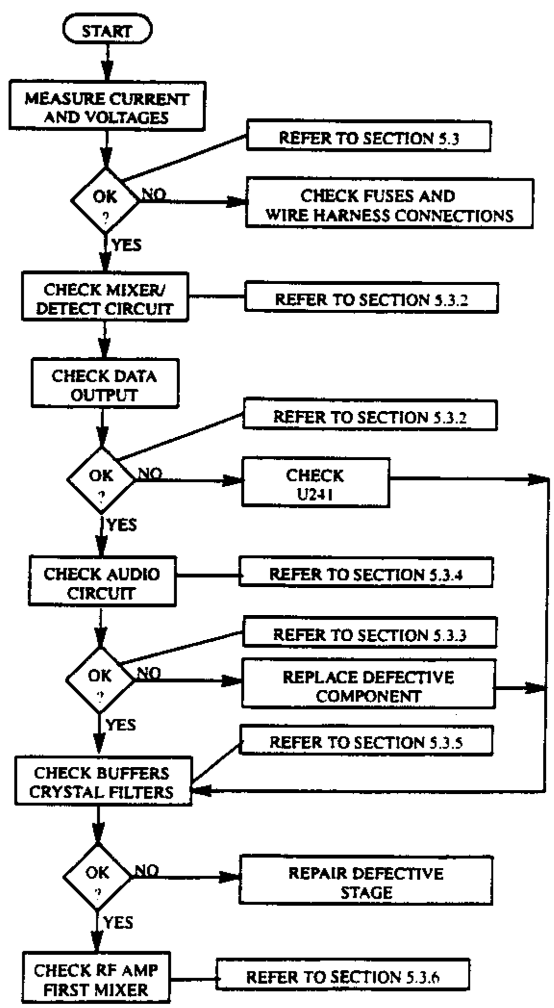

Figure 5-1 RECEIVER SERVICING

5.3.3 SECOND LO (Q401)

Verify that the Second LO signal is present at U241, pin 4. The Second LO should be at 21.90 MHz and not less than 500 mV P-P.

5.3.4 AUDIO BUFFER AMP (U241)

The Data output on J201, pin 13 should be 100-200 mV RMS, with the preceding injection signal. If these levels are not correct, verify proper adjustment of L253 (see Section 6.7). The gain of U241 is 2.8 for 30 kHz radios and 5.5 for 15 kHz radios.

5.3.5 CRYSTAL FILTERS

The 21.45 MHz IF signal is provided to the crystal filters Z221/Z222.

5.3.6 MIXER (Q232)

The mixer converts the RF signal (132-174 MHz) to 21.45 MHz. The Local Oscillator is provided by the VCO and Q302. The level of the LO should be approximately +3 dBm.

5.3.7 LNA (Q202)

The LNA provides approximately 16 dB of gain at 132-174 MHz. Q201 provides active bias to Q202.

5.3.8 PRESCALER FILTERS

The 2-pole and 3-pole LC prescaler filters limit the out-of-band signals from reaching the receiver. The 2-pole filter has approximately 2.5 dB of loss and is composed of L201-L203, CR281/CR282, and C202-C207. The 3-pole filter has approximately 5.5 dB of loss and is composed of L212-L214, CR283/CR284, C214-C217 and C221-C223. These filters are varactor tuned and require a control voltage to tune throughout the band. The voltage on TP281 varies from 2.5V at the low end of the band to over 7V at the high end of the band.

5.3.9 ANTENNA SWITCH

CR561, CR562, L561, C561 and C563 form a Pi-network antenna switch. CR561 and CR562 are reversed biased in Receive Mode.

5.4 TRANSMITTER SERVICING

5.4.1 SUPPLY VOLTAGES AND CURRENT

Measure the supply voltages on the following pins of interface connector J201:

Pin 2 - 13.3V DC nominal
Pin 3 - 3-16V DC
Pin 4 - 0.0V DC (while transmitting)
Pin 5 - 3-16V DC
Pin 6 - 2.5V DC ±1%/1.5V P-P max

Place a DC ammeter in the supply line to the transceiver and the following maximum currents should be measured:

Pin 2 - 2.5A maximum
Pin 3 - 400 µA
Pin 5 - 400 µA

5.4.2 VCO

1. Check VCO after power splitter R894 for power output. (Power output should be at least -3 dBm.)

2. Check 9V Transmit (Q124, emitter).

3. If 9V is not present check Q124, U111, Q121, Q122, Q123, Q101 and Q102 (see Section 4.4.5).

4. Check voltages on Buffer Q501.

   Input = 1.5V DC
   Output = 3.5V DC

   Power output should be at least 2 mW (+3 dBm) at C504 (50 ohm point).

5.4.3 PRE-DRIVER (Q511)

1. Check voltages on Q511.

   Collector = 8.6V DC
   Base = 2.2V DC
   Emitter = 1.6V DC w/o RF (2.2V DC with RF)

   Power output should be at least 100 mW (+13 dBm) at the junction of C517/L518 (50 ohm point).

4.4 FINAL AMPLIFIER (U531)

Check the voltages on U531.

Pin 2 = 5.5V DC (varies with power setting)
Pin 3 = 5.0V DC
Pin 4 = 12.7V DC

Power output at C551 should be 7.5-8.0W (+38.7 to +39 dBm).

.5 ANTENNA SWITCH (CR561/CR562)

Check the antenna switch voltages.

CR561 = 8.6V DC
CR562 = 8.0V DC

The loss through the Antenna Switch should be 1.9 to 2.1 dB.

.6 MODULATION INPUT (J201, PIN 6)

Check for audio/data signals at J201, pin 6, Y801, pin 1 and R821, pin 3.

.7 TCXO (Y801)

Check Y801, pin 1 for 2.5V DC ±1%.

Adjust Y801 to set the transmitter to the frequency of operation.

If the frequency cannot be set to the frequency of operation, replace the TCXO.

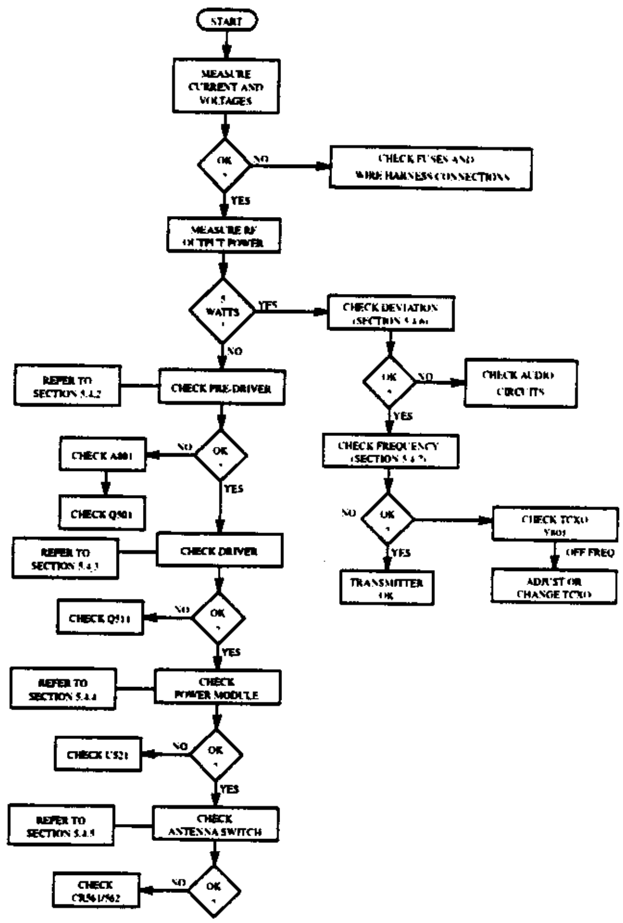

Figure 5-2 TRANSMITTER SERVICING

SECTION 6 ALIGNMENT PROCEDURE

6.1 GENERAL

Receiver or transmitter alignment may be necessary if repairs are made that could affect tuning. Alignment points diagrams are located in Figure 6-3 or component layouts are located in Section 8.

Fabricate test cables by referring to Figure 2-1. This cable should include power and ground, a transmit keying switch that shorts the keying line to ground, data input and data output. The test setup must apply the various supply voltages and load the synthesizer with channel information.

6.2 TEST EQUIPMENT

- Modulation Analyzer, HP8901 or equivalent
- RF Signal Generator, HP8656 or equivalent
- Power Meter
- Oscilloscope
- Digital Multimeter
- Power Supply, HP8264A or equivalent
- Audio Analyzer, HP8903A or equivalent
- Misc. cables, connectors, attenuators.

6.3 INITIAL SETTINGS

1. Adjust power supply voltage to +13.3V DC.
2. Turn off the power supply.
3. Connect RF and power cables.
4. Turn on the power supply.
5. Apply a 2.5V DC ±0.01V level to J201, pin 6.
6. Using a DC voltmeter, monitor the DC voltage at the junction of R822/R823 (wiper of R823), refer to Figure 6-3.
7. Adjust R823 to 0.65V DC ±0.05V.
8. Using a DC voltmeter, monitor the DC voltage at the junction of R826/R827 (wiper of R827), refer to Figure 6-3.
9. Adjust R827 to 1.50V DC ±0.05V.
10. Monitor the DC voltage at TP801 (see Figure 6-3 for top side access to TP801).
11. Adjust R805 for 2.5V DC ±0.025V.
12. Adjust R535 fully counterclockwise.

6.4 VCO CONTROL VOLTAGE

1. Connect the test setup shown in Figure 6-1.
2. Adjust R535 fully counterclockwise.
3. Load the synthesizer with the HIGHEST channel frequency in the band.
4. Key the transmitter.
5. Adjust C873 for 4.8V DC at TP831.
6. Unkey the transmitter.
7. The voltage at TP831 should be less than 4.8V.
8. Load the synthesizer with the LOWEST channel frequency in the band.
9. Key the transmitter.
10. The voltage at TP831 should be greater than 1.2V DC.
11. Unkey the transmitter.
12. The voltage at TP831 should be greater than 0.70V.

6.5 TRANSMITTER AND FREQUENCY

NOTE: If the radio is intended to use Diagnostics or is a Radio/Loader board combination go to Section 6.6.

1. Connect the test setup shown in Figure 6-1.
2. Check to be sure that R572 is installed and R571 is removed (see Figure 6-3).

. Load the synthesizer with a channel frequency in the MIDDLE of the band.

. Key the transmitter.

The voltage at J201, pin 2 should be 13.3V DC.

)o not transmit for extended periods.)

Adjust R535 clockwise for 5.0W +0.5/-0.2W. Adjust voltage and power if necessary.

Check the power at a channel frequency on the LOW and HIGH ends of the band. The power output should be 5W ±1W with current less than 2.5A for 380-512 MHz transmitters.

5.1 MODULATION ALIGNMENT

Apply a 1V, 100 Hz, +2.5V DC bias, square-wave to J201, pin 6.

Transmit into the modulation analyzer and observe modulation output on the oscilloscope. Set the modulation analyzer high pass filtering OFF and no less than a 15 kHz low pass filter.

Preset R827 to the center position.

Load the synthesizer with a channel frequency at the MIDDLE of the band.

Adjust R825 for 2.5V DC at the wiper of R827.

Adjust R827 for a flat square wave.

Apply a 100 Hz, +2.5V DC biased, sine-wave to J201, pin 6. The modulation analyzer should still have the 15 kHz lowpass filter selected.

Adjust the audio analyzer output level to achieve a transmit deviation of:

.5 kHz for 15 kHz BW radios
.0 kHz for 30 kHz BW radios

Load the synthesizer with a channel frequency at the LOW end of the band.

Input a 100 Hz, +2.5V DC biased, sine-wave and set a 0 dB reference on the Modulation Analyzer.

11. Apply a 1 kHz, +2.5V DC biased, sine-wave. The level should be within ±3.5 dB of the reference at 100 Hz.

12. Load the synthesizer with a channel frequency in the MIDDLE of the band.

13. Input a 100 Hz, +2.5V DC biased, sine-wave and set a 0 dB reference on the Modulation Analyzer.

14. Apply a 1 kHz, +2.5V DC biased, sine-wave. The level should be within ±0.5 dB of the reference at 100 Hz.

15. Load the synthesizer with a channel frequency in the HIGH end of the band.

16. Input a 100 Hz, +2.5V DC biased, sine-wave and set a 0 dB reference on the Modulation Analyzer.

17. Apply a 1 kHz, +2.5V DC biased, sine-wave. The level should be within ±3.5 dB of the reference at 100 Hz.

18. Unkey the transmitter.

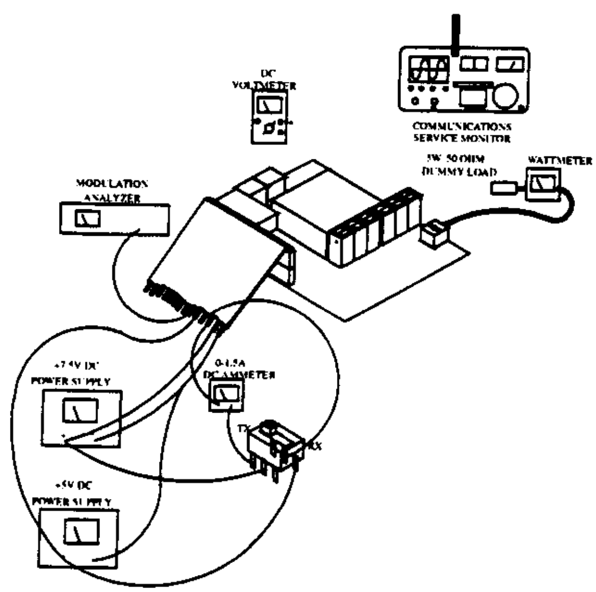

Figure 6-1 TRANSMITTER TEST SETUP

6.6 TRANSMITTER/FREQUENCY WITH LOADER

NOTE: If the radio is not intended to use Diagnostics go to Section 6.5.

NOTE: Subtract the current drawn by the Test Loader or any Interface Units from all measurements.

1. Set the Diagnostic Enable DAC (DAC4) to 255, (FFh).
2. Select a Transmit channel frequency in the MIDDLE of the band. Make sure voltage at J201, pin 2 is 13.3V DC.
3. Adjust R535 fully clockwise for maximum power output.
4. Adjust the Power Adjust DAC setting (DAC1) to set the power output to 5W ±0.3W. Make sure voltage at J201, pin 2 is 13.3V DC.
5. Adjust voltage and power if necessary.
6. Repeat Step 5 for channels on the LOW and HIGH ends of the band.
7. Power output should be 4.7-5.3W (50% duty cycle) and current should be less than 2.5A.
8. Select a Transmit channel frequency in the MIDDLE of the band
9. Adjust the frequency displayed on the Modulation Analyzer to the desired channel frequency by adjusting the TCXO (Y801).

6.6.1 MODULATION ADJUSTMENT

1. Apply a 1V, 100 Hz, 2.5V DC bias, square wave to J201, pin 6.
2. Transmit into the modulation analyzer and observe modulation output on the oscilloscope. The modulation analyzer should not have any high pass filtering selected and no less than a 15 kHz low pass filter.
3. Select a Transmit channel frequency in the MIDDLE of the band. The DAC value should be "125" (the voltage at the wiper of R827 should be set to 1.5V DC).
4. If the square wave is rolled off on the edges, adjust R825 up in value for the flattest square wave.
5. If the square wave is peaked on the edges, adjust R825 down in value for the flattest square wave.
6. Adjust the Modulation Adjust DAC (DAC2) for the flattest square wave.
7. Repeat Steps 5 and 6 for channels on the LOW and HIGH ends of the band.
8. Input a 100 Hz, 2.5V DC bias, sinewave to J201, pin 6. The modulation analyzer should still have the 15 kHz low pass filter selected.
9. Adjust the audio analyzer output level to achieve a transmit deviation of:
   1.5 kHz for 15 kHz radios or
   3 kHz for 30 kHz radios.
10. Select a Transmit channel frequency at the LOW end of the band.
11. Input a 100 Hz, +2.5V DC biased, sine-wave and set a 0 dB reference on the Modulation Analyzer.
12. Apply a 1 kHz, +2.5V DC biased, sine-wave. The level should be within ±0.5 dB of the reference at 100 Hz.
13. Select a Transmit channel frequency in the MIDDLE of the band.
14. Input a 100 Hz, +2.5V DC biased, sine-wave and set a 0 dB reference on the Modulation Analyzer.
15. Apply a 1 kHz, +2.5V DC biased, sine-wave. The level should be within ±0.5 dB of the reference at 100 Hz.
16. Select a Transmit channel frequency in the HIGH end of the band.
17. Input a 100 Hz, +2.5V DC biased, sine-wave and set a 0 dB reference on the Modulation Analyzer.
18. Apply a 1 kHz, +2.5V DC biased, sine-wave. The level should be within ±0.5 dB of the reference at 100 Hz.
19. Unkey the transmitter.

7 RECEIVER

CAUTION

*o not key the transmitter with the generator con-
cted because severe generator damage may result.*

*)TE: If the radio is intended to use Diagnostics or is
Radio/Loader board combination go to Section 6.8.*

*)TE: All distortion and SINAD measurements are
rformed with psophometric audio filtering.*

Connect the test setup shown in Figure 6-2.

Preset tuning slugs of L201, L203, L212, L221 and L224 flush with the top of the can.

Preset tuning slugs of L231 and L242 to the center of the can.

Preset C241 to the center position (slot in-line with axis of the part).

Load the synthesizer with a receive channel fre-quency at the LOW end of the band (-21.45 MHz).

Apply a -47 dBm signal from the RF signal genertor to J501 on the radio. Adjust deviation for 1.5 kHz with 1.5 kHz tone for 15 kHz radios and 3 kHz devi-ation with 3 kHz tone for 30 kHz radios.

Adjust R920 for 2.5V DC ±0.05V at TP281.

Adjust L251 for 2.5V ±0.05V at TP251.

Preset L253 for 2.5V DC ±0.05V at J201, pin 13.

Adjust C241, L231 and L242 for minimum distor-ion in turn (use 30 kHz LPF only).

Repeat Step 10 until no improvement is noted.

Readjust L253 for minimum distortion (use 30 kHz .PF only).

Apply a -47 dBm signal from the RF signal genera-or to J501 on the radio.

14. Adjust for 1.5 kHz deviation with a 1 kHz tone for 15 kHz radios or 3.0 kHz deviation with a 1 kHz tone for 30 kHz radios.

NOTE: Maintain these deviation levels throughout the test when measuring AC levels, SINAD and % distortion.

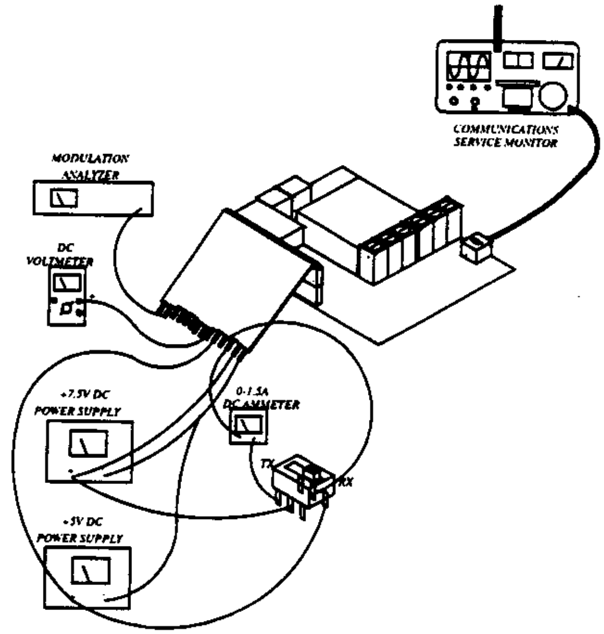

Figure 6-2 RECEIVER TEST SETUP

15. Verify that the receive audio RMS voltage is 150 mV ±50 mV.

16. Measure the % distortion (spec is <3% psophometrically weighted).

17. Adjust the amplitude of the RF signal generator on J501 until an 18 dB SINAD level (psophometrically weighted) is reached.

18. Adjust L221, L212, L224, L201 and L203 in turn for the best SINAD reading adjusting the generator output as necessary to maintain an 18 dB SINAD level. DO NOT turn the slug more than 2-turns from the top of the coil.

19. Turn the slug of L221 1/2-turn clockwise. This helps to center the filter tracking across the band.

20. Measure the 12 dB SINAD sensitivity. The RF input level should be less than -116 dBm (0.35 µV).

21. Load the synthesizer with a receive channel frequency to the MIDDLE of the band.

22. Set the signal generator to the same frequency with an amplitude of -116 dBm.

23. Adjust R920 for the best SINAD reading.

24. Adjust the RF input level until 12 dB SINAD is measured. The RF input level should be less than -116 dBm (0.35 µV).

25. Adjust generator RF level to -120 dBm and measure DC (RSSI) voltage on J201, pin 12 of the radio (spec is less than or equal to 0.90V DC).

26. Adjust generator RF level to -60 dBm and measure DC (RSSI) voltage on J201, pin 12 of the radio (spec is greater than or equal to 1.75V DC).

6.8 RECEIVER WITH LOADER BOARD

CAUTION

Do not key the transmitter with the generator connected because severe generator damage may result.

NOTE: If the radio is NOT intended to use Diagnostics or is NOT a Radio/Loader board combination go to Section 6.7.

NOTE: All distortion and SINAD measurements are performed with psophometric audio filtering.

1. Set the Diagnostic Enable DAC (DAC 4) to 255, (FFh).

2. Preset tuning slugs of L201, L203, L212, L221 and L224 flush with the top of the can.

3. Preset tuning slugs of L231 and L242 to the center of the can.

4. Preset C241 to the center position (slot in-line with axis of the part).

5. Select a receive channel frequency at the LOW end of the band (-21.45 MHz).

6. Apply a -47 dBm signal from the RF signal generator to J501 on the radio. Adjust deviation for:
   1.5 kHz with 1.5 kHz tone for 15 kHz radios or
   3 kHz deviation with 3 kHz tone for 30 kHz radios.

7. Adjust the Front End DAC (DAC 3) value to set the voltage on TP281 to 2.5V DC ±0.05V. The DAC setting will be about 74.

8. Adjust L251 for 2.5V ±0.05V at TP251.

9. Preset L253 for 2.5V DC ±0.05V at J201, pin 13.

10. Adjust C241, L231 and L242 for minimum distortion in turn (use 30 kHz LPF only).

11. Repeat Step 10 until no improvement is noted.

12. Readjust L253 for minimum distortion (use 30 kHz LPF only).

13. Apply a -47 dBm signal from the RF signal generator to J501 on the radio.

14. Adjust for 1.5 kHz deviation with a 1 kHz tone for 15 kHz radios or 3.0 kHz deviation with a 1 kHz tone for 30 kHz radios.

NOTE: Maintain these deviation levels throughout the test when measuring AC levels, SINAD and % distortion.

15. Verify that the receive audio RMS voltage is 150 mV ±50 mV.

16. Measure the % distortion (spec is <3% psophometrically weighted).

17. Adjust the amplitude of the RF signal generator on J501 until an 18 dB SINAD level (psophometrically weighted) is reached.

18. Adjust L221, L212, L224, L201 and L203 in turn for the best SINAD reading adjusting the generator output as necessary to maintain an 18 dB SINAD level. DO NOT turn the slug more than 2-turns from the top of the coil.

9. Turn the slug of L221 1/2-turn clockwise. This helps to center the filter tracking across the band.

0. Measure the 12 dB SINAD sensitivity. The RF input level should be less than -116 dBm (0.35 μV).

1. Select a receive channel frequency to the MIDDLE of the band.

2. Set the signal generator to the same frequency with an amplitude of -116 dBm.

3. Adjust the Front-End DAC (DAC 3) value to peak the SINAD reading (this is a very gradual peak).

24. Adjust the RF input level until 12 dB SINAD is measured. The RF input level should be less than -116 dBm (0.35 μV).

25. Adjust generator RF level to -120 dBm and measure DC (RSSI) voltage on J201, pin 12 of the radio (spec is less than or equal to 0.90V DC).

26. Adjust generator RF level to -60 dBm and measure DC (RSSI) voltage on J201, pin 12 of the radio (spec is greater than or equal to 1.75V DC).

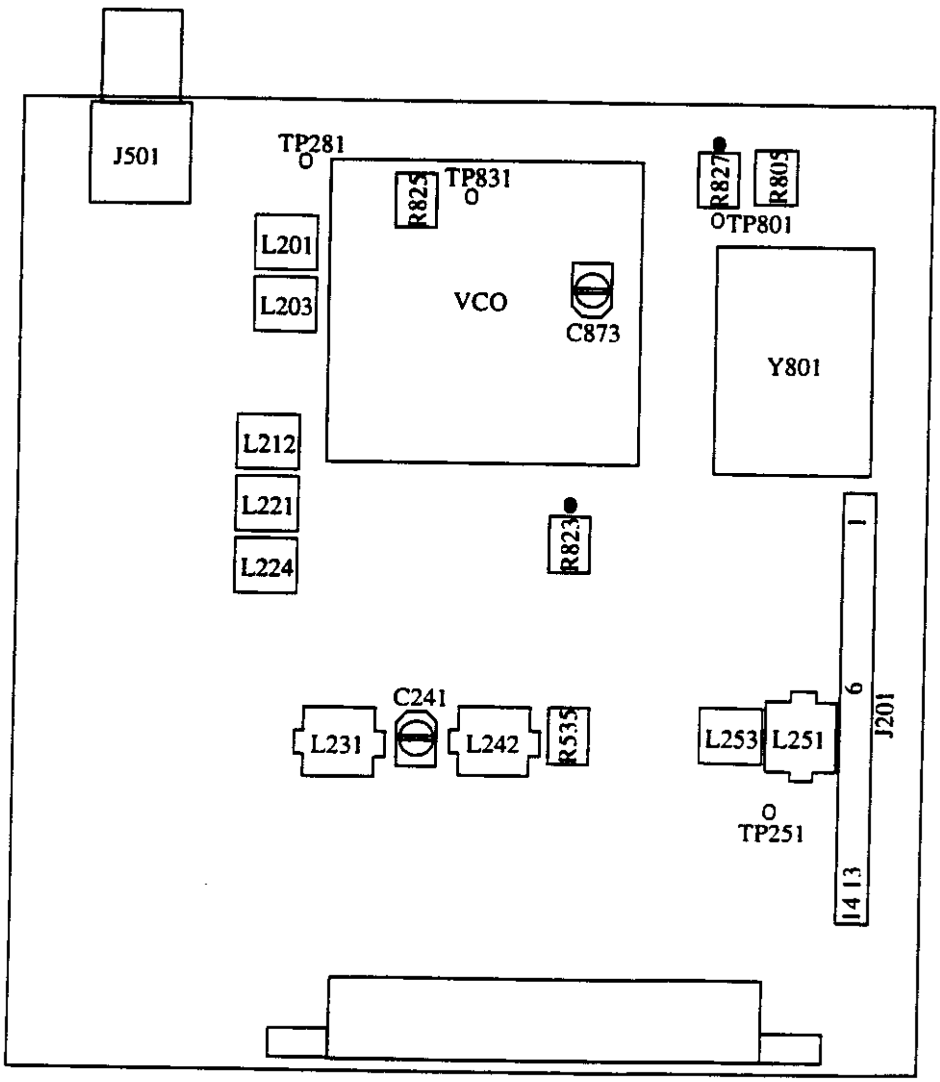

Figure 6-3 ALIGNMENT POINTS DIAGRAM
Figure 6-4

SECTION 7 PARTS LIST

3422 TRANSCEIVER
PART NO. 242-3422-XXX

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 531	Directional coupler	592-5033-001
C 101	.001 µF ±10% X7R 0603	510-3675-102
C 102	1 µF 16V SMD tantalum	510-2625-109
C 103	.001 µF ±10% X7R 0603	510-3675-102
C 104	.01 µF ±10% X7R 0603	510-3675-103
C 105	1 µF 16V SMD tantalum	510-2625-109
C 106	.001 µF ±10% X7R 0603	510-3675-102
C 111	.01 µF ±10% X7R 0603	510-3675-103
C 112	.001 µF ±10% X7R 0603	510-3675-102
C 113	.001 µF ±10% X7R 0603	510-3675-102
C 114	1 µF 16V SMD tantalum	510-2625-109
C 115	.01 µF ±10% X7R 0603	510-3675-103
C 116	.0056 µF ±10% X7R 0805	510-3605-562
C 121	.001 µF ±10% X7R 0603	510-3675-102
C 122	.001 µF ±10% X7R 0603	510-3675-102
C 123	.01 µF ±10% X7R 0603	510-3675-103
C 124	.001 µF ±10% X7R 0603	510-3675-102
C 125	1 µF 16V SMD tantalum	510-2625-109
C 131	.001 µF ±10% X7R 0603	510-3675-102
C 132	1 µF 16V SMD tantalum	510-2625-109
C 133	.001 µF ±10% X7R 0603	510-3675-102
C 134	.01 µF ±10% X7R 0603	510-3675-103
C 135	1 µF 16V SMD tantalum	510-2625-109
C 136	.001 µF ±10% X7R 0603	510-3675-102
C 137	.01 µF ±10% X7R 0603	510-3675-103
C 141	1 µF 16V SMD tantalum	510-2625-109
C 142	.001 µF ±10% X7R 0603	510-3675-102
C 143	.01 µF ±10% X7R 0603	510-3675-103
C 144	.01 µF ±10% X7R 0603	510-3675-103
C 145	1 µF 16V SMD tantalum	510-2625-109
C 146	.001 µF ±10% X7R 0603	510-3675-102
C 151	.001 µF ±10% X7R 0603	510-3675-102
C 152	.001 µF ±10% X7R 0603	510-3675-102
C 153	.001 µF ±10% X7R 0603	510-3675-102
C 154	.001 µF ±10% X7R 0603	510-3675-102
C 155	.001 µF ±10% X7R 0603	510-3675-102
C 156	.001 µF ±10% X7R 0603	510-3675-102
C 157	100 pF ±5% NPO 0603	510-3674-101
C 158	100 pF ±5% NPO 0603	510-3674-101
C 159	100 pF ±5% NPO 0603	510-3674-101

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 160	100 pF ±5% NPO 0603	510-3674-101
C 161	.001 µF ±10% X7R 0603	510-3675-102
C 162	.001 µF ±10% X7R 0603	510-3675-102
C 163	.001 µF ±10% X7R 0603	510-3675-102
C 171	1 µF 16V SMD tantalum	510-2625-109
C 172	.001 µF ±10% X7R 0603	510-3675-102
C 201	.001 µF ±10% X7R 0603	510-3675-102
C 202	15 pF ±5% NPO 0603	510-3674-150
C 203	22 pF ±5% NPO 0603	510-3674-220
C 204	4.7 pF ±.1% NPO 0603	510-3673-479
C 205	4.7 pF ±.1% NPO 0603	510-3673-479
C 206	15 pF ±5% NPO 0603	510-3674-150
C 207	56 pF ±5% NPO 0603 (132-150 MHz)	510-3674-560
	33 pF ±5% NPO 0603 (150-174 MHz)	510-3674-330
C 208	.001 µF ±10% X7R 0603	510-3675-102
C 209	.001 µF ±10% X7R 0603	510-3675-102
C 211	.001 µF ±10% X7R 0603	510-3675-102
C 212	.001 µF ±10% X7R 0603	510-3675-102
C 213	39 pF ±5% NPO 0603	510-3674-390
C 214	15 pF ±5% NPO 0603	510-3674-150
C 215	27 pF ±5% NPO 0603	510-3674-270
C 216	4.7 pF ±.1% NPO 0603	510-3673-479
C 217	15 pF ±5% NPO 0603	510-3674-150
C 221	4.7 pF ±5% NPO 0603	510-3674-479
C 222	180 pF ±5% NPO 0603	510-3674-181
C 223	8.2 pF ±0.1% NPO 0603	510-3673-829
C 231	.01 µF ±10% X7R 0603	510-3675-103
C 232	.001 µF ±10% X7R 0603	510-3675-102
C 233	330 pF ±5% NPO 0603	510-3674-331
C 234	56 pF ±5% NPO 0603	510-3674-560
C 235	.01 µF ±10% X7R 0603	510-3675-103
C 237	18 pF ±5% NPO 0603 (15 kHz BW)	510-3674-180
	6.8 pF ±0.1% NPO 0603 (30 kHz BW)	510-3673-689
C 238	120 pF ±5% NPO 0603	510-3674-121
C 241	1.5-5 pF SMD ceramic	512-1602-001
C 242	10 pF ±0.1% NPO 0603 (15 kHz BW)	510-3673-100
	1.5 pF ±0.1% NPO 0603 (30 kHz BW)	510-3673-159
C 244	47 pF ±5% NPO 0603	510-3674-470

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 245	27 pF ±5% NPO 0603 (15 kHz BW)	510-3674-270
	15 pF ±.1% NPO 0603 (30 kHz BW)	510-3673-150
C 246	.01 µF ±10% X7R 0603	510-3675-103
C 251	.01 µF ±10% X7R 0603	510-3675-103
C 252	.01 µF ±10% X7R 0603	510-3675-103
C 253	330 pF ±5% NPO 0603	510-3674-331
C 254	100 pF ±5% NPO 0603	510-3674-101
C 255	.001 µF ±5% X7R 1206	510-3609-102
C 256	100 pF ±5% NPO 0603	510-3674-101
C 257	100 pF ±5% NPO 0603	510-3674-101
C 258	220 pF ±5% NPO 0603	510-3674-221
C 259	220 pF ±5% NPO 0603	510-3674-221
C 264	47 µF 10V SMD tantalum	510-2624-470
C 265	.01 µF ±10% X7R 0603	510-3675-103
C 266	.001 µF ±10% X7R 0603	510-3675-102
267	.01 µF ±10% X7R 0603	510-3675-103
268	.01 µF ±10% X7R 0603	510-3675-103
271	.01 µF ±10% X7R 0603	510-3675-103
272	.01 µF ±10% X7R 0603	510-3675-103
273	.01 µF ±10% X7R 0603	510-3675-103
275	.01 µF ±10% X7R 0603	510-3675-103
276	.01 µF ±10% X7R 0603	510-3675-103
277	10 pF ±.1% NPO 0603	510-3673-100
278	.01 µF ±10% X7R 0603	510-3675-103
279	.01 µF ±10% X7R 0603	510-3675-103
281	.001 µF ±10% X7R 0603	510-3675-102
282	.001 µF ±10% X7R 0603	510-3675-102
283	.001 µF ±10% X7R 0603	510-3675-102
284	.001 µF ±10% X7R 0603	510-3675-102
285	.001 µF ±10% X7R 0603	510-3675-102
301	.001 µF ±10% X7R 0603	510-3675-102
302	.01 µF ±10% X7R 0603	510-3675-103
303	.001 µF ±10% X7R 0603	510-3675-102
305	47 pF ±5% NPO 0603 132-150 MHz)	510-3674-470
	33 pF ±5% NPO 0603 (150-174 MHz)	510-3674-330
306	.001 µF ±10% X7R 0603	510-3675-102
307	18 pF ±5% NPO 0603	510-3674-180
501	.001 µF ±10% X7R 0603	510-3675-102
502	.001 µF ±10% X7R 0603	510-3675-102
503	.001 µF ±10% X7R 0603	510-3675-102
504	.001 µF ±10% X7R 0603	510-3675-102
505	22 pF ±5% NPO 0603	510-3674-220
506	68 pF ±5% NPO 0603	510-3674-680

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 507	.01 µF ±10% X7R 0603	510-3675-103
C 508	.001 µF ±10% X7R 0603	510-3675-102
C 511	.001 µF ±10% X7R 0603	510-3675-102
C 512	12 pF ±5% NPO 0603	510-3674-120
C 513	.01 µF ±10% X7R 0603	510-3675-103
C 514	.001 µF ±10% X7R 0603	510-3675-102
C 515	.01 µF ±10% X7R 0603	510-3675-103
C 516	.001 µF ±10% X7R 0603	510-3675-102
C 517	.001 µF ±10% X7R 0603	510-3675-102
C 518	6.8 pF ±.1% NPO 0603	510-3673-689
C 519	.001 µF ±10% X7R 0603	510-3675-102
C 521	.001 µF ±10% X7R 0603	510-3675-102
C 522	1 µF 16V SMD tantalum	510-2625-109
C 523	.01 µF ±10% X7R 0603	510-3675-103
C 524	.001 µF ±10% X7R 0603	510-3675-102
C 531	.001 µF ±10% X7R 0603	510-3675-102
C 532	.001 µF ±10% X7R 0603	510-3675-102
C 533	.001 µF ±10% X7R 0603	510-3675-102
C 534	.001 µF ±10% X7R 0603	510-3675-102
C 535	.001 µF ±10% X7R 0603	510-3675-102
C 536	.01 µF ±10% X7R 0603	510-3675-103
C 541	22 pF ±5% NPO 0603	510-3674-220
C 542	68 pF ±5% NPO 0603	510-3674-680
C 543	.01 µF ±10% X7R 0603	510-3675-103
C 544	.001 µF ±10% X7R 0603	510-3675-102
C 551	.001 µF ±10% X7R 0603	510-3675-102
C 552	36 pF ±5% NPO 0805 (132-150 MHz)	510-3601-360
	27 pF ±5% NPO 0805 (150-174 MHz)	510-3601-270
C 553	75 pF ±5% NPO 0805 (132-150 MHz)	510-3601-750
	56 pF ±5% NPO 0805 (150-174 MHz)	510-3601-560
C 554	75 pF ±5% NPO 0805 (132-150 MHz)	510-3601-750
	56 pF ±5% NPO 0805 (150-174 MHz)	510-3601-560
C 555	75 pF ±5% NPO 0805 (132-150 MHz)	510-3601-750
	51 pF ±5% NPO 0805 (150-174 MHz)	510-3601-510
C 556	43 pF ±5% NPO 0805 (132-150 MHz)	510-3601-430
	27 pF ±5% NPO 0805 (150-174 MHz)	510-3601-270
C 557	.001 µF ±10% X7R 0603	510-3675-102

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 561	10 pF ±5% NPO 0805	510-3601-100
C 562	.001 µF ±10% X7R 0603	510-3675-102
C 563	15 pF ±5% NPO 0805	510-3601-150
C 564	.001 µF ±10% X7R 0603	510-3675-102
C 581	.001 µF ±10% X7R 0603	510-3675-102
C 582	100 pF ±5% NPO 0603	510-3674-101
C 583	100 pF ±5% NPO 0603	510-3674-101
C 584	100 pF ±5% NPO 0603	510-3674-101
C 591	.001 µF ±10% X7R 0603	510-3675-102
C 592	.01 µF ±10% X7R 0603	510-3675-103
C 593	.001 µF ±10% X7R 0603	510-3675-102
C 594	.01 µF ±10% X7R 0603	510-3675-103
C 801	.01 µF ±10% X7R 0603	510-3675-103
C 802	.001 µF ±10% X7R 0603	510-3675-102
C 803	.01 µF ±10% X7R 0603	510-3675-103
C 804	.01 µF ±10% X7R 0603	510-3675-103
C 805	.001 µF ±10% X7R 0603	510-3675-102
C 806	.01 µF ±10% X7R 0603	510-3675-103
C 807	2.2 pF ±.1% NPO 0603	510-3673-229
C 808	220 pF ±5% NPO 0603	510-3674-221
C 811	.01 µF ±10% X7R 0603	510-3675-103
C 812	.01 µF ±10% X7R 0603	510-3675-103
C 813	.001 µF ±10% X7R 0603	510-3675-102
C 814	.01 µF ±10% X7R 0603	510-3675-103
C 815	.001 µF ±10% X7R 0603	510-3675-102
C 816	8.2 pF ±.1% NPO 0603 (132-150 MHz)	510-3673-829
	5.6 pF ±.1% NPO 0603 (150-174 MHz)	510-3673-569
C 817	1.8 pF ±.1% NPO 0603 (132-150 MHz)	510-3673-189
	1 pF ±.1% NPO 0603 (150-174 MHz)	510-3673-100
C 821	1 µF 16V SMD tantalum	510-2625-109
C 822	.001 µF ±10% X7R 0603	510-3675-102
C 823	.01 µF ±5% X7R 1206	510-3609-103
C 824	.001 µF ±10% X7R 0603	510-3675-102
C 825	.001 µF ±10% X7R 0603	510-3675-102
C 831	100 pF ±5% NPO 0603	510-3674-101
C 832	.033 µF ±10% X7R 1206	510-3606-333
C 833	.001 µF ±10% X7R 0805	510-3605-102
C 836	.0047 µF ±10% X7R 0805	510-3605-472
C 841	.01 µF ±10% X7R 0603	510-3675-103
C 842	.001 µF ±10% X7R 0603	510-3675-102
C 843	.01 µF ±10% X7R 0603	510-3675-103
C 844	.001 µF ±10% X7R 0603	510-3675-102
C 845	.01 µF ±10% X7R 0603	510-3675-103
C 846	.001 µF ±10% X7R 0603	510-3675-102
C 847	.01 µF ±10% X7R 0603	510-3675-103
C 848	.001 µF ±10% X7R 0603	510-3675-102
C 849	.01 µF ±10% X7R 0603	510-3675-103
C 850	.001 µF ±10% X7R 0603	510-3675-102
C 851	.001 µF ±10% X7R 0603	510-3675-102
C 852	.001 µF ±10% X7R 0603	510-3675-102
C 853	7.5 pF ±.1% NPO 0603 (132-150 MHz)	510-3673-759
	5.1 pF ±.1% NPO 0603 (150-174 MHz)	510-3673-519
C 854	220 pF ±5% NPO 0603 (132-150 MHz)	510-3674-221
	470 pF ±5% NPO 0603 (150-174 MHz)	510-3674-471
C 855	3.9 pF ±0.1% NPO 0603	510-3673-399
C 856	3.9 pF ±0.1% NPO 0603	510-3673-399
C 863	100 pF ±5% NPO 0603	510-3674-101
C 865	100 pF ±5% NPO 0603	510-3674-101
C 866	1 µF 16V SMD tantalum	510-2625-109
C 871	.001 µF ±10% X7R 0603	510-3675-102
C 872	39 pF ±5% NPO 0603	510-3674-390
C 873	1.5-5 pF ceramic SMD	512-1602-001
C 874	27 pF ±5% NPO 0603	510-3674-270
C 875	68 pF ±5% NPO 0603	510-3674-680
C 876	.001 µF ±10% X7R 0603	510-3675-102
C 877	18 pF ±.1% NPO 0603	510-3673-180
C 881	.001 µF ±10% X7R 0603	510-3675-102
C 882	.01 µF ±10% X7R 0603	510-3675-103
C 883	39 pF ±5% NPO 0603 (132-150 MHz)	510-3674-390
	27 pF ±5% NPO 0603 (150-174 MHz)	510-3674-270
C 884	22 pF ±5% NPO 0603	510-3674-220
C 891	.001 µF ±10% X7R 0603	510-3675-102
C 892	18 pF ±.1% NPO 0603 (132-150 MHz)	510-3673-180
	15 pF ±.1% NPO 0603 (150-174 MHz)	510-3673-150
C 901	4.7 µF 16V SMD tantalum	510-2625-479
C 902	.01 µF ±10% X7R 0603	510-3675-103
C 903	.001 µF ±10% X7R 0603	510-3675-102
C 911	.01 µF ±10% X7R 0603	510-3675-103
C 912	.01 µF ±10% X7R 0603	510-3675-103
C 913	.01 µF ±10% X7R 0603	510-3675-103
C 914	.01 µF ±10% X7R 0603	510-3675-103
C 915	.01 µF ±10% X7R 0603	510-3675-103
C 916	5.1 pF ±.1% NPO 0603	510-3673-519
C 917	1 µF 10V SMD tantalum	510-2624-109

YMBOL UMBER	DESCRIPTION	PART NUMBER
918	330 pF ±5% NPO 0603	510-3674-331
920	.001 µF ±10% X7R 0603	510-3675-102
921	.01 µF ±10% X7R 0603	510-3675-103
R201	Switching diode SOT-23	523-1504-002
R251	Varactor BB535 SOD-323	523-5005-022
R281	Dual varactor MMBV609	523-5005-023
R282	Dual varactor MMBV609	523-5005-023
R283	Dual varactor MMBV609	523-5005-023
R284	Dual varactor MMBV609	523-5005-023
R285	Dual varactor MMBV609	523-5005-023
R561	Switch PIN diode SOT-23	523-1504-001
R562	Switch PIN diode SOT-23	523-1504-001
R591	Hot carrier diode SOT-23	523-1504-016
R592	Hot carrier diode SOT-23	523-1504-016
R851	Switch PIN diode SOT-23	523-1504-001
R852	Dual varactor MMBV609	523-5005-023
R853	Dual varactor MMBV609	523-5005-023
R854	Dual varactor MMBV609	523-5005-023
R855	Switch PIN diode SOT-23	523-1504-001
R861	Varactor BB535 SOD-323	523-5005-022
R862	Varactor BB535 SOD-323	523-5005-022
R901	Varactor BB535 SOD-323	523-5005-022
R902	Dual switch diode SOT-23	523-1504-023
111	Ferrite bead SMD	517-2503-001
200	Mini ceramic xtal pin insolator	010-0345-280
501	Ferrite bead SMD	517-2503-001
531	Ferrite bead SMD	517-2503-001
532	Ferrite bead SMD	517-2503-001
533	Ferrite bead SMD	517-2503-001
534	Ferrite bead SMD	517-2503-001
'103	4-40 machine panhead ZPS	575-1604-010
'104	Grafoil M577xx	018-1007-102
01	14-pos single row receptacle	515-7110-214
01	Jack right angle PC mount	142-0701-501
01	4.5T shielded 5mm coil (132-150 MHz)	542-1021-004
	3.5T shielded 5mm coil (150-174 MHz)	542-1021-003
02	390 nH ±10% SMD 0805	542-9003-398
03	4.5T shielded 5mm coil (132-150 MHz)	542-1021-004
	3.5T shielded 5mm coil (150-174 MHz)	542-1021-003

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
L 204	33 nH ±10% SMD inductor	542-9003-337
L 211	100 µH ±5% SMD 0805	542-9003-108
L 212	4.5T shielded 5mm coil (132-150 MHz)	542-1021-004
	3.5T shielded 5mm coil (150-174 MHz)	542-1021-003
L 213	330 nH ±10% SMD inductor (132-150 MHz)	542-9003-338
	270 nH ±10% SMD inductor (150-174 MHz)	542-9003-278
L 214	330 nH ±10% SMD inductor	542-9003-338
L 221	4.5T shielded 5mm coil (132-150 MHz)	542-1021-004
	3.5T shielded 5mm coil (150-174 MHz)	542-1021-003
L 222	330 nH ±10% SMD inductor (132-150 MHz)	542-9003-338
	270 nH ±10% SMD inductor (150-174 MHz)	542-9003-278
L 223	330 nH ±10% SMD inductor	542-9003-338
L 224	4.5T shielded 5mm coil (132-150 MHz)	542-1021-004
	3.5T shielded 5mm coil (150-174 MHz)	542-1021-003
L 231	1 µH ±6% variable inductor	542-1012-015
L 232	470 nH ±10% SMD inductor	542-9003-478
L 233	470 nH ±10% SMD inductor	542-9003-478
L 242	1 µH ±6% variable inductor	542-1012-015
L 251	1 µH ±6% variable inductor	542-1012-015
L 252	470 nH ±10% SMD inductor	542-9003-478
L 253	680 µH quad coil	542-5102-001
L 301	68 nH ±10% SMD inductor	542-9003-687
L 302	47 nH inductor LL2012 F47N (132-150 MHz)	542-9003-477
	39 nH inductor LL2012 F47N (150-174 MHz)	542-9003-397
L 501	3.9 µH SMD inductor	542-9001-399
L 511	56 nH inductor LL2012 F56N	542-9003-567
L 512	1 µH inductor SMD	542-9001-109
L 513	68 µH ±10% SMD 0805	542-9003-687
L 551	43 nH 10-turn air core SMD	542-0030-010
L 552	43 nH 10-turn air core SMD	542-0030-010
L 553	43 nH 10-turn air core SMD	542-0030-010
L 554	43 nH 10-turn air core SMD	542-0030-010
L 555	3.9 µH SMD inductor	542-9001-399
L 561	43 nH 10-turn air core SMD	542-0030-010
L 801	470 nH ±10% SMD 0805	542-9003-478
L 802	470 nH ±10% SMD 0805	542-9003-478

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
L 811	120 nH ±10% SMD 0805	542-9003-128
L 812	470 nH ±10% SMD 0805	542-9003-478
L 851	1 µH SMD inductor	542-9001-109
L 852	1 µH SMD inductor	542-9001-109
L 853	1 µH SMD inductor	542-9001-109
L 854	1 µH SMD inductor	542-9001-109
L 871	`82 nH ±10% SMD 0805	542-9003-827
L 872	18.5 nH 5T air core SMD	542-0030-005
	12.5 nH 4T air core SMD	542-0030-004
L 873	470 nH ±10% SMD 0805	542-9003-478
L 881	82 nH ±10% SMD 0805	542-9003-827
L 891	100 nH ±5% SMD 0805 (132-150 MHz)	542-9003-108
	82 nH ±10% SMD 0805 (150-174 MHz)	542-9003-827
MP101	Heat sink	014-0778-047
MP102	VHF/UHF module shield	017-2225-756
MP107	Low pass top shield	017-2225-771
MP108	Synthesizer bottom shield	017-2225-772
MP109	Driver bottom shield	017-2225-773
MP110	Low pass bottom shield	017-2225-774
MP801	VCO can	017-2225-751
PC001	PC board	035-3422-030
Q 101	NPN digital transistor	576-0013-046
Q 102	PNP digital transistor	576-0013-032
Q 121	NPN digital transistor	576-0013-046
Q 122	NPN digital transistor	576-0013-046
Q 123	PNP digital transistor	576-0013-032
Q 124	NPN high current SOT-223	576-0006-027
Q 131	NPN digital transistor	576-0013-046
Q 171	NPN digital transistor	576-0013-046
Q 172	PNP digital transistor	576-0013-032
Q 173	NPN digital transistor	576-0013-046
Q 201	PNP gen purp SC-70	576-0013-700
Q 202	NPN transmistor NE85619	576-0003-651
Q 231	PNP gen purp SC-70	576-0013-700
Q 232	NPN low noise SOT-23	576-0003-636
Q 251	NPN low noise SOT-23	576-0003-658
Q 281	PNP digital transistor	576-0013-032
Q 301	PNP gen purp SC-70	576-0013-700
Q 302	NPN low noise SOT-23	576-0003-636
Q 501	Bi-polar MMIC SOT-143	576-0003-640
Q 511	NPN low noise SOT-23	576-0003-636
Q 531	NPN high current SOT-223	576-0006-027

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
Q 801	NPN gen purp SC-70	576-0013-701
Q 841	NPN digital transistor	576-0013-046
Q 842	PNP digital transistor	576-0013-032
Q 871	NPN transmistor NE85619	576-0003-651
Q 872	NPN transmistor NE85619	576-0003-651
Q 881	PNP gen purp SC-70	576-0013-700
Q 882	NPN low noise SOT-23	576-0003-636
Q 901	NPN gen purp SC-70	576-0013-701
Q 902	VHF/UHF amp SOT-23	576-0003-634
R 102	1k ohm ±5% .063W 0603	569-0155-102
R 111	33k ohm ±5% .063W 0603	569-0155-333
R 112	10k ohm ±5% .063W 0603	569-0155-103
R 113	10k ohm ±5% .063W 0603	569-0155-103
R 114	20k ohm ±5% .063W 0603	569-0155-203
R 115	10k ohm ±5% .063W 0603	569-0155-103
R 116	150k ohm ±5% .063W 0603	569-0155-154
R 117	150k ohm ±5% .063W 0603	569-0155-154
R 121	100k ohm ±5% .063W 0603	569-0155-104
R 123	10k ohm ±5% .063W 0603	569-0155-103
R 124	470 ohm ±5% .063W 0603	569-0155-471
R 125	3.6k ohm ±5% .063W 0603	569-0155-362
R 126	5.6k ohm ±5% .063W 0603	569-0155-562
R 131	100k ohm ±5% .063W 0603	569-0155-104
R 133	51k ohm ±5% .063W 0603	569-0155-513
R 134	15k ohm ±5% .063W 0603	569-0155-153
R 141	100k ohm ±5% .063W 0603	569-0155-104
R 142	15k ohm ±5% .063W 0603	569-0155-153
R 171	10k ohm ±5% .063W 0603	569-0155-103
R 134	15k ohm ±5% .063W 0603	569-0155-153
R 201	22k ohm ±5% .063W 0603	569-0155-223
R 202	150k ohm ±5% .063W 0603	569-0155-154
R 203	22k ohm ±5% .063W 0603	569-0155-223
R 204	820 ohm ±5% .063W 0603	569-0155-821
R 205	2.2k ohm ±5% .063W 0603	569-0155-222
R 206	82 ohm ±5% .063W 0603	569-0155-820
R 226	470 ohm ±5% .063W 0603	569-0155-471
R 231	180 ohm ±5% .063W 0603	569-0155-181
R 232	22k ohm ±5% .063W 0603	569-0155-223
R 233	150k ohm ±5% .063W 0603	569-0155-154
R 234	10k ohm ±5% .063W 0603	569-0155-103
R 235	22k ohm ±5% .063W 0603	569-0155-223
R 236	18 ohm ±5% .063W 0603	569-0155-180
R 243	560 ohm ±5% .063W 0603	569-0155-561
R 253	100k ohm ±5% .063W 0603	569-0155-104
R 254	1k ohm ±5% .063W 0603	569-0155-102
R 255	39k ohm ±5% .063W 0603	569-0155-393

YMBOL UMBER	DESCRIPTION	PART NUMBER
257	100 ohm ±5% .063W 0603	569-0155-101
258	150k ohm ±5% .063W 0603	569-0155-154
259	22k ohm ±5% .063W 0603	569-0155-223
261	100 ohm ±5% .063W 0603	569-0155-101
263	68k ohm ±5% .063W 0603 (15 kHz BW only)	569-0155-683
265	8.2k ohm ±5% .063W 0603 (15 kHz BW)	569-0155-822
	18k ohm ±5% .063W 0603 (30 kHz BW)	569-0155-183
266	33k ohm ±5% .063W 0603	569-0155-333
271	3.3k ohm ±5% .063W 0603	569-0155-332
272	2.4k ohm ±5% .063W 0603	569-0155-242
274	330 ohm ±5% .063W 0603	569-0155-331
275	330 ohm ±5% .063W 0603	569-0155-331
281	100k ohm ±5% .063W 0603	569-0155-104
282	100k ohm ±5% .063W 0603	569-0155-104
283	100k ohm ±5% .063W 0603	569-0155-104
284	100k ohm ±5% .063W 0603	569-0155-104
285	100k ohm ±5% .063W 0603	569-0155-104
286	10k ohm ±5% .063W 0603	569-0155-103
301	150 ohm ±5% .063W 0603	569-0155-151
302	22k ohm ±5% .063W 0603	569-0155-223
303	150k ohm ±5% .063W 0603	569-0155-154
304	22k ohm ±5% .063W 0603	569-0155-223
305	100 ohm ±5% .063W 0603	569-0155-101
306	68 ohm ±5% .063W 0603	569-0155-680
307	100 ohm ±5% .063W 0603	569-0155-101
308	330 ohm ±5% .063W 0603	569-0155-331
501	150 ohm ±5% .063W 0603	569-0155-151
502	39 ohm ±5% .063W 0603	569-0155-390
503	150 ohm ±5% .063W 0603	569-0155-151
504	470 ohm ±5% .063W 0603	569-0155-471
505	470 ohm ±5% .063W 0603	569-0155-471
511	4.7k ohm ±5% .063W 0603	569-0155-472
512	1.8k ohm ±5% .063W 0603	569-0155-182
513	10 ohm ±5% .063W 0603	569-0155-100
514	560 ohm ±5% .063W 0603	569-0155-561
515	100 ohm ±5% .063W 0603	569-0155-101
531	120 ohm ±5% 1206 SMD	569-0115-121
532	120 ohm ±5% 1206 SMD	569-0115-121
533	470 ohm ±5% .063W 0603	569-0155-471
534	100k ohm ±5% .063W 0603	569-0155-104
535	100k ohm SMD trimmer	562-0130-104
536	10k ohm ±5% .063W 0603	569-0155-103
561	100 ohm ±5% .063W 0603	569-0155-101
565	47k ohm ±5% .063W 0603	569-0155-473

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 573	10k ohm ±5% .063W 0603	569-0155-103
R 574	10k ohm ±5% .063W 0603	569-0155-103
R 581	10 ohm ±5% .063W 0603	569-0155-100
R 582	10k ohm ±5% .063W 0603	569-0155-103
R 583	10k ohm ±5% .063W 0603	569-0155-103
R 584	10 ohm ±5% .063W 0603	569-0155-100
R 585	10k ohm ±5% .063W 0603	569-0155-103
R 586	10k ohm ±5% .063W 0603	569-0155-103
R 591	51 ohm ±5% .063W 0603	569-0155-510
R 592	1k ohm ±5% .063W 0603	569-0155-102
R 593	51 ohm ±5% .063W 0603	569-0155-510
R 594	1k ohm ±5% .063W 0603	569-0155-102
R 802	20 ohm ±5% .063W 0603	569-0155-200
R 803	4.7k ohm ±5% .063W 0603	569-0155-472
R 804	10k ohm ±5% .063W 0603	569-0155-103
R 805	10k ohm SMD trimmer	562-0130-103
R 806	33k ohm ±5% .063W 0603	569-0155-333
R 807	27k ohm ±5% .063W 0603	569-0155-273
R 808	22k ohm ±5% .063W 0603	569-0155-223
R 811	4.7k ohm ±5% .063W 0603	569-0155-472
R 812	6.8k ohm ±5% .063W 0603	569-0155-682
R 813	4.7k ohm ±5% .063W 0603	569-0155-472
R 814	6.8k ohm ±5% .063W 0603	569-0155-682
R 815	4.7k ohm ±5% .063W 0603	569-0155-472
R 816	6.8k ohm ±5% .063W 0603	569-0155-682
R 817	4.7k ohm ±5% .063W 0603	569-0155-472
R 821	39k ohm ±5% .063W 0603	569-0155-393
R 822	11k ohm ±5% .063W 0603	569-0155-113
R 823	20k ohm SMD trimmer	562-0130-203
R 824	33k ohm ±5% .063W 0603	569-0155-333
R 825	100k ohm SMD trimmer	562-0130-104
R 826	10k ohm ±5% .063W 0603	569-0155-103
R 827	220k ohm SMD trimmer	562-0130-224
R 828	120k ohm ±5% .063W 0603	569-0155-124
R 829	100k ohm ±5% .063W 0603	569-0155-104
R 831	10 ohm ±5% .063W 0603	569-0155-100
R 832	22k ohm ±5% .063W 0603	569-0155-223
R 838	10k ohm ±5% .063W 0603	569-0155-103
R 841	10k ohm ±5% .063W 0603	569-0155-103
R 842	100 ohm ±5% .063W 0603	569-0155-101
R 843	1.5k ohm ±5% .063W 0603	569-0155-152
R 844	270k ohm ±5% .063W 0603	569-0155-274
R 845	33k ohm ±5% .063W 0603	569-0155-333
R 846	33k ohm ±5% .063W 0603	569-0155-333
R 847	10k ohm ±5% .063W 0603	569-0155-103
R 851	10k ohm ±5% .063W 0603	569-0155-103
R 852	1.5k ohm ±5% .063W 0603	569-0155-152

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 861	47k ohm ±5% .063W 0603	569-0155-473
R 862	47k ohm ±5% .063W 0603	569-0155-473
R 863	1k ohm ±5% .063W 0603	569-0155-102
R 871	10 ohm ±5% .063W 0603	569-0155-100
R 872	1k ohm ±5% .063W 0603	569-0155-102
R 873	6.8k ohm ±5% .063W 0603	569-0155-682
R 874	10k ohm ±5% .063W 0603	569-0155-103
R 875	10k ohm ±5% .063W 0603	569-0155-103
R 876	390 ohm ±5% .063W 0603	569-0155-391
R 881	270 ohm ±5% .063W 0603	569-0155-271
R 882	22k ohm ±5% .063W 0603	569-0155-223
R 883	150k ohm ±5% .063W 0603	569-0155-154
R 884	22k ohm ±5% .063W 0603	569-0155-223
R 885	18 ohm ±5% .063W 0603	569-0155-180
R 886	18 ohm ±5% .063W 0603	569-0155-180
R 887	18 ohm ±5% .063W 0603	569-0155-180
R 891	1k ohm ±5% .063W 0603	569-0155-102
R 892	18 ohm ±5% .063W 0603	569-0155-180
R 893	18 ohm ±5% .063W 0603	569-0155-180
R 894	18 ohm ±5% .063W 0603	569-0155-180
R 901	4.7k ohm ±5% .063W 0603	569-0155-472
R 911	10k ohm ±5% .063W 0603	569-0155-103
R 912	10k ohm ±5% .063W 0603	569-0155-103
R 913	22k ohm ±5% .063W 0603	569-0155-223
R 914	3.9k ohm ±5% .063W 0603	569-0155-392
R 915	330 ohm ±5% .063W 0603	569-0155-331
R 916	2k ohm ±5% .063W 0603	569-0155-202
R 917	15k ohm ±5% .063W 0603	569-0155-153
R 918	10 ohm ±5% .063W 0603	569-0155-100
R 920	100k ohm SMD trimmer	562-0130-104
U 111	Quad op amp LMC660	544-2020-020
U 131	Voltage regulator adjustable	544-2603-093
U 141	Voltage regulator adjustable	544-2603-093
U 241	FM IF SA676DK	544-2002-037
U 531	5W RF power module (132-150 MHz)	544-4001-061
	5W RF power module (150-174 MHz)	544-4001-062
U 581	Op amp SO-8 MC33172D	544-2019-017
U 801	Single op amp SOT-23-5	544-2016-001
U 811	Fractional-N synthesizer	544-3954-027
U 831	Op amp SO-8 MC33172D	544-2019-017
U 911	Quad 8-bit TLC5620ID	544-2031-014
U 912	8-stage shift register SOIC	544-3016-094
U 913	Triple 2-chnl mux/demux	544-3016-053

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
Y 801	14.85 MHz TCXO ±2.5 PPM	518-7009-525
Z 231	21.45 MHz 4-pole 8 kHz BW (15 kHz BW)	532-0009-020
	21.45 MHz 4-pole 15 kHz BW (132-150 MHz 30 kHz BW)	532-0009-019
Z 232	21.45 MHz 4-pole 8 kHz BW (15 kHz BW)	532-0009-020
	21.45 MHz 4-pole 15 kHz BW (30 kHz BW)	532-0009-019
Z 241	450 kHz 9 kHz BW ceramic (15 kHz BW)	532-2004-015
	450 kHz 20 kHz BW ceramic (132-150 MHz 30 kHz BW)	532-2004-013
Z 242	450 kHz 9 kHz BW ceramic (15 kHz BW)	532-2004-015
	450 kHz 20 kHz BW ceramic (132-150 MHz 30 kHz BW)	532-2004-013

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DL3286 4-LEVEL 9600 Bps MODEM
SERVICE MANUAL

3286 9600 / 4800 BPS PROGRAMMABLE 4-LEVEL FSK MODEM
PART NO. 242-40VW-WYZ

The Johnson Data Telemetry Corporation designs and manufactures radios and radio modems to serve a wide variety of data communication needs. The Johnson Data Telemetry Corporation produces equipment for the fixed data market including SCADA systems for utilities, petrochemical, waste and fresh water management markets and RF boards for OEM applications in the Radio Frequency Data Capture market.

JOHNSON DATA TELEMETRY PRODUCT WARRANTY

The manufacturer's warranty statement for this product is available from your product supplier or from the Johnson Data Telemetry Corporation, 299 Johnson Avenue, PO Box 1733, Waseca, MN 56093-0833. Phone (507) 835-8819.

WARNING

This device complies with Part 15 of the FCC rules. Operation is subject to the condition that this device does not cause harmful interference. In addition, changes or modification to this equipment not expressly approved by Johnson Data Telemetry Corporation could void the user's authority to operate this equipment (FCC rules, 47CFR Part 15.19).

DO NOT allow the antenna to come close to or touch, the eyes, face, or any exposed body parts while the radio is transmitting.

DO NOT operate the radio near electrical blasting caps or in an explosive atmosphere.

DO NOT operate the radio unless all the radio frequency connectors are secure and any open connectors are properly terminated.

DO NOT allow children to operate transmitter equipped radio equipment.

SAFETY INFORMATION

Proper operation of this radio will result in user exposure below the Occupational Safety and Health Act and Federal Communication Commission limits.

The information in this document is subject to change without notice.

DATA TELEMETRY Johnson
A Dataradio Company

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SECTION 1

GENERAL INFORMATION

1.1 SCOPE OF MANUAL

1.1.1 INTRODUCTION

This manual contains setup and service information for the Johnson Data Telemetry (JDT) DL-3286 Telemetry Modem. For servicing information on the 3400-series telemetry radios which may be used with this modem, refer to the specific transceiver service manual.

1.2 MODEM DESCRIPTION

1.2.1 GENERAL

The function of a modem is to convert digital data to an analog signal which can be used to modulate an RF carrier. The modem also converts the received signal back into its original digital data. This allow digital data to be transferred using a wireless RF link.

1.2.2 DL-3412, DL-3422 or DL-3492

When the JDT 3286 modem is paired with a DL-3412, DL-3422 or DL-3492, the radio modem covers the full UHF band at 25 kHz, 12.5 kHz and 6.25 kHz channel steps and the full VHF band at 30 kHz, 15 kHz and 7.5 kHz channel steps. This modem uses a 4-Level Root-Raised Cosine FSK modulation scheme. It operates in a half-duplex configuration and has the capability to be set up in a repeater mode.The DL-3286 modem is capable of packetized and non-packetized data.The DL3286 supports Flow Control (FEC), DCE/DTE (FEC), DCE/DTE (No FEC), Data only (FEC), and Data-only (no FCE) protocols.

The 3286 is capable of sending and receiving data at two different speeds. This can be used selectively to change to the lower speed (if necessary). The half-channel modem has a high speed of 9600 bps and a low speed of 4800 bps.

Front panel LEDs provide visual indication for transmit, receive and power. Set-up software uses a Windows® Program and includes network diagnostics capable of showing the number of packets sent, number of packets received, data reception quality and CRC packet errors. Programming set-up provides a unique programming ID that allows diagnostics to be reported both locally and "over-the-air" from any location.

Built-in radio diagnostics are capable of reporting specific unit programming, loop back testing and radio performance statistics (i.e. RSSI, temperature, supply voltage, current, internal supply voltages, and transmitter power).

1.3 ACCESSORIES

Accessories available for the 3286 Modem are listed in Table 1-1. To order accessories by phone, dial the toll-free number and enter "3" (see Section 1.4). The Sales Fax number is 507-835-6648 or orders may be sent by mail (see JDT address in Section 1.4).

Table 1-1 ACCESSORIES

Description	Part No.
Setup and Diagnostic software with Modem Programming/Power Cable, 4' long DB-9 male to DB-9 female	
Power Interconnect Cable	023-3472-004
3286 Service Manual	001-3286-001
3412 Service Manual	001-3412-002
3422 Service Manual	001-3422-001
3492 Service Manual	001-3492-001

1.4 FACTORY CUSTOMER SERVICE

The Customer Service Department of the Johnson Data Telemetry Corporation provides customer assistance on technical problems and serves as an interface with factory repair facilities. Customer Service hours are 7:30 a.m. - 4:30 p.m. Central Time, Monday - Friday. In the continental United States, the Technical Service Department can be reached at this toll-free number:

1-800-992-7774

When your call is answered at the Johnson Data Telemetry Corporation, you will hear a brief message that contains the options: 1 for Sales, 2 for Order Entry, 3 for Customer Service, 4 for Marketing, 7 for other issues or 9 to repeat the message. If you have a pulse-type telephone, wait until the message is finished and an operator will come on the line to assist you.

With a touch-tone type telephone, you may also enter the 4-digit extension number of the person that you want to reach if you know what it is.If you are calling from outside the continental United States, the Customer Service telephone numbers are as follows:

Customer Service Department - (507) 835-6911
Customer Service FAX Machine - (507) 835-6969

You can contact the Customer Service Department by mail. Please include all information that may help solve your problem. The mailing address is:

Johnson Data Telemetry Corporation
Customer Service Department
299 Johnson Avenue
P.O. Box 1733
Waseca, MN 56093-0833

JDT has an email address for customer general support:

support@johnsondata.com

1.5 PRODUCT WARRANTY

The warranty statement for this modem is available from the Warranty Department at JDT (see address or telephone number in Section 1.4. The Warranty Department can be contacted for Warranty Service Reports, claim forms, or any questions concerning warranties or warranty service.

1.6 REPLACEMENT PARTS

To obtain replacement parts for the DL-3286 Modem, contact the Service Parts Department at the address or dial the toll-free number listed in the previous section.

1.7 IF A PROBLEM ARISES...

Johnson Data Telemetry products are designed for long life and failure-free operation. If a problem arises, factory service is available. Contact the Customer Service Department before returning equipment. A service representative may suggest a solution eliminating the need to return equipment.

1.7.1 FACTORY REPAIR

Component level field repair is not recommended on the 3286 modem. Surface mount technology is used to install many components. Those components require specialized training and equipment to service. JDT's factory is best equipped to diagnose problems and make repairs.

When returning equipment for repair, fill out a Factory Repair Request Form for each unit to be repaired regardless of warranty status. These forms are available free of charge by calling Customer Service (see Section 1.4.) Describe the problem in the space provided and note any prior physical damage to the equipment. Include a form in the shipping container with each unit. Your telephone number and contact name are **important**. There are times when technicians have specific questions that need to be answered in order to identify the problem and repair the equipment.

When returning equipment for repair, use a reference number on your paperwork in case you need to call Customer Service about your unit. That number is referenced on the repair order to make it easier to locate your unit in the lab.

Return Authorization (RA) numbers are not necessary unless you have been iven one by the Customer Service Department. They require RA numbers for exchange units or if they want to be aware of a specific problem. If you have been given an RA number, reference this number on the Factory Repair Request From sent with the unit. The repair lab will contact the Customer Service Department when the unit arrives.

DL-3286 SPECIFICATIONS

The following are general specifications intended for use in testing and servicing this Modem. For current advertised specifications, refer to the specification sheet available from the Marketing Department. Specifications are subject to change without notice.

GENERAL

Dimensions	
3412/22/92	4.2" L x 3.25" W x 2.175" H
Operating Voltage	10-16V DC
Current Drain	
3412/22/92	2100 mA TX, 120 mA RX
Operating Mode	Half-Duplex
Front Panel Indicators	PWR, TX, RX
Data I/O Connector	DB9 to female
Time-Out Timer	Variable second switchable on/off
Diagnostics	Configuration, test performance statistics
Power Connector	2 pin connector

DATA I/O

Data Rate	4800 or 9600 bps (user selectable)
Signal Level	EIA RS-232
Data Format	Asynchronous, serial
Word Length	8 bit words, 1 or 2 stop bits
Parity	Even, odd, or none
Handshake	RTS-CTS/Data Only/Flow Control
Turnaround Time	RTS-CTS delay*:

Bps	Normal Delay	Extended (Rptr) Delay
4800	30ms	60ms
9600	30ms	60ms

*Times are extended 10ms if online diagnostics are enabled.

NETWORK SPECIFICATIONS

Modulation	4 Level Root-raised cosine, FSK packet
Communication Mode	Serial synchronous
BER	0 at -101 dBm

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SECTION 2

SET UP AND ALIGNMENT

2.1 GENERAL

2.1.1 INTRODUCTION

This section contains set-up and alignment for the Johnson Data Telemetry (JDT) DL3286 Modem. For servicing information on the 3400-series telemetry radios which may be used with this modem, refer to the specific transceiver service manual.

2.2 SET UP

2.2.1 GENERAL

The 3286 Modem is factory aligned and should not require adjustment in the field. The following procedure describes adjustments (if settings other than those set in the factory are desired.)

2.2.2 EQUIPMENT REQUIRED

- +10 to +16V adjustable, regulated 2.5 amp supply
- Radio service monitor (IFR or equivalent)
- Cable with SMA connector (modem to IFR)
- An IBM compatible PC (running Windows® 3.11 or later)
- Radio Service software (RSS)
- RSS setup cable (DB-9 - DB-9 male to female)
- common alignment tools
- Power cable (Part number 023-3472-004)

2.2.3 ADJUSTMENTS

There are 4 adjustments on the DL-3286 modem.

- 8 Position DIP Switch S100
- Transmit Deviation Level Adjustment
- Receive Level Adjusment
- 2.5 VDC Level Adjustment

2.2.4 8 POSITION DIP SWITCH S100

The first 3 DIP switches (1 - 3) are for selecting the desired channel (Table 2-1). The last DIP switch (8) is for putting the modem into setup mode (Table 2-2). For more information on programming channels see Section 3.

Table 2-1 Channel Selection

CHANNEL	3	2	1
1	OFF	OFF	OFF
2	OFF	OFF	ON
3	OFF	ON	OFF
4	OFF	ON	ON
5	ON	OFF	OFF
6	ON	OFF	ON
7	ON	ON	OFF
8	ON	ON	ON

Table 2-2 Setup Mode

	8
Setup Mode	ON
Operating Mode	OFF

2.2.5 TRANSMIT DEVIATION LEVEL ADJUSTMENT

From the Production Test Screen of the 3286 Programmer Software select Random Data for TX Mode (see Figure 2-1.) Hit the F5 key on the PC keyboard to key the transmitter. Adjust R508 to set the transmitter deviation for 1.5 kHz (see Figure 2.2.)

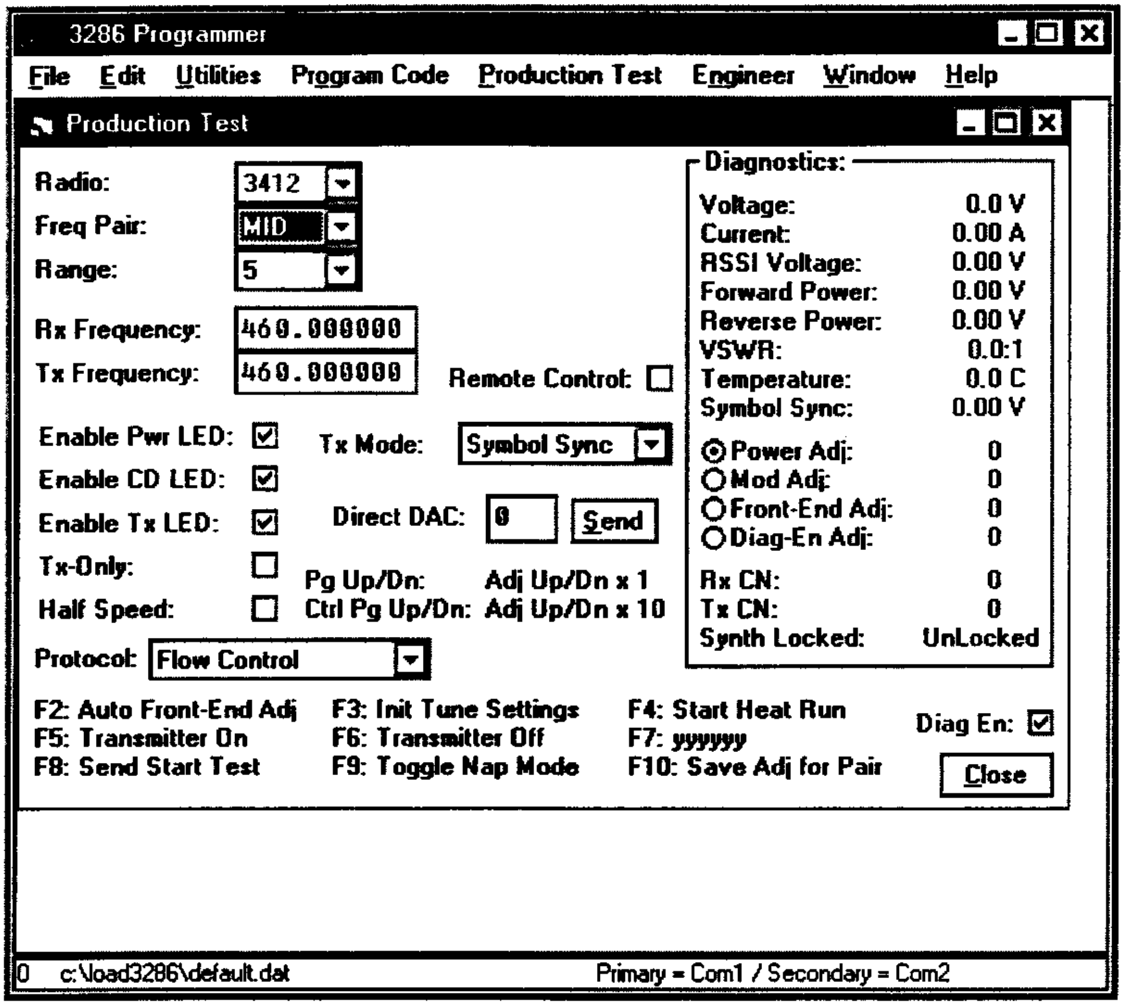

Figure 2-1 3286 Programming Software Screen

2.2.6 RECEIVE LEVEL ADJUSTMENT

Input a -80 dBm signal on frequency into the RF transceiver modulated with a 1.2 kHz sine wave with 1.5 kHz of deviation. Monitor the recovered audio at TP 400 (see Fig. 2-2.) Adjust 410 for 1Vp-p (354 mVrms.)

2.2.7 2.5 VDC LEVEL ADJUSTMENT

Adjust R 632 for 2.5 VDC at TP 600 (see Fig. 2-2.)

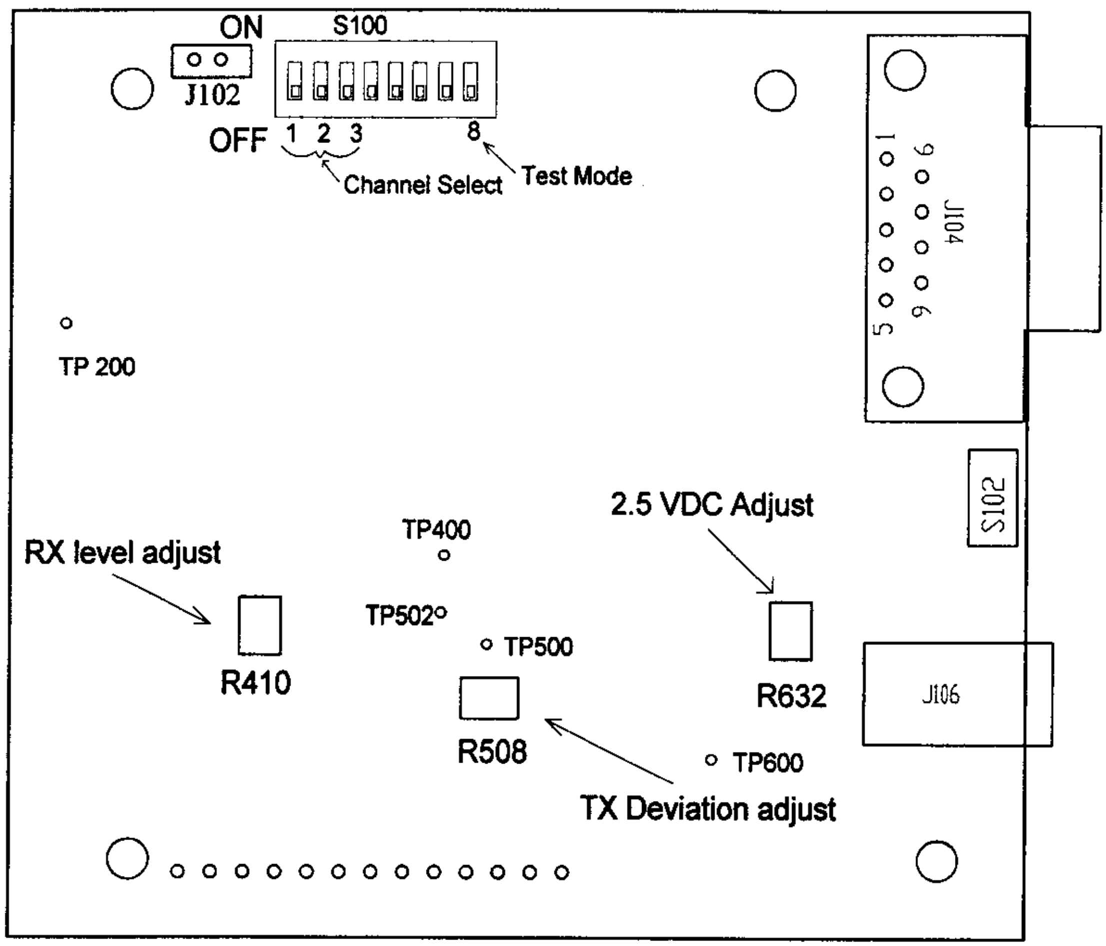

Figure 2-2 3286 Modem Board

SECTION 3

PROGRAMMING

3.1 GENERAL

3.1.1 INTRODUCTION

This section describes the use of the DL3286 Programming software. The programming parameters are factory installed with default parameters. Programming information is stored in an EEPROM in the modem's microprocessor. Desired, radio parameters, frequency and file changes are made using the 3286 Programming software (part number 023-9998-001) and the programming/power cable (part number 023-3286- .) This information is designed for use by personnel familiar with normal radio shop procedures.

3.1.2 3286 PROGRAMMING OPERATION

The 3286 programming software operates in a Windows® environment. When the 3286 program is run, a blank window appears with the menu options:

- File
- Edit
- Utilities
- Program Code
- Production Test
- Engineer
- Window
- Help

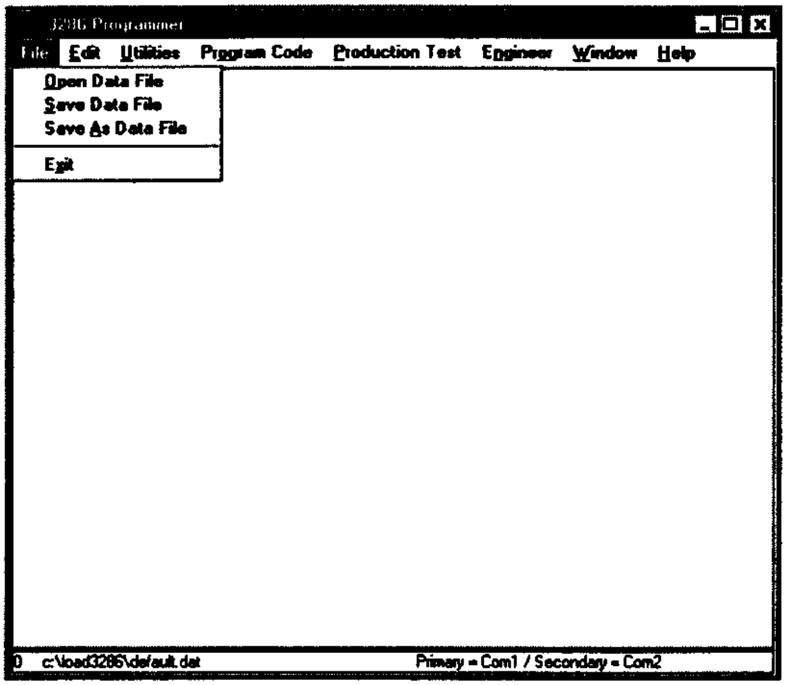

Figure 3-1 Main Window

3.2 3286 WINDOWS

This window provides access to pull-down menu options.

3.2.1 FILE

Data files contain the information for frequency programming and allow the user to install previously defined configurations. Data file menu choices include

- Open Data File - Opens a data file to be used in the Edit Frequencies menu
- Save Data File - Saves the current data file with the current data file name
- Save As Data File - Saves a data file with a new file name
- Exit - Exits the 3286 programming software

3.2.2 EDIT

The Edit menu is used to used to create new files and setup or change radio parameters, frequency range and channel spacing.

- Radio Type - Toggles through the available radio types (3412, 3422, 3492)

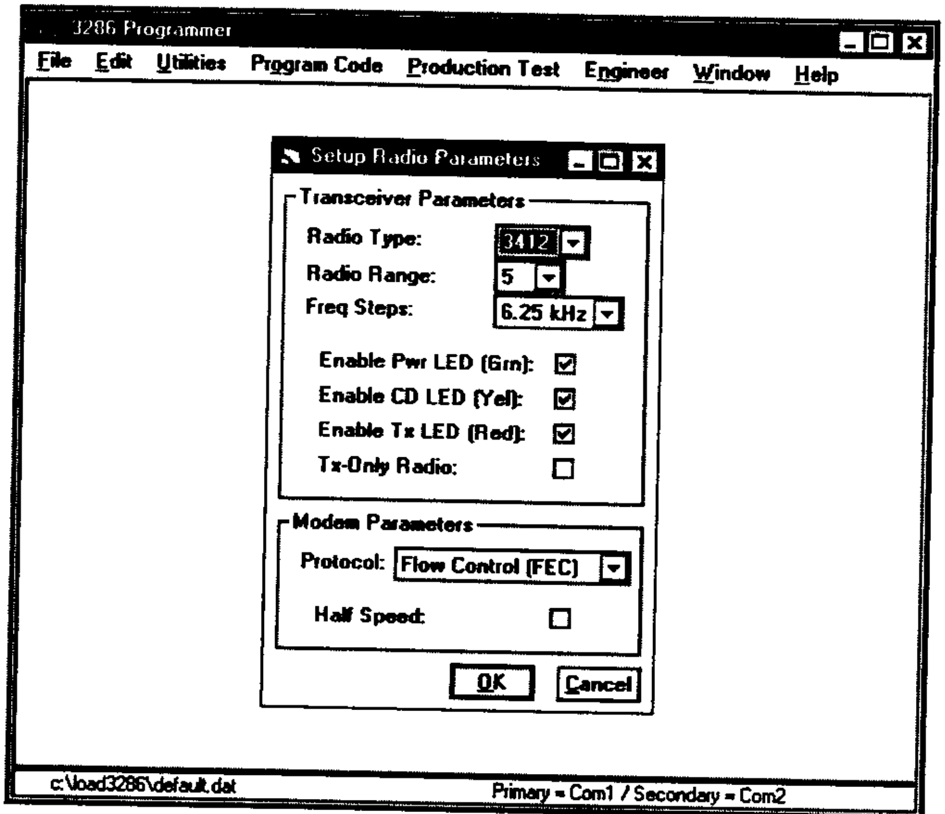

Figure 3-2 Edit Radio Types Window

- Radio Range - Toggles through the frequency ranges 1 - 8 (see Table 3-1 for available JDT transceivers for different frequency ranges)

Table 3-1 Radio Type/Frequency Range

Frequency Range	3412	3422	3492
1	380-403 MHz		
2	403-419 MHz		
3	419-435 MHz		
4	435-451 MHz	132-150 MHz	
5	450-470 MHz	150-174 MHz	928-960 MHz
6	464-480 MHz		
7	480-496 MHz		
8	496-512 MHz		

- Frequency Steps - Toggles through frequency step sizes 2.5 kHz, 5 kHz, 6.25 kHz, and 7.5 kHz

  NOTE: Frequency step size will not effect the functionality of the transceiver/modem. This is just a check for the user to verify the selected frequency is the desired step size.

  Example: If the user is operating on a 6.25 kHz system and enters a 7.5 kHz frequency, an error message will be displayed but the 3286 software will load the 7.5 kHz frequency into the transceiver.

- LED Functions - There are three LEDs on the 3286 modem. When there is power to the modem, the Power LED (green) will be lit. When the receiver is receiving a carrier, the CD LET (yellow) will be lit. When the transmitter is transmitting a signal, the TX LED (red) will be lit. These LEDs can be enabled by clicking next to each one (see Figure 3-2.)

  TX Only - When the TX Only is enabled, the receiver is disabled. When a transmit only radio is used this function should be enabled.

- Protocol - Selects the protocol between the computer and the modem. The protocol formats that are available include Flow Control (FEC - Forward Error Correction), DCE/DTE (FEC), DCE/DET (no FEC), Data Only (FEC), and Data Only (no FEC).

- Half-Speed - Selects the RF wireless link speed; not the PC to modem link

  Half-Speed enabled = 4800 bps
  Half-speed not enabled = 9600 bps

3.2.3 EDIT FREQUENCIES WINDOW

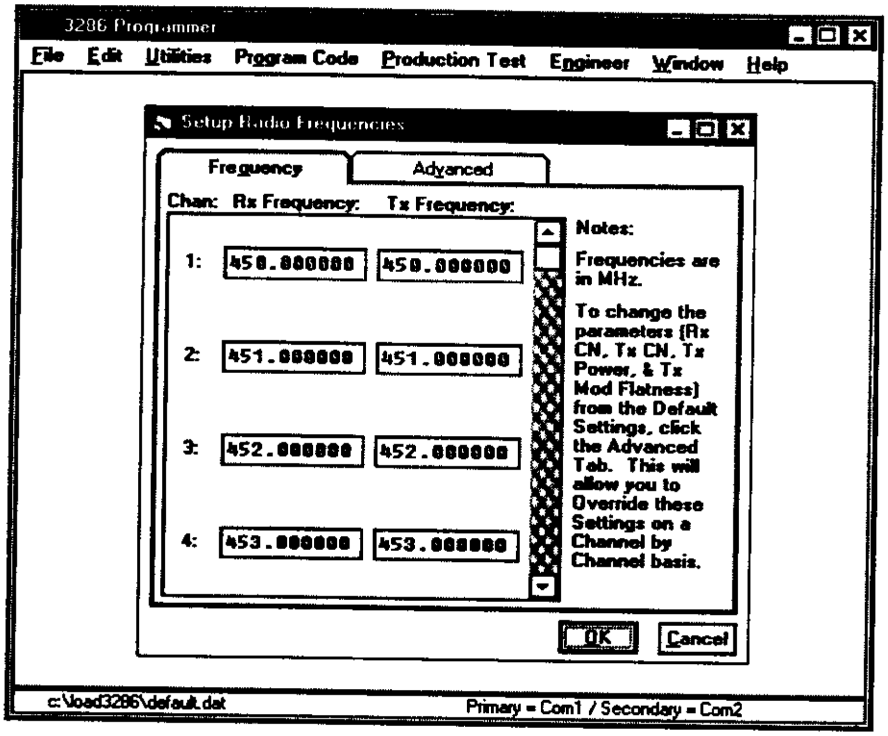

Figure 3-3 Edit Frequencies Window

- Receive and Transmit Frequencies - There are a maximum of 8 pairs of channels (8 Rx and 8 Tx) that can be programmed into the modem. Channel frequencies can be copied from one channel to another by double clicking on the desired frequency, holding the right mouse button, dragging and dropping the data to the channel to be changed.

The Tx CN, Rx CN, Tx Power, and Tx Mod values are all set to factory settings. To override the factory settings, click on Override and type in the new CN numbers. After all the parameters are set up, the data file can be saved using the File pull-down menu and selecting Save Data File or Save As Data File (see Section 3.2.1.)

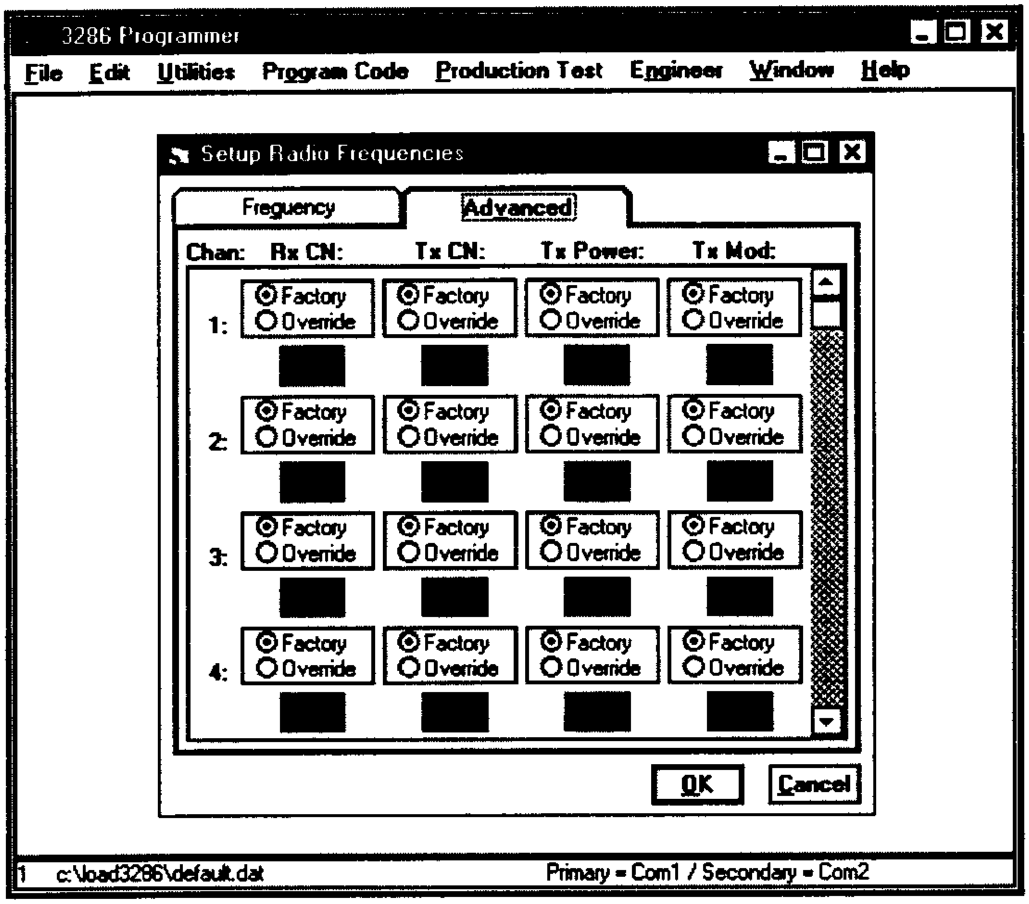

Figure 3-4 Advanced Radio Frequencies Window

- Version Request - Reports the current version of software downloaded to the 3286
- Write or Read Parameters - Write sends the open data file to the 3286 modem. Read retrieves the current data file from the modem. Before a Read or Write Parameters is executed, press S102 (see Section 2, Figure 2-2) to put the modem into setup mode. After the parameters are sent or received, the power to the modem must be cycled to place the modem back in normal operation so the data transfer can be completed.
- Cut - Deletes selected text and copies it to the PC's clipboard
- Copy - Copies selected text to the PC's clipboard
- Paste - Pastes text stored in the PC's clipboard

3.2.4 UTILITIES

- Communication Settings - Sets parameters for Com Port and Baud Rate for communication between the PC and the modem. Sets parameters for primary and secondary receive and transmit modes.

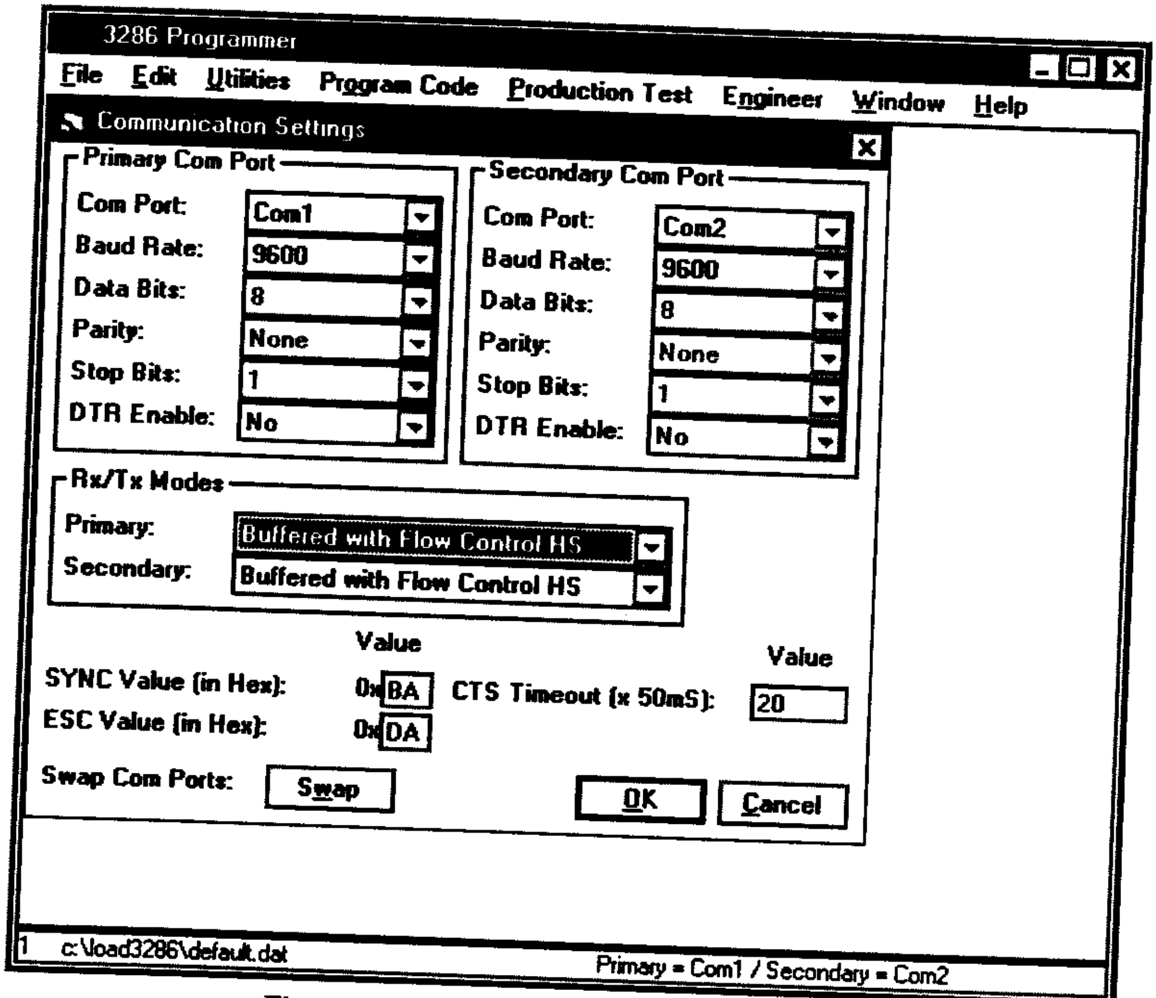

Figure 3-5 Communication Settings Window

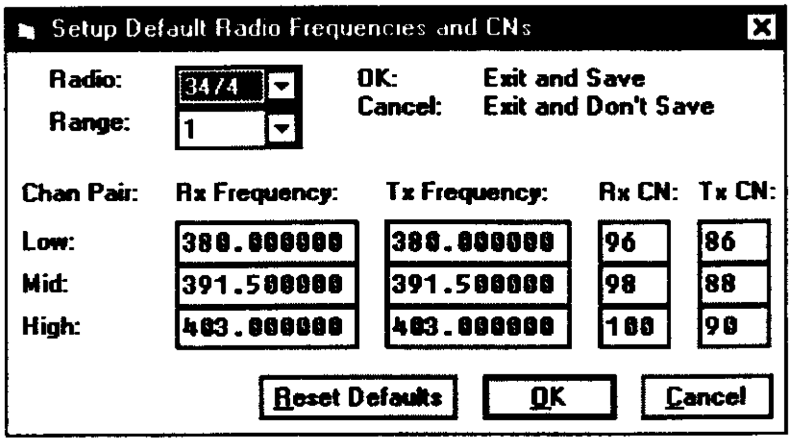

Figure 3-6 Edit Radio Specifications Window

- Edit Radio Specs - Resets default radio frequencies.

3.2.5 PROGRAM CODE

- Program Code - To install a new version of firmware, the modem must be taken out of it's case. Short the two pins of J102 and cycle power (see Section 2, Figure 2-2).
- Boot File change / Modem File Change - These functions are used only if the Boot Code needs to be changed or a new Modem Code is to be installed into Flash memory.

3.2.6 PRODUCTION TEST

This window allows initial setup of transceivers and displays diagnostics information for Temperature, RSSI, voltage, current internal supply voltage, transmitter power, VSWR, Symbol Sync.Rx CN, Tx CN, Synth locked, and adjust for Power, Mod., Front-End, and Diag. En (see Figure 3-7.)

Parameters setup in this window are for temporary purposes. When the Production Test window is closed these parameters are lost. For permanent data settings, use the Edit Radio Specs. under the Edit pull-down menu. Before any functions under the Production Test pull-down menu can be executed, press S102 (see Section 2, Figure 2-2) to put the modem in setup mode. When production testing is completed, power to the modem must be cycled to place the modem in normal operation mode to complete data transfer.

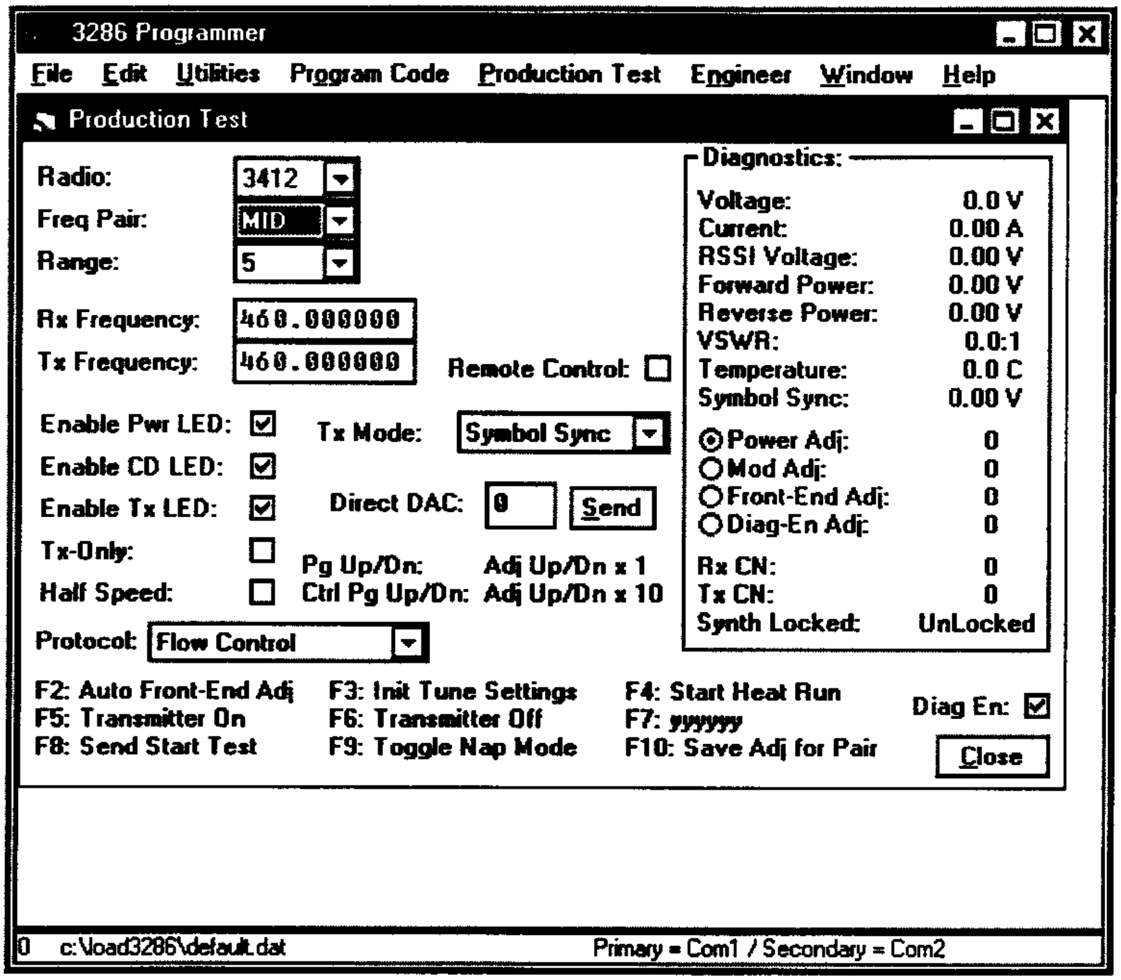

Figure 3-7 Production Test Window

- Tx Only - Disables the receiver. Must be selected when a transmit only radio is used.
- Half Speed - Selects the RF wireless link speed (NOT the PC to modem link)

Half-speed enabled = 4800 Bps
Half-speed not enabled = 9600 Bps

- Tx Mode

Table 3-2 Tx Modes

Tx Mode	Description
Symbol Sync	Carrier is modulated with sine wave Full-Speed 1.2 kHz sine wave Half-Speed 600 Hz sine wave
Random Data	Carrier is modulated with random data
Test Data	Carrier is modulated with test data
Square Wave	Carrier is modulated with a 100 Hz square
No Modulation	Carrier tone with no modulation

- Diag. En - Enables diagnostics
- Protocol - Selects the protocol between the PC and modem. The available protocols are Flow Control (FEC), DCE/DTE (FEC), DCE/DTE (no FEC), Data Only (FEC), and Data Only (no FEC)
- Radio - Toggles through compatible radio types (3412, 3422, 3492)
- Range - Toggles through the frequency ranges (1 - 8) See Section 1, Table 1-1 for JDT transceivers available for individual frequency ranges.
- LED Functions - There are three LED's on the 3286 modem. When power is applied to the modem, the Power (green) LED will be lit. When the receiver detects a signal, the CD LED (yellow) will be lit. When the transmitter is sending a signal, the Tx LED (red) will be lit. These LEDs are enabled by clicking in the box.
- Tx Only - Disables the receiver. Must be selected when a transmit only radio is used.
- Half Speed - Selects the RF wireless link speed (NOT the PC to modem link)

Half-speed enabled = 4800 Bps
Half-speed not enabled = 9600 Bps

3.2.7 SETUP PRODUCTION FREQUENCIES

Some of the same functions appear in the Edit Frequencies window as in the Edit Radio Specs. window (see Figures 3-6 and 3-8).

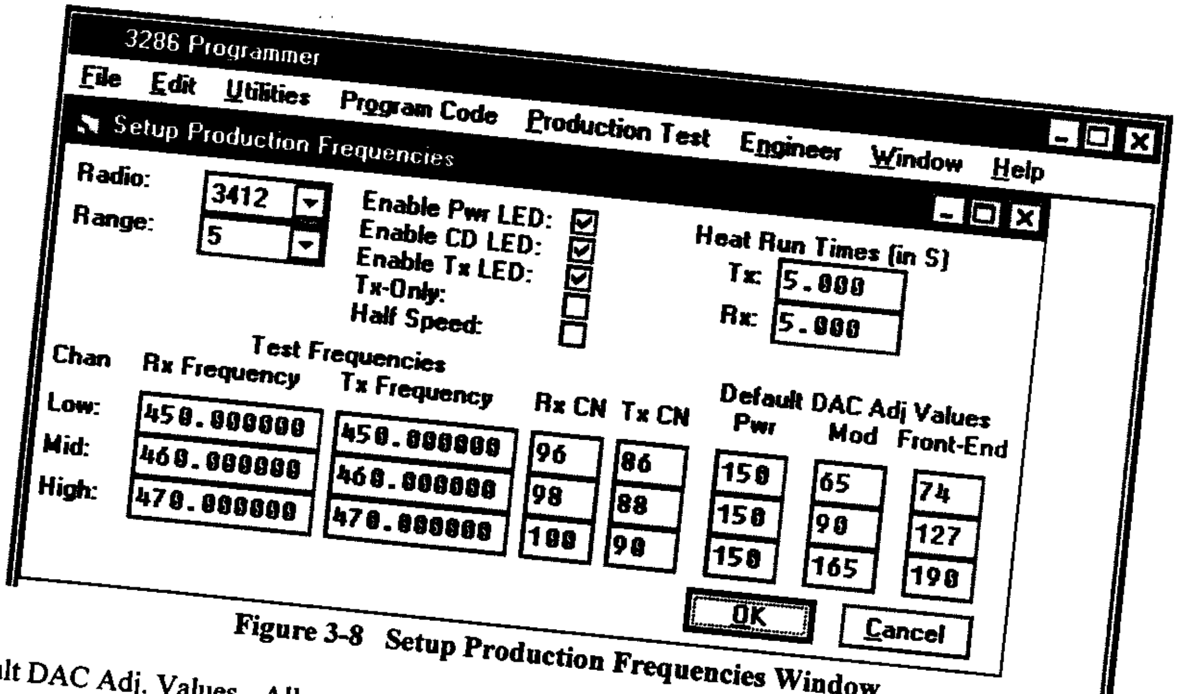

Figure 3-8 Setup Production Frequencies Window

- Default DAC Adj. Values - Allows temporary changes to Power Adj., Mod Adj., and Front-End Adj.To change values, click next to the parameter and enter a new DAC value. Select OK to temporarily send new parameter to the modem. If the Test Freq. pair is changed or the Production Test window is closed, the DAC values will return to their original settings. Parameters may be permanently stored by pressing F10.

3.2.8 F KEY FUNCTIONS

Table 3-3 F Key Functions

F Key	Function	Description
F2	Auto Front-End Adjust	Automatically tunes front end filters of receiver (tunable front-end currently available on DL-3422)
F3	Initial Tune Settings	Sends default settings to modem for Tx CN, Rx CN, Tx Pwr, and Tx Mod.
F4	No function	
F5	Transmitter ON	Keys transmitter
F6	Transmitter OFF	Unkeys transmitter
F7	No function	
F8	Send Start Test	Puts modem into test mode
F9	Toggle Nap Mode	Puts the modem/transceiver into a low current sleep
F10	Save adj. for pair	Permanently saves current DAC values to modem

3.2.9 TEST FILE

Test files contain the information for frequency programming along with the CN, Power Adjust, Mod. AdjUst, and front end tuning (if applicable.)

- Open Test File - Opens a data file for use in the Production Test or Edit Frequencies menu
- Save Test File - Saves the current data file with the current data file name
- Save As Test File - Saves a data file with a new file name

3.2.10 ENGINEER

This window offers the same options as the Production Test Window as well as the option to make frequency changes.

3.2.11 WINDOW

The pull-down window menu allows the user to set screen display preferences for Cascade, Tile Horizontally, Tile Vertically or Arranging Icons.

SECTION 4

3286 PROTOCOL

4.1 INTRODUCTION

4.1.1 GENERAL

The specifications is Section 4 describe the requirements for the DL-3286, a 9600 bps half-channel or 19200 full-channel 4-level FSK Modem.

4.2 RTU INTERFACE

4.2.1 INTERFACE DESCRIPTION

The RTU Interface is an RS232 connection. The data format will be 8 data bits, 1 start bit, 1 stop bit and no parity. The baud rate is programmable (19200 / 9600 / 4800 baud) with the 3286 Setup Software (a Windows® based program.) While in the setup mode, the modem uses 9600 baud.

The Modem and the RTU uses either a Flow Control protocol or an RTS/CTS Handshaking protocol.

4.2.2 FLOW CONTROL PROTOCOL

When the Flow Control protocol is used, the modem will send packetized data containing Forward Error Correction (FEC) information. With this protocol, the Modem can be programmed to expect an ACK or NACK for each packet sent, or the modem can packetize the data and send as is. The CTS output of the Modem signals the RTU when it can transmit characters and when it should not transmit characters. When the CTS is high (asserted), the Modem's receive buffer IS NOT full. When the CTS is low (unasserted), the Modem's receive buffer IS full. This is the default protocol since it sends data in packets and utilizes Forward Error Correction.

This protocol can be used by users sending small packets (less than xx characters) who do not want to deal with the RTS and CTS signals. the following figures show the Flow Control protocol. Figure 4.1.1 shows the CTS signal controlling the flow of data from the RTU. Figure 4.1.2 shows how a small packet (less than xx characters) would not even use the CTS signal, since there were not enough characters to fill the receive buffer.

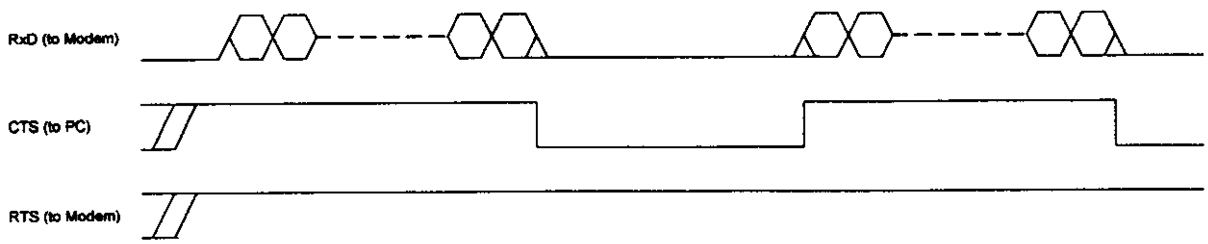

Figure 4-1 RTU Data Controlled by CTS Signal

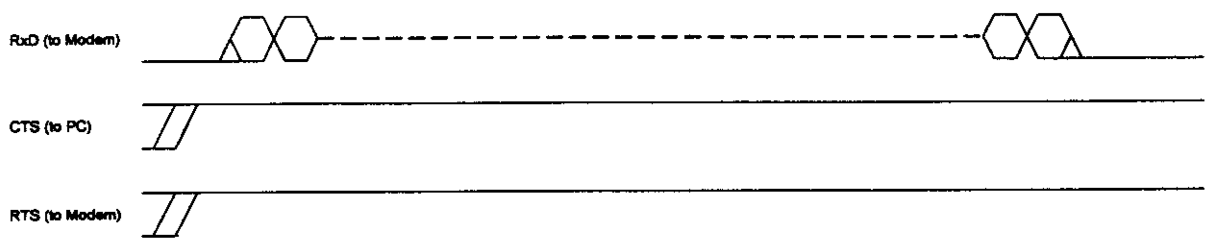

Figure 4-2 Absence of CTS Signal in Small Packet Use

4.2.3 RTS/CTS HANDSHAKING PROTOCOL

When the RTS/CTS Handshaking protocol is used, the modem will send raw data containing NO Forward Error Correction information. with this protocol, the Modem CAN NOT be programmed to expect an ACK or NACK for each packet sent. This is the protocol used by the JDT 3282 and 3276 Modems. Figure 4-3 shows the RTS/CTS Handshaking protocol, where the RTS signal resembles a PTT signal.

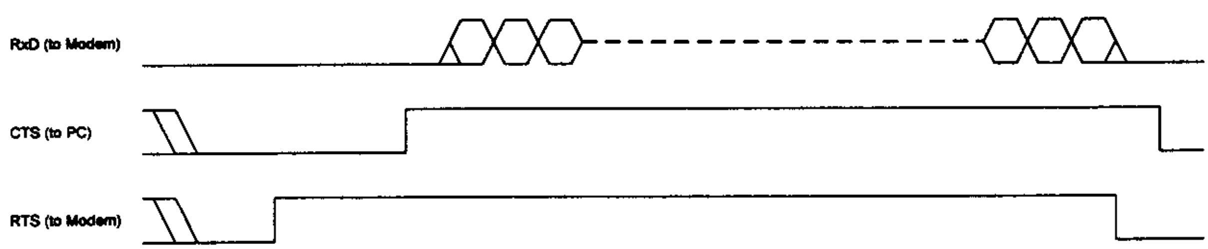

Figure 4-3 RTS/CTS Handshaking Protocol (Resembling a PTT Signal)

4.3 DIAGNOSTICS

4.3.1 GENERAL

The 3286 Modem is capable of tracking different hardware (voltages) and network (modem) diagnostics. These diagnostics are available locally via the RS232 Interface and remotely via an RF link. Local diagnostics are available only while the modem is in the setup mode. Remote diagnostics are available anytime, provided there is a master modem connected to a PC running the Setup Software.

4.3.2 HARDWARE DIAGNOSTICS

The 3286 Modem is capable of the following hardware diagnostics:

- Input Voltage
- Input Current
- Temperature
- RSSI
- Forward Power
- Reverse Power

4.3.3 NETWORK DIAGNOSTICS

The 3286 Modem is capable of the following network diagnostics:

- Number of packets sent
- Number of packets received
- Data reception quality
- CRC packet errors

4.3.4 MISCELLANEOUS

The 3286 Modem is capable of sending and receiving data at two different speeds. This could be used to automatically change to the lower speed (if necessary.) The half-channel modem has a high speed of 9600 bps and a low speed of 4800 bps.

Some programmable parameters are:

- Number of re-tries (for modem setup to receive an ACK for each packet)
- Ability to change baud rates automatically (for modem setup to receive an ACK for each packet)
- A unique identification number (65,000 numbers)
- Mode to allow communication between two modems (with use of Unique ID)

SECTION 5

CIRCUIT DESCRIPTION

5.1 GENERAL

5.1.1 INTRODUCTION

The modem board (Part number 023-3286-001) 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 and connects to the radio through a 14-pin connector, J100. Programming channels and other operating parameters are provided through a DB-9 connector. A block diagram of the modem is shown at the end of Section 5.

5.1.2 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 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 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 modulating the radio. Potentiometer R508 sets the transmit deviation.

5.1.3 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 before moving to the processor which searches for a symbol sync pattern. Once the symbol sync pattern is found, the processor enables the modem to start accepting the data from the low-pass filter, U402-3. The modem IC takes the analog signals, removes the overhead bits, and performs the error correcting.

5.1.4 SYNTHESIZER PROGRAMMING

The processor loads the synthesizer on power up, wake up, and 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 regained. Eight channel frequency select is provided by DIP switches 1, 2, and 3 of S1.

5.1.5 POWER SUPPLIES

U604 provides 5.5V for the receiver 5.5REG and analog modem circuitry, while U602 provides 5V for the CPU and other digital logic.

5.1.6 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.