MNT-PC-UC

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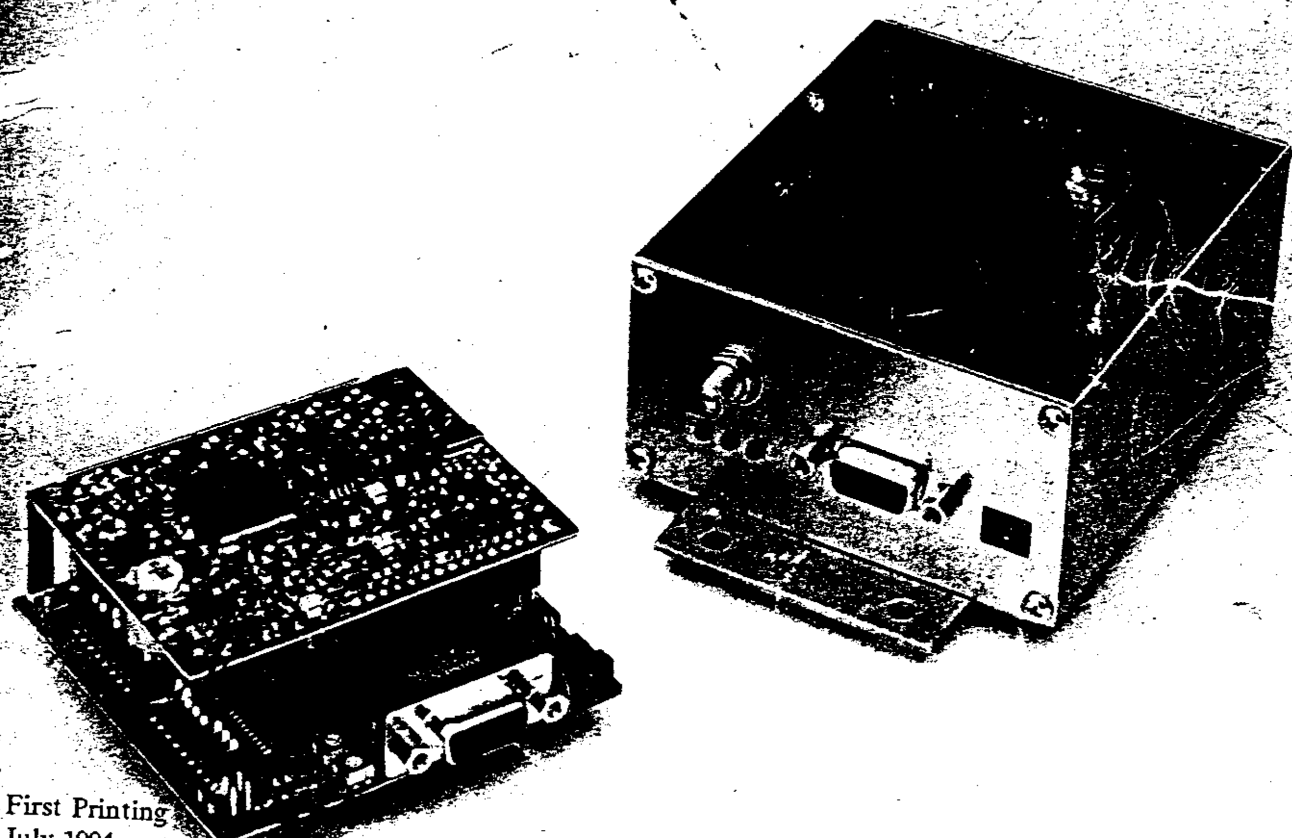
OPERATION CENTER
(OC)

EFJohnson

3472 SYNTHESIZED UHF DATA TRANSCEIVER
403–512 MHz SERVICE MANUAL



First Printing
July 1994
Supersedes: Part No. 001-3472-211

1.6W - 2.4W UHF
Part No. 242-3472-xxx

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3472 SYNTHESIZED UHF DATA TRANSCEIVER
403–512 MHz SERVICE MANUAL

teledesign:
Mark Hubbard
408-436-1024

1.6W - 2.4W, UHF
PART NO. 242–3472–xxx 403–512 MHz

The E.F. Johnson Company designs and manufactures two–way radio equipment to serve a wide variety of communications needs. Johnson produces equipment for the mobile telephone and land mobile radio services which include business, industrial, government, public safety, and personal users. In addition, Johnson designs and manufactures electronic components used in communications equipment and other electronic devices.

LAND MOBILE PRODUCT WARRANTY

The manufacturer's warranty statement for this product is available from your product supplier or from the E.F. Johnson Company, 299 Johnson Avenue, Box 1249, Waseca, MN 56093–0514. Phone (507) 835–6222.

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 E. F. Johnson 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.

This manual covers revisions through July 1994.

MNT_PC_VC

TABLE OF CONTENTS

TABLE OF CONTENTS [cont.]

LIST OF FIGURES

LIST OF FIGURES [cont.]

LIST OF TABLES

MNT _ PC _ UC

SECTION 1
GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This service manual contains alignment and service information for the Johnson DM3472 UHF Data Module Transceiver, DL3472 Synthesized Data Link Transceiver, and DL3472 Radio Modem Synthesized Data Link Transceiver. Also included is information on the Loader board used with the –x30/x40 models, the 9600 Baud Modem used with the –x12/x22 models and the Audio/RSSI board used with –x10/x20 models and the programming necessary to load the DM3472.

1.2 EQUIPMENT DESCRIPTION

1.2.1 GENERAL

The E.F. Johnson DM3472 and DL3472 Models are synthesized data transceivers (transmitter and receiver) which operate in the 403–512 MHz UHF frequency range. Transmitter power output is 2 watts nominal, and operation is simplex or half duplex.

Versions of the 3472 covered in this manual are indicated in Section 1.3. Versions are available with a frequency stability of ± 2.5 PPM or ± 5 PPM, and each of these versions is available with or without the Loader board or Modem (see Section 3).

The number of channels that can be selected with the DM3472 model is determined by the customer supplied synthesizer loading circuitry. DL3472 models are supplied with the Loader board or Modem and have up to two channels that can be programmed.

1.2.2 DL3472 WITH LOADER BOARD

The DL3472 –x30/–x40 versions include the 2–channel Loader board, Part No. 023–3472–330, which performs synthesizer loading. In addition, this board has circuitry which provides transmit/receive data conditioning and gating, carrier detect, and RSSI buffering. The gating circuits allow the type of data 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 E.F. Johnson Remote Programming Interface (RPI) and 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 DM3472 SYNTHESIZER PROGRAMMING

The versions of the 3472 without the Loader board or Modem require customer supplied circuitry to load the synthesizer with channel information. The protocol that this circuitry must follow is described in Sections 3.2 and 3.2.9.

1.2.4 AUDIO/RSSI BOARD

Audio/RSSI board, Part No. 023–3472–230, is an option for DM3472 models. This board is normally required unless the receive data amplification, carrier detect, and RSSI buffering functions of that board are not needed or are performed by customer supplied circuitry. This board is not required with models with the loader board because the loader board includes that circuitry.

1.2.5 DL3472 9600 BAUD MODEM MODULE

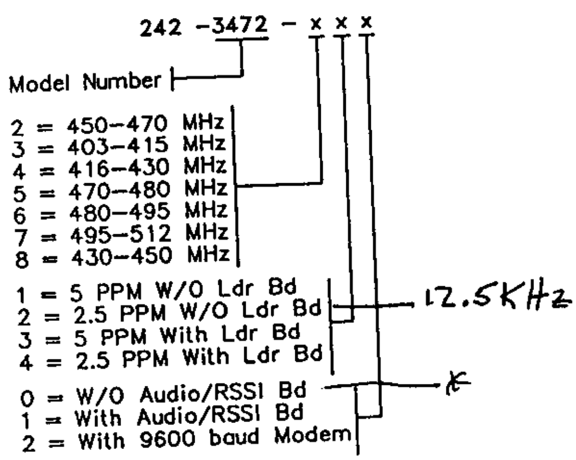
The DL3472 –x12/–x22 versions include the 9600 Baud Modem. The Modem module formats, limits and filters the transmit and receive data, regulates and switches the power supplies, and programs the synthesizer for the receive and transmit frequencies (see Section 4.6). Two DIP switches program the 9600 baud Modem for: Radio Type, Serial Data Signal, Baud Rate, Character Length, Serial Configuration, Duplex Selection, Handshake Protocol and Time–Out Timer (see Section 3.4).

1.2.6 DL3472 9600 BAUD MODEM PROGRAMMING

The DL3472 can be programmed for up to 15 separate frequency pairs. A frequency pair is programmed by down loading a control string of ASCII characters through the modem serial port with a dumb terminal or personal computer, see Section 3.4.

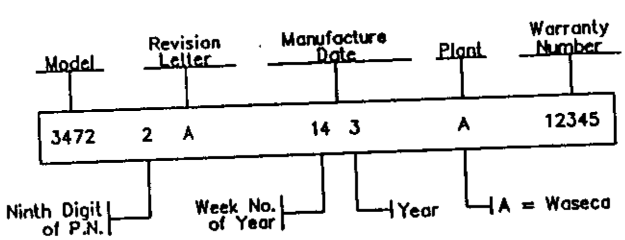
1.3 PART NUMBER BREAKDOWN

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



1.4 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:



NOTE: Units with an "A" revision letter use a slightly different format in which the ninth digit of the part number is not used, and the manufacture date is the month/year instead of week/year.

1.5 ACCESSORIES

Accessories available for the 3472 data transceiver are listed in Table 1-1. Currently, the -x30 Audio/RSSI Board is not standard with any version and must be ordered separately. The loader board and case kit can be used to add those components to the -x10/x20 models. The -x30 model is configured from the factory with a Loader board and case.

TABLE 1-1
ACCESSORIES

Accessory	Part No.
Audio/Rssi Board	023-3472-230
Loader Board and Case Kit	250-3472-001
DM-3472 Receive Test Filter	023-3472-040
DL-3472 Test Cable	023-3472-007
DL-3472 Radio/Modem Pwr Cable	023-3472-004
DL-3472 Radio Power Cable	023-3410-109
Hirose to SMA RF cable	023-3472-008
Programming interface box (RPI)	023-9750-000
RPI-Radio Loader interface cable	597-2002-200
IBM Software	
5.25" Floppy Disk	023-9998-263
3.5" Diskette	023-9998-264

1.6 FACTORY CUSTOMER SERVICE

The Customer Service Department of the E.F. Johnson Company provides customer assistance on technical problems and the availability of local and factory repair facilities. Customer Service hours are 7:30 a.m. - 4:30 p.m. Central Time, Monday - Friday. There is also a 24-hour emergency technical support telephone number. From within the continental United States, the Customer Service Department can be reached at this toll-free number:

1-800-328-3911

When your call is answered at the E.F. Johnson Company, you will hear a brief message informing you of numbers that can be entered to reach various departments. This number may be entered during or after the message using a tone-type telephone. If you have a pulse-type telephone, wait until the message is finished and an operator will come on the line to assist you. When you enter a first number of "1" or "2", another number is requested to further categorize the type of information you need. You may also enter the 4-digit extension number of the person that you want to reach if you know what it is.

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

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 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:

E.F. Johnson Company
Customer Service Department
299 Johnson Avenue
P.O. Box 1249
Waseca, MN 56093-0514

1.7 PRODUCT WARRANTY

The warranty statement for this transceiver is available from your product supplier or from the Warranty Department, E.F. Johnson Company, 299 Johnson Avenue, Box 1249, Waseca, MN 56093-0514. 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

E.F. Johnson replacement parts can be ordered directly from the Service Parts Department. To order parts by phone, dial the toll-free number and then enter "7" as described in Section 1.6. When ordering, please supply the part number and quantity of each part ordered. E.F. Johnson 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 1.4).

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.

E.F. Johnson Company
Service Parts Department
299 Johnson Avenue
Box 1249
Waseca, MN 56093-0514

1.9 FACTORY RETURNS

Repair service is normally available through local authorized E.F. Johnson 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 "8".

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.

3472 DATA TRANSCEIVER SPECIFICATIONS

MNT - PC - UC

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	403–512 MHz
Frequency Control	Synthesized
Minimum Channel Spacing	25 kHz
Maximum T/R Spread	20 MHz; 5 MHz for lock time less than 12 ms
Mode of Operation	Simplex or Half Duplex
Operating Voltage	+13.8V DC ±10% (DL3472) +7.5V DC ±10% (DM3472)
Regulated Supply Voltages	+7.5V DC ±10%, +5V DC ±5%
Connectors	
RF Input/Output	Hirose Subminiature Female on Transceiver SMA RF connector on DL3472 (w/Loader or Modem)
Power and Data Interface	14–pin in–line socket, 100 mil center (w/o Loader Board) 10–pin 3M 3591 ribbon type (w/Loader Board) 2–pin Molex or 9–pin D connector (w/Modem)
Operating Temperature	–30° to +60° C (–22° to +140° F)
Maximum Dimensions (w/o Loader Bd)	2.83" L (7.19 cm), 2.19" W (5.56 cm), 0.67" H (1.70 cm)
Weight (w/o Loader Bd)	1.94 oz (55 g)
FCC Compliance	Part 90
FCC Type Acceptance	2423472–001 Loader 5 PPM, 2423472–003 Loader 2.5 PPM 2423472–002 Modem 5 PPM, 2423472–004 Modem 2.5 PPM DM3472 customer must apply.
DOC Type Acceptance	933 212 113 A Loader, 933 212 112 A Modem

------------RECEIVER------------

Bandwidth	20 MHz
Frequency Stability	±5 PPM or ±2.5 PPM
Sensitivity – 12 dB SINAD	0.45 μV (DM3472) 0.30 μV (DL3472) Less than 1 x 10^{-6} for 1 μV (–107 dBm) (DL3472 Modem)
RF Input Impedance	50 ohms
Selectivity	–55 dB
Spurious and Image Rejection	–55 dB; –50 dB half IF and secondary image
Intermodulation	–55 dB
FM Hum and Noise	–38 dB
Conducted Spurious	–57 dB
Receive Current Drain	< 43 mA at 5V DC (w/o loader board) < 70 mA at 5V DC (w/loader board) < 75 mA at 5V DC (w/Modem)
Receive Attack Time	< 12 ms (dependent on synthesizer loading implementation)
RSSI Attack Time	< 10 ms
Carrier Detect Attack Time	2 ms
Audio	
Distortion	< 5%
Output Level DM3472	600–1200 mV P–P or 200–400 mV RMS (1 kHz at ±3 kHz)
DL3472	+1/–3 from 6 dB/octave de–emphasis from 300–3000 Hz
Response	
DM3472/DL3472 Wideband	±2 dB from DC to 5 kHz (reference to 1 kHz)
DL3472 Narrowband	
Minimum Load Impedance	10k ohms

3472 DATA TRANSCEIVER SPECIFICATIONS

------------TRANSMITTER------------

Bandwidth	20 MHz
Frequency Stability	±5 PPM or ±2.5 PPM
TCXO Coupling	DC
RF Power Output	2W nominal 403–480 MHz (w/o Loader) 1.8W nominal 470–480 MHz (w/Loader) 1.8W nominal 480–512 MHz (w/o Loader) 1.6W nominal 480–512 MHz (w/Loader) 2W nominal (w/Modem)
RF Output Impedance	50 ohms
Modulation Distortion	< 5%
Duty Cycle	
DM3472	50%, 60 seconds maximum transmit
DL3472 (w/Loader)	20%, 10 seconds maximum transmit
DL3472 (w/Modem)	50%, 60 seconds maximum transmit
Transmitter Attack Time	< 12 ms (dependent on synthesizer implementation)
Spurious and Harmonic FM	–52 dBc
FM Hum and Noise	–37 dB
Data Input Impedance	40k ohm
Modulation Response	±2 dB from DC to 5 kHz (reference to 1 kHz)
Current Drain	< 800 mA at 2W, +7.5V DC (w/o Loader) < 850 mA at 2W, +7.5V DC (w/Loader) < 850 mA at 2W, +7.5V DC (w/Modem)
Modulation Sensitivity	5 kHz deviation per volt (P–P) ±20% 1 kHz tone (0.35V RMS 1 kHz sinewave produces ±5 kHz deviation ±20%)

------------MODEM DATA INTERFACE------------

Data Interface Connector	9–pin D, female, DCE
Data Rate	300–9600 bits per second
Data Format	Asynchronous (7–8 bit data words) Synchronous (w/user recovered clock)
Data Interface Levels	RS–232 or TTL
RTS to CTS Delay	20 ms to 250 ms in eight steps
Handshake Protocols	This Modem is always configured as a DCE

- **Standard DCE/DTE Protocol:**
  DSR: Active when DCE powered
  DCD: Active when receive carrier is detected
  CTS: Active when (1) RTS is active and the channel is ready for data transmission. This time is determined by the radio selected (see "Setting DIP Switches") or (2) DTR is active.
  DTR: Activated by DTE when DTE is powered
  RTS: Activated by DTE when DTE data transmission is needed.
- **Transmit Data Activation Protocol:**
  DSR: Active when DCE is powered
  DCD: Active when receive carrier is detected
  CTS: Active when DCE is powered
  DTR/RTS: Not used

SECTION 2
INSTALLATION

2.1 PRE-INSTALLATION CHECKS

Field alignment should not be required before the 3472 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 Sections 6.3 and 6.4.

2.2 INTERFACING WITH DATA EQUIPMENT

2.2.1 DM3472 ONLY

When the Loader board or Modem are not used, connector J1 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 J1 input and output signals.

Pin 1 (Ground) - Chassis ground.

Pin 2 (+7.5V DC Continuous) - This voltage should be stabilized near +7.5V DC. Variations from +6V to +9V can change power output as much as 6 dB.

Pin 3 (+7.5V DC Transmit) - This input should be +7.5V DC in transmit mode only.

Pin 4 (+5V DC Receive) - This input should be +5V DC in the receive mode only.

Pin 5 (+5V DC Continuous) - This voltage should be stabilized near +5V DC.

Pin 6 (Data Input) - Provides a response of ±2 dB from DC to 5 kHz. The sensitivity is approximately 5 kHz deviation per volt RMS. 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 must be FCC/Canada approved 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 U801.

Pin 9 (Synthesizer Data) - Serial data line used for programming synthesizer IC U801.

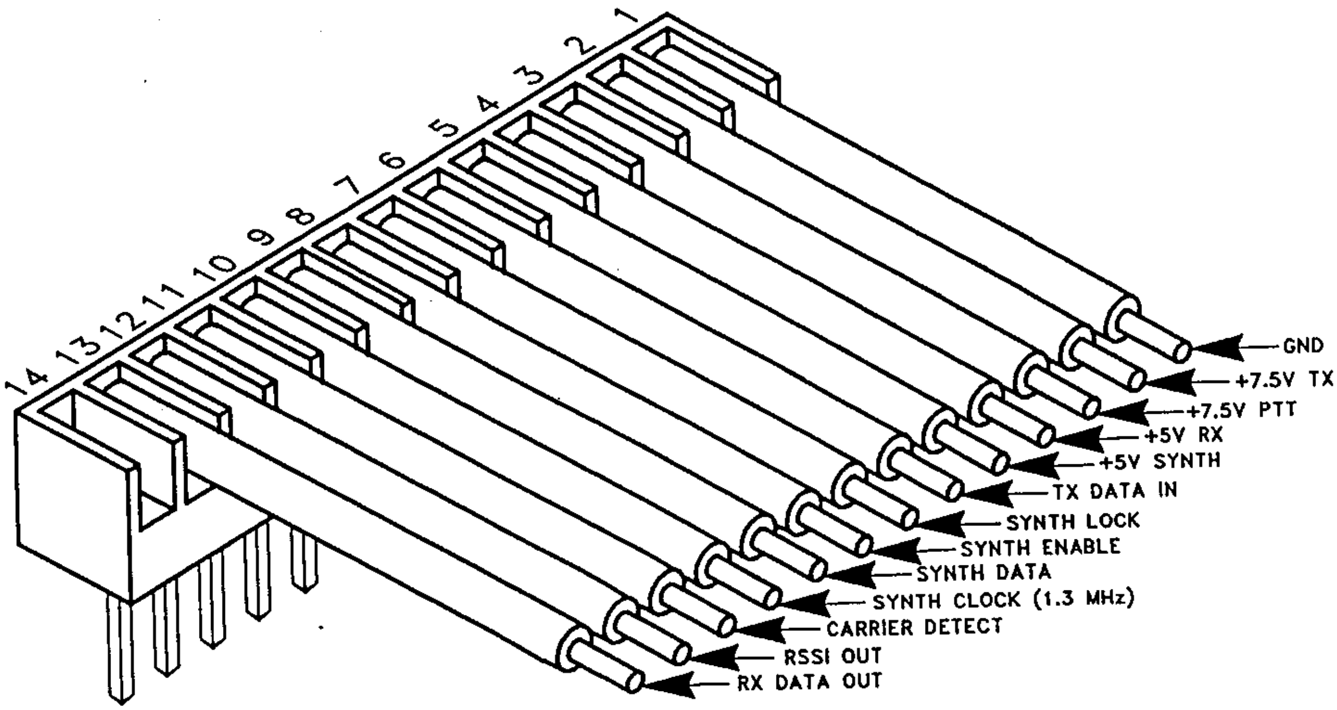
Pin 10 (Synthesizer Clock) - Software-generated serial clock. Data is valid on the rising edge of this signal.

NOTE: The following descriptions are with the Audio/RSSI board installed.

Pin 11 (Carrier Detect) - This output goes low (near 5 volts) when the receive signal increases to a preset level (with Audio/RSSI board only).

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

Pin 13 (Data Output) - The data output level is 600-1200 millivolts P-P (200-400 mV RMS) with a modulation signal of 1 kHz at ± 3 kHz deviation. The output is DC coupled and referenced to +2.7V DC. Load impedance should be 10k-100k ohms.



DM3472 INTERFACE CABLE
FIGURE 2–1

2.2.2 DL3472 WITH LOADER BOARD

When the Loader board is used, it plugs into J1 on the transceiver PC board and the data equipment interface is J2 on the Loader board. This is the same 10–pin connector used on other E.F. Johnson telemetry modules (see Figure 2–7).

An interface cable diagram and also the connector pin designations for this configuration are shown in Figure 2–2. This cable is not included with the data transceiver. However, a 36" cable assembly with discrete wires that could be used for this application is listed in Table 1–1.

The following is a general description of the various J2 input and output signals.

Pin 1 (Tx Wideband Data In) – Provides a response of ±2 dB from DC to 5 kHz. The sensitivity is approximately 5 kHz deviation/V RMS. When this input is used, a temperature compensated 2.5V DC bias is required because variations in voltage cause the frequency to change.

Pin 2 (Rx Wideband Data Out) – Provides a response of ±2 dB from DC to 5 kHz. The output is DC coupled and referenced to +2.7V DC. Load impedance should be 10k–100k ohms. The data output level is 600–1200 mV P–P (200–400 mV RMS) with a modulation signal of 1 kHz at ±3 kHz deviation.

Pin 3 (Channel Select In) – A logic low level selects Channel 1 and a high level selects Channel 2.

NOTE: If the preceding line is not connected, channel 2 is automatically selected because it is pulled high by an internal pull–up resistor.

Pin 4 (RSSI Out) – The Receive Signal Strength Indicator output provides a voltage that increases in proportion to the strength of the RF input signal.

Pin 5 (+13.8V DC In) – This voltage should be stabilized near +13.8V DC. Variations from +9V to +16V can be tolerated by the interal +9V regulator.

Pin 6 (Tx Key In) – A logic low level keys the transmitter and a high level unkeys the transmitter.

Pin 7 (Carrier Detect Out) – This output goes low (near 0V) when the receive signal increases to the preset level.

Pin 8 (Tx Data In) – The standard data input which provides +1, –3 dB pre-emphasis from a standard 6 dB per octave characteristic from 300–3000 Hz referenced to 1 kHz. This pre-emphasis can be bypassed if desired (see Section 3.3). Also provided with this input is limiting and filtering. The sensitivity is approximately 5 kHz deviation per volt.

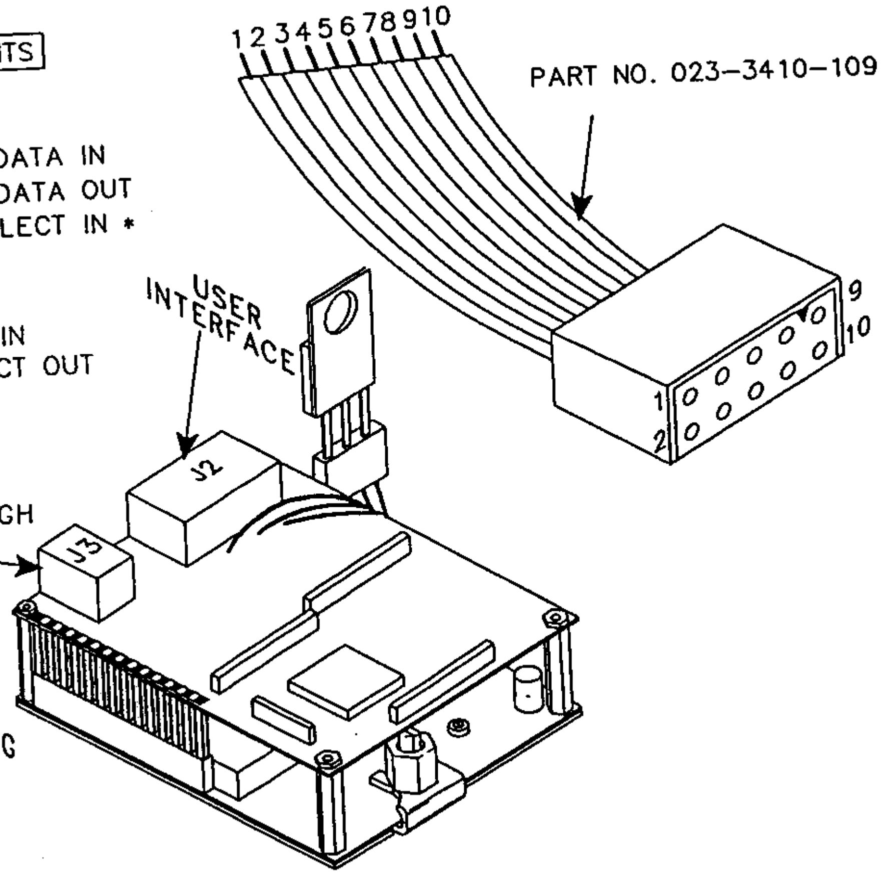
Pin 9 (Ground) – Chassis ground.

Pin 10 (Rx Data Out) – The standard data output which provides +1, –3 dB per octave de-emphasis from a standard 6 dB per octave characteristic from 300–3000 Hz referenced to 1 kHz. This de-emphasis can be bypassed if desired (see Section 3.3). Load impedance should be equal to or greater than 600 ohms. The data output level is adjustable from approximately 0–1200 mV P-P (0–400 mV RMS) with a modulation signal of 1 kHz at ± 3 kHz deviation.

CONNECTOR PIN ASSIGNMENTS

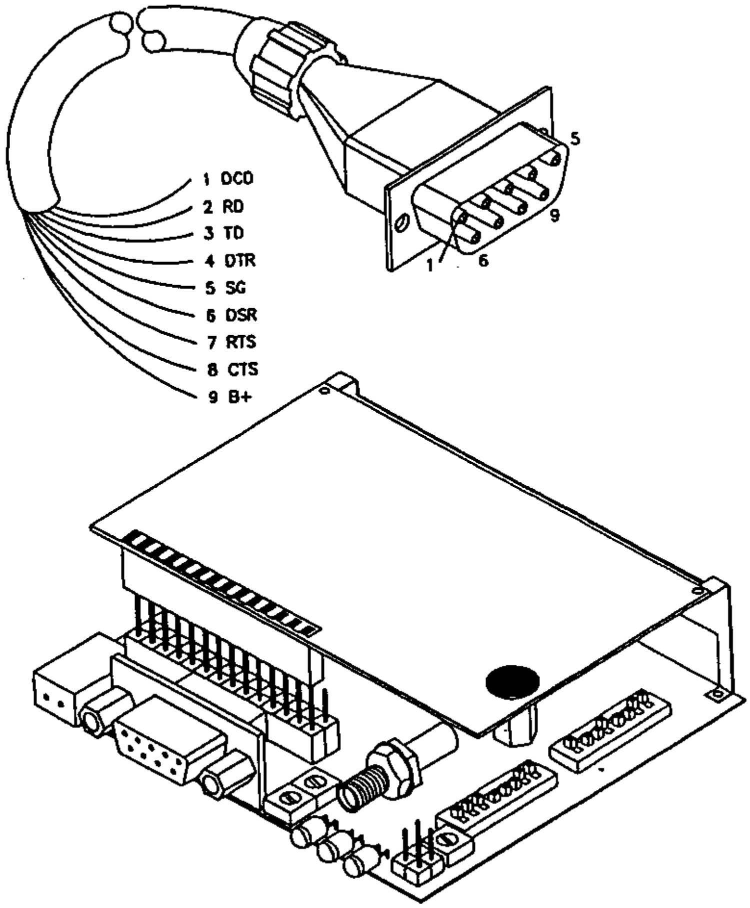
PIN	FUNCTION
1	TX WIDEBAND DATA IN
2	RX WIDEBAND DATA OUT
3	FREQUENCY SELECT IN *
4	RSSI OUT
5	+13.8V DC IN
6	$\overline{\text{TX KEY}}$ (PTT) IN
7	CARRIER DETECT OUT
8	TX DATA IN
9	GROUND (–)
10	RX DATA OUT

* CH 1 = LOW, CH 2 = HIGH



DL3472 WITH LOADER BOARD INTERFACE CABLE INSTALLATION
FIGURE 2–2

MNT _ PC _ UC



DL3472 RADIO MODEM AND INTERFACE CABLE
FIGURE 2–3

2.2.3 DL3472 WITH MODEM BOARD

When the 9600 Modem board is used, it plugs into the transceiver PC board through J11 and the data equipment interface is a 9–pin D serial interface connector J1 on the Modem board.

An interface cable diagram and also the connector pin designations for this configuration are shown in Figure 2–3. This cable is not included with the data transceiver. However, a 36" power supply cable that could be used for this application is listed in Table 1–1.

The following is a list of the various J1 input and output signals (see Section 2.3.13).

J1 Interface Connector

Pin 1 – Data Carrier Detect (DCD)
Pin 2 – Receive Data (RD)
Pin 3 – Transmit Data (TD)
Pin 4 – Data Terminal Ready (DTR)
Pin 5 – Signal/Power Ground (SG)
Pin 6 – Data Set Ready (DSR)
Pin 7 – Request–To–Send (RTS)
Pin 8 – Clear–To–Send (CTS)
Pin 9 – Radio Modem Power (9–16V)

J2 Power Connector

Pin 1 – Ground
Pin 2 – Supply

2.3 9600 BAUD MODEM SETUP

2.3.1 GENERAL

The various operating modes of this modem are selected by two 8-section DIP switches (S1 and S2) on the modem PC board. These switches are shown in the diagram in Figure 6-10. Note the "ON" and "OFF" positions of these switches. Also shown in this diagram are the location of the receive and transmit data level controls and the pin numbering and assignments of the connectors.

To set the DIP switches of the separate modem, the modem and radio module must be removed from the case. In order to remove these modules, the four face plate screws and the four screws on the bottom of the case holding the radio heat sink to the case must be removed. Once the modules have been removed, the DIP switches are directly accessible. After the DIP switches have been set, the radio module can be re-installed. If frequency programming is required do not re-install the modules at this time (see Section 3.4).

2.3.2 ANTENNA CONNECTOR

The antenna interface to the modem is through a 50 ohm SMA straight bulkhead jack connector (see Figure 2-6). The modem should never be allowed to transmit without connecting either an antenna or dummy load to this connector. A variety of antennas can be used with the modem, but it is important that the antenna used provides a 50 ohm load at the operational frequencies. Any cabling used to remote the antenna must be good quality coaxial cable with 50 ohm characteristic impedance. Depending on the license obtained for operation, there may be restrictions on the type and height of the antenna which may be used.

2.3.3 POWER CONNECTOR (J2)

Power can be fed into the modem either through the 2-pin Molex connector J2 on the front of the modem or through the serial port J1, pin 9 (see Figure 6-10). The power into the modem should be a well regulated DC voltage between 9 and 16V. The power pin of the Molex J2, pin 2 and J1, pin 9 are directly connected. In most applications, J1, pin 9 of the serial port is either unused (unconnected) or is a ring indicator which is a modem output. For systems operating on RS-232 levels, the power feeding to this pin is in the normal RS-232 voltage range and should not present a problem. For other systems, it may be necessary to leave J1, pin 9 of the serial port unconnected.

2.3.4 SERIAL PORT CONNECTOR (J1)

The serial port connector is a female 9-pin D connector. The cable used to connect to the serial port should be good quality shielded cable with metal connectors. The cable connectors should be securely screwed to the modem's serial port.

TABLE 2-1
LED INDICATORS

LEDs TX	LEDs RX	Description
OFF	ON	Carrier detected
ON	OFF	Transmitting data
ON	ON	Programming Mode
Flashing	OFF	Test mode
FLASHING		
Alternately flashing		Unprogrammed chnl selected
Both flash 3 times		Valid prog. string accepted

2.3.5 LEDs

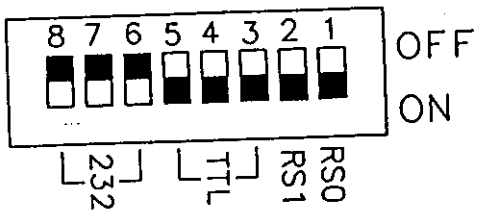
The modem has LEDs for Power (PWR), Receive (RX), and Transmit (TX). The power LED lights when power is applied to the modem.

NOTE: The Power LED does not guarantee the input voltage levels are correct.

In normal operation the RX LED indicates that the modem's receiver is receiving (carrier detected on the radio channel). The TX LED indicates that the modem is transmitting data over the radio channel. In normal operation, the RX and TX LEDs should never be on simultaneously. If an unprogrammed channel is selected, the RX and TX LEDs will alternately flash.

In program mode, the RX and TX LEDs both light continuously. When a valid frequency programming string is entered, the LEDs flash together 3 times to indicate that a valid program string has been accepted by the modem.

In Test mode, the TX LED flashes and the RX LED is off.



DIP SWITCH S1
FIGURE 2-4

2.3.6 RADIO SELECT (RS0/RS1)

These switches configure the modem for the specific operation with the various receiver/transmitter options. Parameters such as receive data inversion are selected by these switches. The configuration for each radio is as follows:

	S1	
Radio	**RS1**	**RS0**
UHF Synthesized	On	On
VHF Crystal	On	Off
UHF Crystal	Off	On

2.3.7 SERIAL DATA LEVEL SELECT

The TTL/232 switches select signal levels used by the data equipment connected to serial port J1. Either TTL or RS-232 levels can be used. To select TTL levels, all three "TTL" switches should be ON and all three "232" switches should be OFF. To select RS-232 levels, these switches should be in the opposite position. TTL signals are 0 and 5V levels and RS-232 signals are -5V and +5V levels.

CAUTION

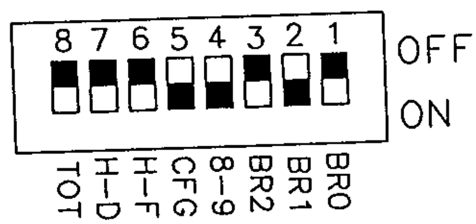
To avoid possible damage to the modem, do not leave both sets of switches in the ON position.

	S1	
Interface Type	**TTL**	**232**
RS-232	All off	All on
TTL	All on	All off

2.3.8 BAUD RATE SELECT (BR0-BR2)

These switches select the user serial interface baud rate. When the switches are configured for Test Mode, the modem transmits random 9600 baud 8-bit characters. The mode is indicated by the transmit (TX) LED flashing. The selectable baud rates are:

		S2	
Baud Rate	**BR2**	**BR1**	**BR0**
300 bps	on	on	on
1200 bps	on	on	off
2400 bps	on	off	on
4800 bps	on	off	off
9600 bps	off	on	on
Tx Test Mode	off	on	off
Rx Test Mode	off	off	on



DIP SWITCH S2
FIGURE 2-5

2.3.9 HANDSHAKE/DATA PROTOCOL

The H/D switch selects either the standard DCE/DTE handshake protocol or the data activation (limited) handshake protocol (see Section 2.3.13.

	S2
Handshake Protocol	**H/D**
Standard DCE/DTE	Off
Data only	On

2.3.10 CHARACTER LENGTH SELECT (8-9)

This switch selects the number of data bits in each serial character. This number does not include the start and stop bits. Common data protocols and the corresponding switch settings are as follows:

Operating Mode	S2 8–9
8–bit characters	off
9–bit characters	on

Data bits	Parity	Stop bits	Switch Setting
7	no	2+	off
7	yes	1+	off
8	no	1+	off
8	yes	1+	on
9	no	1+	on

2.3.11 TRANSMIT TIME-OUT TIMER

When enabled, the transmit time–out timer automatically terminates a transmission after 60 seconds of continuous transmission. With the DCE/DTE protocol, transmission is terminated 60 seconds after the RTS line is activated. With the data only mode, transmission terminates 60 seconds after detection of activity on the TD line with a continuous transmission. In the DCE/DTE mode the time–out timer is reset when the RTS line is deactivated, or after the 10 character end of transmission timer has expired in the data only mode.

Time–Out Timer	S2 TOT
Enabled	On
Disabled	Off

2.3.12 POWER CABLE INSTALLATION

The modem requires a power source with a nominal voltage of 13.8V DC (the operating range is 9–16V DC). If the modem is not in the same case with a receiver/transmitter module, the data, carrier detect, and keying signals also need to be applied to the modem.

The serial port connector (J13) is used to apply these signals to the modem and can supply the operating voltage or the power can be applied to power connector J2 (see Figure 6–10).

2.3.13 SERIAL PORT

The interface utilizes a female 9–pin D connector. The modem serial port can operate with either a handshake protocol (standard handshake) or a data activation protocol (no handshake required).

2.3.14 HANDSHAKE PROTOCOL

The handshake protocol utilizes the full complement of serial handshake lines, including Request To Send (RTS), Clear To Send (CTS), Data Carrier Detect (DCD), Data Set Ready (DSR) and Data Terminal Ready (DTR). These handshake lines follow the standard DTE/DCE serial handshake protocol. The modem is considered the DCE (Data Communication Equipment) while the user's equipment is the DTE (Data Terminal Equipment). In handshake mode, the user initiates transmission by asserting (positive voltage) the RTS line. When the modem responds by activating the CTS line, user data can be sent to the modem for transmission. The DCD line is asserted by the modem when the modem detects activity on the radio channel. The DSR line is always asserted by the modem. The DTR line must be asserted by the DTE (user equipment) in order for the modem to receive or transmit. If the DTR line is left unconnected, the modem automatically pulls it to the asserted state.

2.3.15 DATA ACTIVATION PROTOCOL

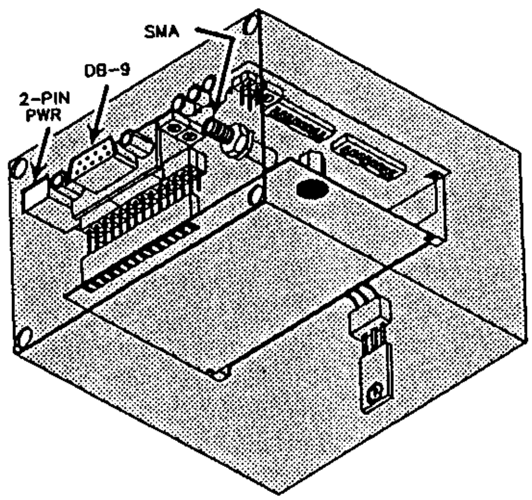
The data activation protocol requires the use of only the Transmit Data (TD) and Receive Data (RD) lines. When activity is detected on the transmit data line, the transmitter is keyed. The transmitter remains keyed until there is no activity on the transmit data line for at least 10 character periods. A character period is considered 11–bit periods (i.e. for 9600 baud: 11/9600 – 1.15 msec). The DCD and DSR line act the same way as for the handshake protocol. The DTR and RTS lines are ignored and the CTS line is continuously active. In data activation protocol, the first transmit character sent to the modem is lost. Therefore it is important for the user to pad the beginning of transmission with a dummy character.

2.3.16 DATA SYNCHRONIZATION

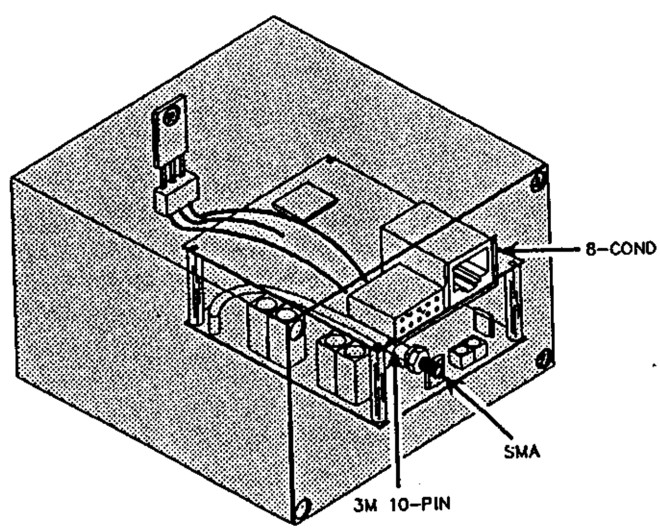
At the beginning of transmission, the modem stores incoming data until the transmit and receive modems are synchronized. This synchronization requires 20 ms. The modem will not begin the synchronization process until after it has received at least 1 character and has verified that the channel is not being changed. Therefore the total end–to–end delay, or time from the start of data sent to the modem to when data is sent to the user by the receiving modem, is 20 ms + 2 character periods.

2.3.17 DECAY PERIOD

At the end of transmission, there is a transmit decay period of approximately 19 msec. During this period transmissions and receptions by the previously transmitting modem are not allowed. Additionally, for the data activation protocol there is a 10 character period delay from when the user sends the last character to the modem and when the modem begins the transmit decay period.



DL3472 TRANSCEIVER MODEM
FIGURE 2–6



DL3472 WITH LOADER BOARD
FIGURE 2–7

MNT_PC_VC

SECTION 3
PROGRAMMING

3.1 INTRODUCTION

DM3472 – 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 when the loader board is not used.

DL3472 – The information in Section 3.3 describes the programming of 2–Channel Loader Board, Part No. 023–3472–330. This board is standard with –x30/x40 models and optional with –x10/x20 models (see Section 1.3).

DL3472 Radio Modem – The information in Section 3.4 describes programming the Modem. This module is standard with –x12/x22 models (see Section 1.3).

3.2 DM3472 SYNTHESIZER DATA PROTOCOL

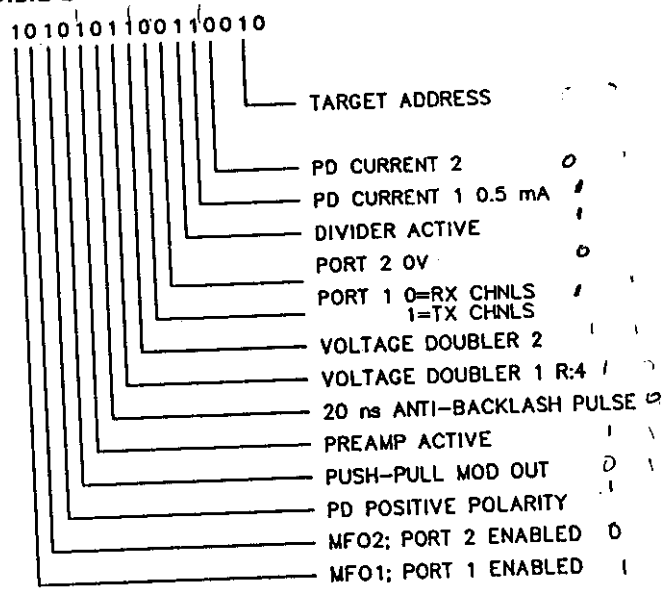
3.2.1 GENERAL

The loading of synthesizer IC U801 with status information and divide numbers is performed over a three–line serial bus consisting of the SYNTH ENABLE, SYNTH DATA and SYNTH CLK lines. Three data words are required to load U801 with this information. These words and the order they are sent are as follows:

STATUS2 Word
 16 bits + Enable Pulse
R Divider Word (with synchronous transfer)
 19 bits + Enable Pulse
N/A Divider Word (dual modulus)
 22 bits + Enable Pulse

The information contained in these words is described in the following information.

3.2.2 STATUS2 WORD



STATUS WORD
FIGURE 3–1

Receive: STATUS2 = 43,826 Decimal (AB32 Hex)
Transmit: STATUS2 = 43,954 Decimal (ABB2 Hex)

Rx STAT2 16 bit word 1010 1011 0011 0 — 010 (STATUS2 — T)

Tx STAT2 16 bit word 1010 1011 1011 0 — 010 (STATUS2 — T)

3.2.3 R DIVIDER

Reference Frequency = 14.5 MHz
Loop Frequency = 12.5 kHz
Target Address: 101 for Synchronous Transfer

14.5 MHz ÷ 12.5 kHz = 1160 (488h)
R Divider word is 9,825 Decimal (2445 Hex)

R Divider 19 bit word is 000 0010 0100 0100 0 — 101 (R — T)

10 kHz = 1450 = 5AAh = 010 1101 0101 0 101
2 D 5 5

25 kHz = 580 = 244h = 0010 0100 0100 101
1 2 2 5

MNT_PC_UC

3.2.4 N/A DIVIDER

N Divider
Transmit Range: 403–430 MHz
Nmin = 503 Decimal
Nmax = 537 Decimal

Receive LO Range: 358–385 MHz
Nmin = 447 Decimal
Nmax = 481 Decimal

RX FREQ - 45MHz

A Divider
Range: 0–63 Decimal (Tx/Rx)
Target Address: 111 for Dual–Modulus

Example:
Transmit Frequency: 415.250 MHz
Total Div. No. = 415.250 MHz ÷ 12.5 kHz = 33,220
N = INT (33,220 ÷ 64) = 519.0625 = **519**
A = [(33,220 ÷ 64) – N] x 64
A = (519.0625 – 519) x 64 = 0.0625 x 64 = **4**

A Word = 0000100
N Word = 001000000111
Target Address Word = 111
N/A divider word is 135,231 Decimal (2103F Hex)

N/A Divider 22–bit word =

0000100	001000000111	111
A	N	T

3.2.5 DUAL REFERENCE FREQUENCY LOADING PROTOCOL

To improve the lock–up time of the synthesizer, a 25 kHz reference frequency is initially used. This increases the bandwidth of the loop which decreases the settling time. The original reference frequency of 12.5 kHz is again used when the "Quasi–Set" status is reached (approximately 5 ms). The recommended protocol is as follows:

1. Load in the STATUS2 word.
2. Load R–Divider word for 25 kHz reference.
3. Load N/A divider word relative to 25 kHz reference.
4. Wait approximately 5 ms.
5. Load original R–Divider word for 12.5 kHz reference.
6. Load N/A divider word relative to 12.5 kHz reference.

Example:

Transmit Frequency = 415.250 MHz
Total Divide = 415.250 MHz ÷ 25 kHz = 16,610

Initial Loop Frequency = 25 kHz
14.5 kHz ÷ 25 kHz = 580

R–Divider word 4,645 Decimal (1225 Hex)

R–Divider 19–bit word =

0101010	000100011111	111
A	N	T

Wait approximately 5 ms, then load in the R and N/A of the example in Section 3.2.4.

3.2.6 SYNCHRONOUS/ASYNCHRONOUS PROGRAMMING

Programming of the dividers and status control is performed on the 3–line bus. The assignment of data word content to the functional units is made with a target address transmitted in the last three bits of the data word before the EN signal. In addition to the assignment data, the target address contains status information, single/dual–modulus and synchronous/asynchronous data transfer.

The following target addresses are valid. The single/dual–modulus decision is made simultaneously with the programming of the N or N/A divider.

...001 EN: status 1
...010 EN: status 2
...011 EN: status 3
...110 EN: N divider = single modulus
...111 EN: N/A divider = dual modulus
...101 EN: R divider + synchronous transfer
...100 EN: R divider + asynchronous transfer

The TBB206 Synthesizer IC, provides for programming the dividers synchronously with the reference frequency. This ensures that control starts from the momentary status of the phase detector when a frequency/channel is altered as in lock–in, where the control operation begins with a phase difference of zero. Thus, there can be no brief error signals on the phase detector as in asynchronous data transfer.

In asynchronous programming, the new data is transferred to the status or the R, N (N/A) divider using intermediate registers L2. Since there is no guarantee that all R and N divider data will be present in time, error signals on the phase detector output may result due to the division factors if the dividers do not correspond. The system interprets this as a phase difference and compensates for it.

Synchronous programming allows data transfer while maintaining the phase difference at the time of (internal) programming. This is done as follows:

Setting the mode "synchronous transfer" by appropriate programming of the R divider. This setting is maintained until programmed differently. When the EN of the R divider programming occurs, the "new" data is read into capture register L1 only.

Programming of the N or N/A divider. When the EN signal occurs, the "new" data is likewise read into capture register L1 only. At the same time, synchronous transfer into intermediate register L2 is primed for all dividers. This transfer is then made with the next zero crossing of the particular divider. A phase difference existing at the instant of transfer is maintained. This is the start condition for further control operations based on "newly" read data.

Because of the synchronizing circuit, the delay in data transfer is maximally 2 x 1/fRef.

The synchronous programming operation is always initiated by the EN signal of the N or N/A divider and applied to the R divider even if its data has not been altered. Therefore, if the data content of the R divider is to be altered (to change the reference frequency), it has to be done before programming the N or N/A divider.

Synchronous transfer is particularly advantageous if extreme channel jumps are to be made with a short setting time. For a fast "coarse" setting, a switch is made to a greater reference frequency which increases the bandwidth of the loop. The original reference frequency is again used when the "quasi-set" status is reached. Change back to the "actual" value is made with the known setting response as in small channel jumps. Synchronous transfer ensures that no extra phase errors occur as a result of changing the reference frequency.

3.2.7 PROGRAMMING TIMES

Initialization, sequence: R divider before N divider

Single–Modulus:	Σ50 bits
Status 2	16 bits
R divider	19 bits
N divider	15 bits
Dual–Modulus:	Σ57 bits
Status 2	16 bits
R divider	19 bits
N divider	22 bits

Change of channel, at same reference frequency

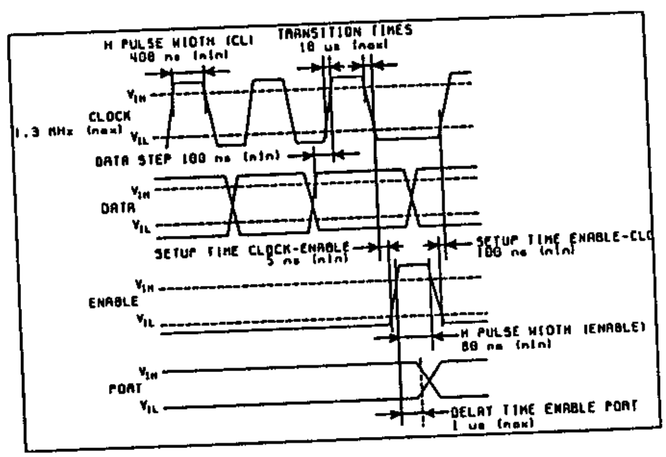
Single–modulus	15 bits
Dual–modulus	22 bits

If the reference frequency is altered, the R divider also has to be loaded (+19 bits).

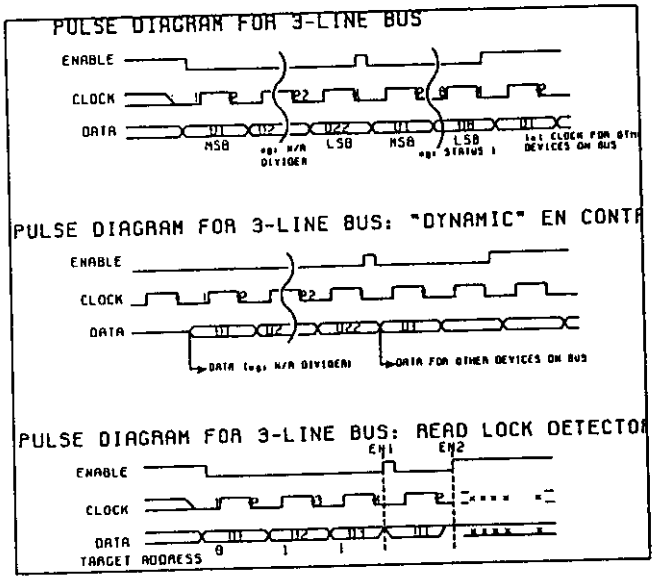
Maximum repetition rate for channel change fFI:N.

NOTE: After the supply voltage is applied, there must be at least three clock pulses on the clock input with EN = Low before the first data word occurs.

3.2.8 THREE–LINE BUS TIMING

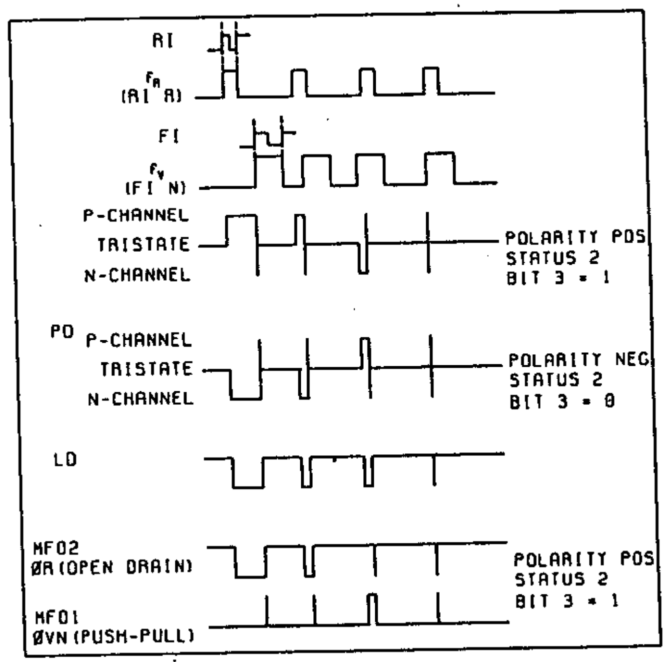


BUS TIMING
FIGURE 3–2

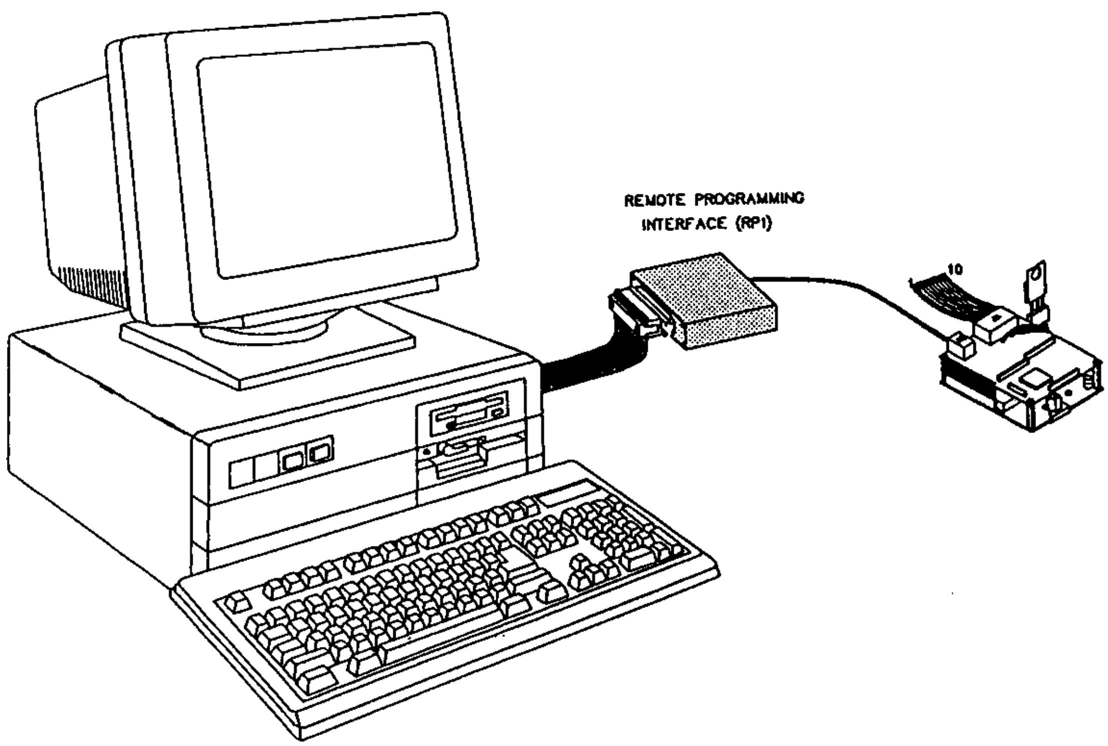


BUS TIMING
FIGURE 3–3

3.2.9 PHASE/LOCK DETECT TIMING



PHASE/LOCK DETECTOR TIMING
FIGURE 3–4



LOADER BOARD PROGRAMMING SETUP
FIGURE 3–5

3.3 DL3472 LOADER PROGRAMMING

3.3.1 PROGRAMMING SETUP

The following items are required to program the loader board. The part numbers of this equipment are shown in Table 1-1 in Section 1. A programming set-up is shown above.

- IBM PC or compatible personal computer
- E.F. Johnson Remote Programming Interface (RPI)
- Cables from the RPI to the computer and Loader board.
- E.F. Johnson Loader board programming software.

3.3.2 COMPUTER DESCRIPTION

The programming software is designed to run on an IBM PC or compatible computer that meets the following *minimum* requirements:

- One 3.5" or 5.25" disk drive, either standard or high density.
- 384K of memory
- MS-DOS version 3.0 or higher
- One serial port
- Monochrome or color monitor and video card

Although the program uses color to highlight certain areas on the screen, a monochrome (black and white) monitor also provides satisfactory operation. Most video formats can be used such as CGA, EGA, and VGA. A serial port is required to connect the RPI to the computer. This port is standard with most computers.

The cables from the RPI to the computer and loader board are not included with the RPI. The RPI-to-computer cable is a standard DB-25 to DB-25 cable and with most computers, M-F connectors are required (the female connector plugs into the computer). If your computer requires a male connector, a male-to-male cable is also listed in Table 1-1. The cable from the RPI to the loader board plugs into the modular jack on the loader board. The cable for this application is also listed in Table 1-1.

3.3.3 REMOTE PROGRAMMING INTERFACE (RPI)

The RPI provides the required interface between the computer and Loader board. It converts the RS-232 logic levels from the computer to the TTL logic levels required by the Loader microprocessor and vice versa. The RPI switch is not used in this application. The RPI power is from the Loader and the green LED is a power indicator.

3.3.4 EEPROM DATA STORAGE

The data programmed into the loader board is stored by EEPROM (Electrically Erasable Programmable Memory) U1. This type of device stores data indefinitely without the need for a constant power supply. Therefore, the loader board can be removed from power and even stored on a shelf indefinitely without affecting programming. Since an EEPROM is also reprogrammable, a new device is not needed if programming must be changed.

3.3.5 SOFTWARE INSTALLATION

The programming software is available on 5.25" (P.N. 023-9998-263) or 3.5" (P.N. 023-9998-264) disks. It is available only for IBM® PC or compatible computers. The program is approximately 174K in a file called LP.EXE and a mouse is supported.

When you receive the programming software, make a backup copy and store the master in a safe place. Then use the backup copy for programming. To make a copy of the distribution disk, use the DOS diskcopy command. For single drive systems, type DISKCOPY A: A:, and for dual drive systems type DISKCOPY A: B:. Then follow the instructions on the screen. (DOS file DISKCOPY.EXE must be in the current directory or path.)

If you have a hard disk drive, you may want to create a separate directory for loader board programming and then transfer the program files to that directory. To create a new directory, use the MKDIR command. For example, to create directory LOADERPRG, type MKDIR \LOADERPRG. Then to make the new directory the current directory, type CHDIR \LOADERPRG. To copy all files from a floppy disk in drive A: to this directory, type COPY A:*.*. To copy only the program file, type COPY A:LP.EXE.

MNT _ PC _ VC

3.3.6 HARDWARE HOOKUP

The programming setup is shown in Figure 3-5. The RPI is connected to serial port 1 unless it is already in use. It can then be connected to port 2 and the default serial port is changed as described in the next section. The cable from the RPI is plugged into J2 on the loader board which is an 8-pin modular connector. The outer two pins of this connector are the serial data bus of the micro-processor on the loader board. Power must also be applied to the loader board as described in Section 2.2.1.

3.3.7 STARTING THE PROGRAM

Turn on the computer and obtain the DOS prompt (usually A: or C:). The current directory should be the directory containing LP.EXE file. Refer to your computer operation manual for information on how to do this if needed. To run the program, type LP and press the ENTER key.

NOTE: This program has a built-in screen saver which automatically blanks the screen if no keys are pressed for approximately 15 minutes. To re-enable the screen, simply press any key.

3.3.8 COMPUTER CONFIGURATION OPTIONS

Serial Port Selection

The programming software defaults to serial port 1 for communication with the RPI. If this port is used, the software can be reconfigured to use serial port 2. To do this, in the main menu move the highlight cursor to "Setup" and select "Change Serial Port to COM2". Press Enter to toggle between the modes. The new configuration is saved when the program is exited using "Quit".

Color or Monochrome Monitor

The programming software utilizes color if you have a color monitor and video card. However, with LCD-type displays, this may result in some information being hard to read because of poor contrast. To improve contrast in this situation, the monochrome mode can be selected. To do this, in the main menu move the highlight cursor to "Setup" and select "Black and White Mode". Press the Enter key to toggle between this and "Color Mode".

3.3.9 MAIN MENU

The main menu shown in Figure 3-6 is used to select the pull-down menus listed along the top of the screen. To select a menu, move the cursor using the arrow keys or mouse and then press the ENTER key or left mouse button.

The current time is shown in the upper right side of the menu, and a brief help message for the selected parameter and the current filename are shown on the bottom. The menus and the function of each are as follows:

NOTE: To go back to the previous menu, press the ESCAPE key or the right mouse button.

File Menu

Saving a File – To save the current information to a specific file, do so before exiting the program or turning the computer off. To save the current file, select "Save Data File". A prompt asks for the name to call the file. This name must follow the standard DOS protocol of up to eight characters with a three-character extension.

When the program is exited by selecting "Quit" the current information is saved to a file called LOADER.DAT. When the program is started again, this file is automatically loaded. It can then be edited further and saved using a different filename if desired. If the computer is reset or turned off before saving the current file or exiting using "Quit", the data in the current file is lost.

Loading a File – To load a specific file from disk for reading or editing, select "Load Data File". A prompt asks for the filename. If the name of the file is not known, display a directory, with the DOS wildcard *. For example, to display all files in the current directory, type *.*. To display only the files with a .DAT extension, type *.DAT. Highlight the file to load and then press Enter. If the file is on another drive, type the drive letter and then the wildcard, for example, A:*.*.

Edit Menu

The Edit menu (see Figure 3-6) is used to enter data for channels 1 and 2. Move the cursor to the desired parameter using the arrow keys or mouse and then enter the information. To accept the information and exit to the main menu, press the Ctrl and Enter keys. To clear the screen and exit to the main menu, press the Escape key. More information on the channel parameters is shown in Figure 3-6.

Program Menu

The Program menu is used to download the programming information to the Loader board and also to read data programmed in a Loader board.

Setup Menu

The Setup menu is used to change the serial port from COM1: to COM2: and also to select a color or monochrome monitor. Refer to Section 3.3.8 for more information. Changes to the radio configuration are saved in a file called LP.CFG when the program is exited using the Quit function.

Quit

The Quit function exits the program and returns to DOS. In addition, it saves the current data to a file called LOADER.DAT. This file is automatically loaded whenever the program is started.

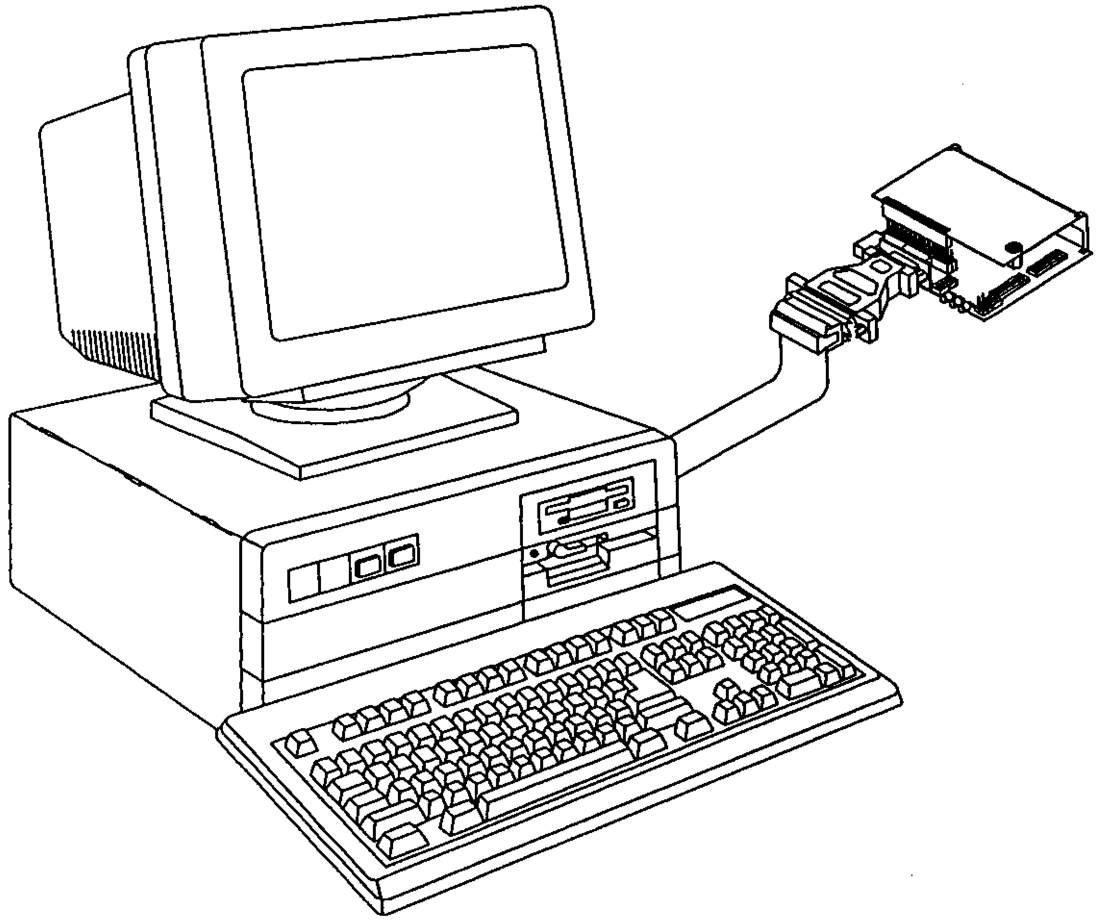
MNT_PC_UC

MAIN MENU
FIGURE 3–6

```
File      Edit      Program      Setup      Quit                        07:52:03

          Channel 1:                                Channel 2:

    Rx Frequency = 469.2625 MHz             Rx Frequency = 469.7125 MHz
    Tx Frequency = 469.2625 MHz             Tx Frequency = 469.7125 MHz

    External Mod Input (Y/N) = N            External Mod Input (Y/N) = N
    Audio Pre-Emphasis (Y/N) = Y            Audio Pre-Emphasis (Y/N) = Y
    Audio De-Emphasis (Y/N) = Y             Audio De-Emphasis (Y/N) = Y

Load or Save Data Files to Disk                              LOADER.DAT
```

FUNCTION	PARAMETERS	DESCRIPTION
Receive Frequency	403–512 MHz	Receive frequency in MHz. (Program Band Select first.)
Transmit Frequency	403–512 MHz	Transmit frequency in MHz. (Program Band Select first.)
External Modulation Input	Yes, No	Yes – This mutes the standard transmit audio input of the user interface connector (J2–8) when the wideband data input (J2–1) is used. No – This routes the standard audio input (J2–8) through the audio processing circuitry and then out to the transmitter. The wideband data input (J2–1) should be open.
Audio Pre–Emphasis (Transmit)	Yes, No	Yes – Opens pre–emphasis bypass gate U12B and closes pre–emphasis gate U12A to provide 6 dB per octave transmit audio pre–emphasis. No – Closes pre–emphasis bypass gate U12B and opens pre–emphasis gate U12A to provide a flat transmit audio response.
Audio De–Emphasis (Receive)	Yes, No	Yes – Opens de–emphasis bypass gate U4B and closes de–emphasis gate U4A to provide 6 dB per octave receive audio de–emphasis. No – Closes de–emphasis bypass gate U4B and opens de–emphasis gate U4A to provide a flat receive audio response curve.

MNT_ PC - UC



MODEM PROGRAMMING SETUP
FIGURE 3–7

3.4 DL3472 RADIO MODEM PROGRAMMING

3.4.1 GENERAL

For proper operation of the synthesized UHF radio, it is necessary to program the radio for the desired frequencies. The modem can be programmed for up to 15 separate frequency pairs (receive and transmit frequencies).

3.4.2 PROGRAMMING JUMPERS

To program the modem, the program jumper (TB1) inside the modem must be placed in the program position (see Figure 6–10), and the modem must be powered. To access the program jumper, the top cover must be removed. The jumper can be assessed without removing the radio module (top PC board).

NOTE: It is not necessary to have the radio module attached to the modem for programming.

A frequency pair is programmed by down loading a control string of ASCII characters through the modem serial port with a dumb terminal or personal computer. The configuration of the serial port during programming is controlled by the "TTL"/"232" (signal levels). "BRO–BR2" (baud rate) and "8–9" (character length) DIP switches. However, only the 7 least significant bits are used to signify an ASCII character. Therefore, any parity or 8th and 9th bit will be ignored.

3.4.3 PROGRAMMING CONTROL STRING

The programming control string is:

+TSCxxRyyy.yyyyTzz.zzzz

xx = 2-digit channel number 01-15.
yyy.yyyy = Receive frequency MHz.
zzz.zzzz = Transmit frequency MHz.

It is important that the letters are UPPER CASE, and that the decimal place is included in the frequency. Immediately following the last digit entered the Transmit and Receive LEDs flash together three times, and then return to both on indicating that a correct frequency sequence has been entered. When the modem is in program mode, both the RX and TX LEDs are continuously on.

The lowest frequency which can be programmed into the synthesized UHF radio is 402.7500 MHz, and the highest frequency is 512.2500 MHz.

Example 1:
Channel 1
Tx frequency = Rx frequency = 409.2500 MHz
The ASCII control string is:

+TSC01R409.2500T409.2500

Example 2:
Channel 1
Tx frequency = Rx frequency = 422.2500 MHz
The ASCII control string is:

+TSC01R422.2500T422.2500

3.5 CHANNEL SELECTION

3.5.1 SYNTHESIZED RADIO

When the modem is powered up, it comes up on frequency pair 01. To change the frequency pair, an ASCII string is loaded into the modem through the serial port. The control string for changing to a new frequency pair is +TSxx . The xx signifies the frequency channel from 01 to 15. If a frequency channel is selected which has not previously been programmed, the RX and TX LEDs alternately flash (see Section 2.3.5).

Example 1:
The control string for frequency pair 12 is: +TS12

Example 2:
To return to frequency pair 01: +TS01

Changing the frequency pair is accomplished just the same as sending a burst of data. The frequency change control string can be sent alone, or it can be appended to the beginning of a transmission burst.

If just the control string is sent to the modem, the modem switches to the new frequency pair and continues to receive. If the control string is appended onto the beginning of a burst, the modem switches to the new transmit frequency and transmits the burst (without the control string). The control string must be the first characters that the serial port receives. For Handshake Mode, this implies that the control string must be the first characters received after RTS is activated. For Data Only Mode, this means that there should not have been any characters sent to the serial port for at least 10 character times before the control string.

SECTION 4
CIRCUIT DESCRIPTION

4.1 GENERAL

4.1.1 INTRODUCTION

The main subassemblies of this transceiver are the RF board, VCO board, TCXO (-x10/x20 model only), Audio/RSSI board, Loader board and Modem board. The Audio/RSSI board is an option available for the -x10/x20 models, the Loader board is standard with the -x30/x40 models and the Modem board is standard with the -x12/-x22 models (refer to Section 1.3). A block diagram of the transceiver is located in Figure 4-1.

The Audio/RSSI board plugs into connector P201 on the RF board. When the Loader board is used, the Audio/RSSI board is not used because the Loader board includes that circuitry. (Jumpers R218 and R219 are installed when the Loader board is used.) The VCO board is enclosed by a metal shield and soldered directly to the RF board. The VCO is not serviceable. When the Modem board is used neither the Loader or Audio/RSSI boards are used because the Modem contains this circuitry.

The 3472 is available with a reference oscillator stability of ±2.5 PPM or ±5 PPM. The ±2.5 PPM version uses a TCXO (Temperature Compensated Crystal Oscillator) module that is soldered directly to the RF board. The ±5 PPM version uses an oscillator formed by discrete components on the RF board. These components are not installed with the ±2.5 PPM version.

4.1.2 SYNTHESIZER

The synthesizer 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 45 MHz below the receive frequency. The synthesizer output signal is produced by a VCO (voltage-controlled oscillator). The frequency of this oscillator is controlled by a DC voltage produced by the phase detector in synthesizer chip U801.

Channels are selected by programming counters in U801 to divide by a certain number. This programming is performed over a serial bus formed by the Synth Lock, Synth Enable, and Synth Data pins of J1. This programming is performed by user-supplied hardware and software or by the loader board (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 45 MHz and 455 kHz. Two helical bandpass filters reject the image, half IF, injection, and other unwanted frequencies. A two-pole crystal filter enhances receiver selectivity.

4.1.4 TRANSMITTER

The transmitter produces a nominal RF power output of 2 watts. Frequency modulation of the transmit signal occurs in the synthesizer. Transmit audio processing circuitry is contained in the customer-supplied equipment or the loader board.

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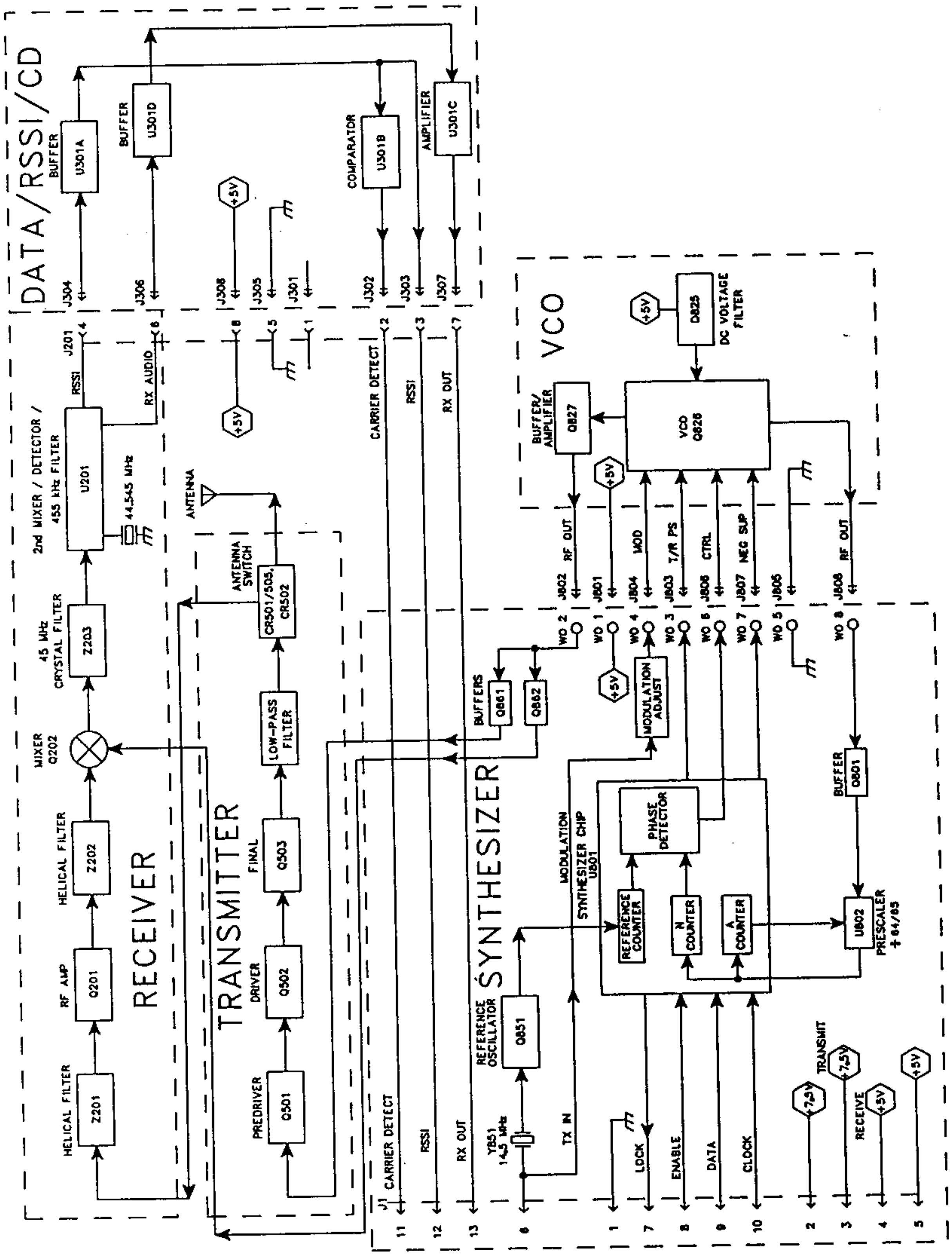
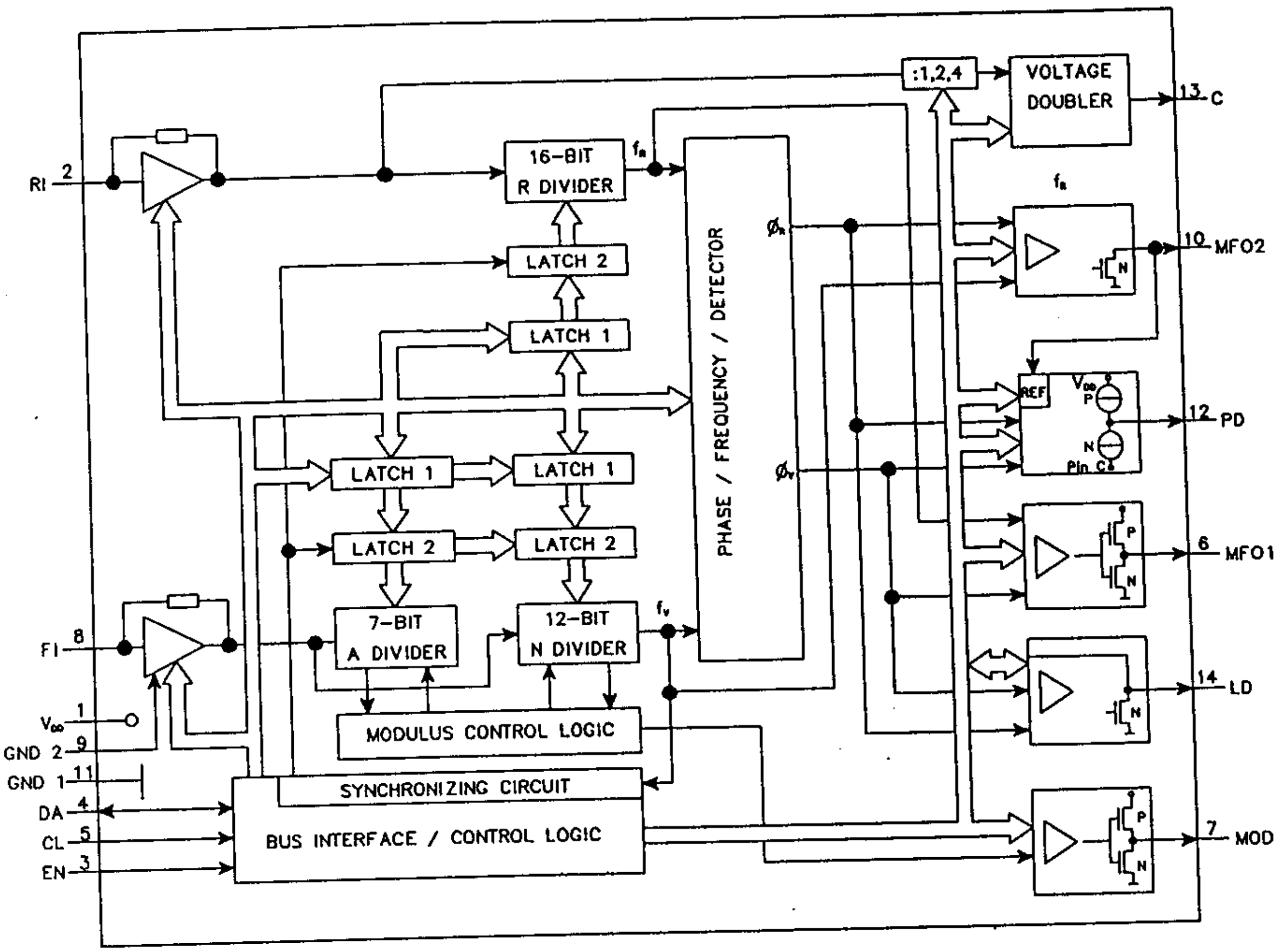


DATA TRANSCEIVER BLOCK DIAGRAM
FIGURE 4-1



U801 SYNTHESIZER BLOCK DIAGRAM
FIGURE 4-2

4.2 SYNTHESIZER

4.2.1 INTRODUCTION

A block diagram of the synthesizer is shown in Figure 4-1 and a block diagram of synthesizer IC U801 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 U801. 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.

One input signal is the reference frequency (f_R). This frequency is produced by the R counter which divides the 14.5 MHz reference oscillator frequency by 1160. This results in a reference frequency that is half the channel spacing or 12.5 kHz.

The other phase detector input signal (fv) is the VCO frequency divided by prescaler U802 and the "N" counter in U801. These counters are programmed for each channel so that when the VCO is locked on the correct frequency, the fv input to the phase detector is the same frequency as the f_R input.

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4.2.2 VOLTAGE-CONTROLLED OSCILLATOR

Oscillator (Q826)

The VCO is formed by Q826, several capacitors and varactor diodes, and a resonator formed by a section of transmission line. It oscillates at the transmit frequency in transmit mode and first injection frequency in the receive mode (approximately 400 MHz). Biasing of Q826 is provided by R829, R830 and R831. An AC voltage divider formed by C834, C837 and C836 initiates and maintains oscillation and also matches Q826 to the tank circuit.

The resonator is a grounded transmission line that provides shunt inductance to the tank circuit. Variable capacitor C830 tunes the tank circuit to the desired frequency range.

Frequency Control and Modulation

The VCO frequency is controlled in part by DC voltage across varactor diode CR825. As voltage across a reverse-biased varactor diode increases, its capacitance decreases. Therefore, VCO frequency increases as the control voltage increases. The control line is isolated from tank circuit RF by choke L826, decoupling capacitor C826, and resistor R825. The amount of frequency change produced by CR825 is controlled by series capacitor C829.

The VCO frequency is modulated using a similar method. The transmit audio/data signal is applied across varactor diode CR827 which varies the VCO frequency at an audio rate. Series capacitor C832 sets the amount of deviation produced. R828 and C819 provide isolation from tank circuit RF. R815 provides a 5V bias, and potentiometer R814 balances VCO and reference oscillator modulation signals.

4.2.3 VCO AND REFERENCE OSCILLATOR MODULATION

Both the VCO and reference oscillator (TCXO) are modulated in order to achieve the required frequency response. If only the VCO was modulated, the phase detector in U801 would sense the frequency change and increase or decrease the VCO control voltage to counteract the change (especially at the lower audio frequencies). If only the reference oscillator frequency is modulated, the VCO frequency would not change fast enough (especially at the higher audio frequencies). Modulating both VCO and reference oscillators produces a flat audio response. Potentiometer R814 sets the VCO modulation sensitivity so that it is equal to the reference oscillator modulation sensitivity.

4.2.4 +5V DC VOLTAGE FILTER (Q825)

Q825 functions as a capacitance multiplier to provide filtering of the +5V supply to Q826. Resistor R833 provides transistor bias, and C840 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 C840. Therefore, base current does not change and transistor current remains constant. CR828 decreases the charge time of C840 when power is turned on. This shortens the startup time of the VCO. R834 provides isolation, and C839/C841/C842 are RF decoupling capacitors.

4.2.5 AMPLIFIER (Q827), BUFFERS (Q861, Q862)

Amplifier Q827 provides amplification and isolation between the VCO and receiver and transmitter. C838 provides DC blocking between the amplifier and oscillator. Bias for Q827 is provided by R835, R836 and R837. Inductor L827 and capacitor C845 provide impedance matching on the output.

The output signal is applied to a 50-ohm pad formed by R820, R821, and R822. This pad provides 12 dB of attenuation. Q861 and Q862 form a shared-bias buffer amplifier which provides amplification and also additional isolation between the VCO and receiver and transmitter. Biasing for these stages is provided by R861-R865, and decoupling of RF signals is provided by C861, C863, C866, and C867. Impedance matching with the transmitter is provided by L862 and C864, and impedance matching with the receiver is provided by L861, C869, and R816.

4.2.6 BUFFER (Q801), PRESCALER (U802)

Prescaler buffer Q801 provides amplification and isolation similar to Q827. C835 provides DC blocking and also impedance matching between oscillator Q826 and Q801. Resistor R807 provides biasing, R807 provides supply voltage isolation, and C808 provides DC blocking between the buffer and prescaler. Impedance matching with the prescaler is provided by C808, L801, R806 and C807.

U802 is a dual-modulus prescaler. A prescaler is a counter capable of operating at high frequencies, and dual modulus refers to the two divide numbers, 64 and 65. This counter divides an input signal in the 450 MHz range down to the 7 MHz range so that it is within the operating range of the counters in U801. The prescaler divides by 64 when the control input (pin 6) is high, and by 65 when it is low. This particular counter is also capable of dividing by 128/129. It divides by 64/65 when pin 3 is high and by 128/129 when it is low. C804 couples the output signal to U801.

4.2.7 REFERENCE OSCILLATOR (Q851)

Q851 is a modified Colpitts oscillator that is temperature compensated to provide a frequency stability of ±5 parts per million (PPM) from −30° to +60° C (−22° to +140° F). Capacitors C855 and C857 control feedback, and C854 sets the adjustment range of C851.

Temperature compensation is provided by C852/C853 and thermistor RT851. The capacitance (as well as the resistance) of RT851 changes with temperature. This change in capacitance compensates for frequency drifting of the crystal caused by temperature changes. The value of C853 is specially selected for each crystal, and the value is stamped on the crystal. The transmit audio/data signal applied across varactor diode CR851 frequency modulates the oscillator frequency (see Section 4.2.3).

A ±2.5 PPM TCXO module is installed in the −x20/x40 transceivers. When this module is used, the 5 PPM oscillator components on the PC board are not installed.

4.2.8 SYNTHESIZER INTEGRATED CIRCUIT (U801)

Introduction

Synthesizer chip U801 is shown in Figure 4−2. This device contains the following circuits: R (reference), N, and A counters; phase and lock detectors, and counter programming circuitry. The basic operation was described in Section 4.2.1.

Channel Programming

Frequencies are selected by programming the R, N and A counters in U801 to divide by a certain number. These counters are programmed by a user supplied programming circuit or by the loader board (refer to Section 1.3). More information on channel programming is located in Section 3.

U802 Operation

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 (f_V) is the same frequency as the reference oscillator−derived frequency (f_R). The reference frequency is produced by dividing the 14.5 MHz TCXO frequency by 1160.

The VCO frequency is divided by the prescaler (U802) and the "N" counter to produce the fv input to the phase detector. As stated in Section 4.2.6, the prescaler divides by 65 when the control voltage on pin 6 is low and 64 when it is high. The number of pulses counted in each mode is controlled by the "A" and "N" counters.

Both the N and A counters begin counting down from the number that they are programmed with. When the A counter reaches zero, it halts until the N counter reaches zero. Both counters then reset and the cycle repeats. The A counter is always programmed with a smaller number than the N counter. While the A counter is counting down, the modulus control output on pin 7 is low and the prescaler divides by 65. Then when the A counter is halted, the modulus control output is high and the prescaler divides by 64.

To describe the operation of the prescaler, "N" and "A" counters, the following example will be used. Assume that the transceiver is transmitting on 421.500 MHz. This is also the VCO frequency in the transmit mode. To produce this frequency, the N and A counters are programmed as follows:

N = 526   A = 56

NOTE: Section 5.2.6 describes how the N and A counter numbers can be calculated for other frequencies.

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The overall divide number of the prescaler and N counter can be determined by the number of VCO output pulses required to produce one N counter output pulse. In this case, the prescaler divides by 65 for 65 x 56 or 3,640 input pulses. It then divides by 64 for 64 x (526 – 56) or 30,080 input pulses. The overall divide number K is therefore 30,080 + 3,640 or 33,720. The VCO frequency of 421.500 MHz ÷ 33,720 = 12.5 kHz, the f_R input to the phase detector. The overall divide number K can also be determined by the following formula:

$$K = 64N + A$$

Where,
N = N counter divide number and
A = A counter divide number.

4.2.9 LOCK DETECT

When the synthesizer is locked on frequency, the SYNTH LOCK output of U801, pin 14 (J1, pin 7) is basically a high voltage because only narrow negative-going pulses are present. Then when the synthesizer is unlocked, the negative-going pulses become much wider and the output is basically a low voltage.

4.3 RECEIVER CIRCUIT DESCRIPTION

4.3.1 HELICAL FILTER (Z201), RF AMPLIFIER (Q201)

Capacitor C201 couples the receive signal from the antenna switch to helical filter Z201. (The antenna switch is described in Section 4.4.3.) Z201 is a bandpass filter tuned to pass only a narrow band of frequencies to the receiver. This attenuates the image and other unwanted frequencies. The helicals are tuned using the screw in the top.

Impedance matching between the helical filter and RF amplifier Q201 is provided by C202, C203 and L201. Q201 amplifies the receive signal to recover filter losses and also to increase receiver sensitivity. Biasing for Q201 is provided by R201, R202 and R203; and C204/C205 provide RF bypass. CR201 protects the base-emitter junction of Q201 from excessive negative voltages that may occur during high signal conditions. Additional filtering of the receive signal is provided by Z202. L202 and C206 provide impedance matching between Q201 and Z202. Resistor R204 is used to lower the Q of L202 to make it less frequency selective.

4.3.2 MIXER (Q202)

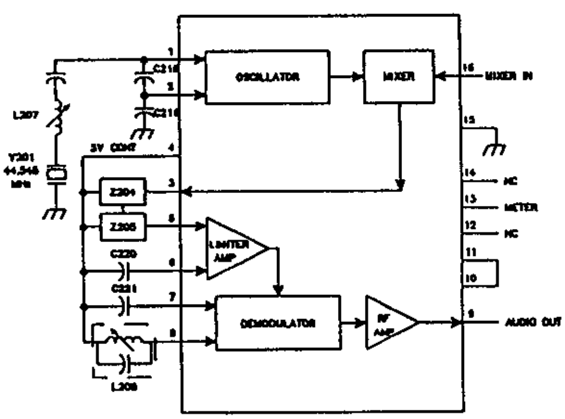
First mixer Q202 mixes the receive frequency with the first injection frequency to produce the 45 MHz first IF. Since low-side injection is used, the injection frequency is 45 MHz below the receive frequency. Matching between Z202 and the mixer is provided by L203, L204 and C209. The output of Q202 is tuned for 45 MHz by an LC filter formed by L205, C212 and C213. This filter presents a low impedance to 45 MHz and attenuates the receive, injection, and other frequencies outside the 45 MHz passband. R211 lowers the Q of L205.

Z203 is a two-pole crystal filter with a –3 dB passband of 15 kHz. This filter establishes the receiver selectivity by attenuating the adjacent channel and other signals close to the receive frequency. L206, R216, and C214 provide impedance matching between the filter and U201.

4.3.3 SECOND MIXER/DETECTOR (U201)

<u>Oscillator and Mixer</u>

As shown in Figure 4–3, U201 contains second oscillator, second mixer, limiter, detector, and squelch circuitry. The 45 MHz IF signal is mixed with a 44.545 MHz signal produced by an internal oscillator and crystal Y201. L207 is used to adjust the oscillator frequency.



U201 BLOCK DIAGRAM
FIGURE 4–3

Ceramic Filter

The output of the internal double-balanced mixer is the difference between 45 MHz and 44.545 MHz which is 455 kHz. This 455 kHz signal is fed out on pin 3 and applied to ceramic filters Z204 and Z205. These filters have passbands of 15 kHz at the -6 dB points and are used to attenuate wideband noise.

Limiter-Amplifier

The output of Z204/Z205 is applied to a limiter-amplifier circuit in U201. This circuit amplifies the 455 kHz signal and any noise present and then limits this signal to a specific value. When the 455 kHz signal level is high, noise pulses tend to get clipped off by the limiter; however, when the 455 kHz signal level is low, the noise passes through. C220, C221 decouple the 455 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 455 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. L208 is tuned to provide maximum undistorted output from the detector. R214 is used to lower the Q of L208. From the detector the audio and data signal is fed out on pin 9.

Audio/Data Amplifier

NOTE: The Audio/RSSI board is not used with some models (see Section 1.2).

The audio/data output of U201 on pin 9 is fed to the Audio/RSSI board through pin 6. (If the loader board is used, it is fed to that board as described in Section 4.5.) The signal is buffered by U301D and then fed to U301C. This stage amplifies the detected audio/data signal and shifts the DC bias level to 2.7V. The gain is set at approximately 1.5 by R305/R306. R301 and R302 provide a 2.7V DC reference bias voltage and RT302/R314 provide temperature compensation.

Receive Signal Strength Indicator (RSSI)

U201, pin 13 is an output for the RSSI circuit which provides a current proportional to the strength of the 455 kHz IF signal. The voltage developed across R217 is applied to buffer U301A on the audio/RSSI board. The output of U301A has a voltage swing of approximately 100 mV to 2.5V DC. This voltage increases with the level of the 455 kHz signal.

Carrier Detect

The RSSI output signal of U301A is also used to provide the carrier detect signal. U301B is configured as a comparator, and when the RSSI signal on pin 6 reaches the reference level on pin 5, the output goes low to indicate carrier detect. The reference voltage on pin 5 is produced by R310, R311 and R313. R312 provides hysteresis to prevent an intermittent carrier detect indication when receiving a weak or fading signal. Potentiometer R311 sets the carrier detect threshold level by adjusting the input level to U301B.

4.4 TRANSMITTER CIRCUIT DESCRIPTION

4.4.1 PRE-DRIVER (Q501)

Pre-driver Q501 is biased class A by R501 and R502. Zener diode CR503 and R511 provide regulation of the bias voltage. C502 and C507 bypass RF from the DC line, and R503 provides supply voltage isolation. Impedance matching between Q501 and Q502 is provided by L502, L503 and C504. R514 lowers the Q of L503 to broaden the frequency response of the matching network.

4.4.2 DRIVER (Q304), FINAL (Q305)

Driver Q502 is biased nearly Class C by R505 and R506. Zener diode CR504 and R512 provide regulation of the bias voltage. The supply voltage to Q502 is isolated from RF by C509 and ferrite bead EP501. Impedance matching with Q503 is provided by L505 and several capacitors.

Q503 is self-biased for Class C operation by L506. The output is matched to the low-pass filter by L507, a section of microstrip, L508, and several capacitors. The supply voltage is isolated from RF by ferrite bead EP502 and several capacitors.

MNT - PC - JC

The low-pass filter consists of C525, L509, C526, L510, and C527. The filter attenuates spurious frequencies occurring above the transmit frequency band. The transmit signal is then fed through the antenna switch to antenna jack J501.

4.4.3 ANTENNA SWITCH (CR501, CR502)

The antenna switching circuit switches the antenna to the receiver in the receive mode and the transmitter in the transmit mode. In the transmit mode, +7.5V is applied to L511 and current flows through PIN diodes CR501/CR505, L512, PIN diode CR502, and R509/R510. When a PIN diode is forward biased, it presents a low impedance to the RF signal; conversely, when it is reverse biased (or not conducting), it presents a high impedance (small capacitance). Therefore, when CR501/CR505 are forward biased, the transmit signal has a low-impedance path to the antenna through coupling capacitor C530.

C528, L512, and C531 form a discrete quarter-wave line. When CR501 is forward biased, this quarter-wave line is effectively AC grounded on one end by C532. When a quarter-wave line is grounded on one end, the other end presents a high impedance to the quarter-wave frequency. This blocks the transmit signal from the receiver.

In the receive mode, no power is applied to L511, so all the PIN diodes are "off". The receive signal then has a high-impedance path into the transmitter and a low-impedance path into the receiver because the quarter-wave line is no longer grounded.

4.5 LOADER BOARD CIRCUIT DESCRIPTION

NOTE: A Loader board block diagram is located in Figure 4-4.

4.5.1 +7.5V DC VOLTAGE REGULATOR

The +13.8V input to the Loader board is on J2, pin 5 that is connected to +8V regulator U14, pin 1 (input) through wireout 1. The base-emitter drop is about 0.7V which results in a +7.5V regulated output on U14, pin 3. U14, pin 2 is connected to ground through wireout 3. The output is connected to the Loader board through wireout 2. This +7.5V source also supplies the +5V regulator circuit.

4.5.2 MICROPROCESSOR (U8), EEPROM (U1)

The Loader board connects to the 3472 transceiver module through 14-pin connector P2. EEPROM U1 stores the information programmed into the Loader board using the computer and software described in Section 3.3. U1 stores up to 16 x 16 bits. A 4 MHz clock generates the pulses used by the microprocessor to program the synthesizer. Programming information is fed out on the Enable, Data, and Clock lines (pins 31, 35, and 36) and is buffered by U5A, U5B, and U5F.

The PB2, PB3, PB4, PB5, and PB6 outputs of the microprocessor control U12A, U12B, U12C, U4B, and U4C which provide gating of the transmit and receive data signals. The data signal is in the form of audio tones that can be transmitted and received. These audio tones are converted back to digital data by the user-supplied data equipment.

4.5.3 GATES (U12A, U12B), FILTER (U10A)

There are two transmit data inputs available (only one can be used); Wideband data input (J2-1) and Standard data input (J2-8). The input on pin 8 is applied to R3 which sets the input level. The signal is then routed to pre-emphasis stage U10A or bypassed around this stage by gates U12A and U12B. Programming determines if pre-emphasis is used. The gate passes the input signal when the control input (pin 13/5) is high and blocks it when it is low. Q10 and Q12 provide buffering and level translation from 5V to 7.5V.

U10A provides 6 dB per octave pre-emphasis to the data signal. This and the de-emphasis at the receiving end improves the signal-to-noise ratio. If the data signal is bypassed around U10A, it has a flat response characteristic.

4.5.4 LIMITER (U10B), SPLATTER FILTER (U10C, U10D), GATE (U4C)

Limiter U10B prevents overmodulation caused by high input levels by saturating. The output signal is coupled to splatter filter U10C/D. This is a low-pass filter which attenuates frequencies above approximately 3 kHz resulting from amplitude limiting. These frequencies could cause adjacent channel interference.

The output from the filter is fed to R2 which sets the deviation limiting level. Bias adjust R82 sets the DC voltage level to +2.5V DC, ±.1V. When the data input J2, pin 8 is used, gate U12D passes the audio signal to P1, pin 8. Conversely, when the wideband data input on J2, pin 1 is used, it blocks the signal from pin 8.

When the wideband data input is used, a +2.5V DC, ±.1V temperature-compensated bias source must be provided on pin 1. This is required because any DC voltage changes on the wideband data input, changes the transmit and receive frequency.

4.5.5 BUFFER (U9D), AMPLIFIER (U9C)

The receive data signal on J2, pin 13 is buffered by U9D and then fed to data amplifier U9C. This stage amplifies the signal and shifts the DC bias level to 2.7V DC. R15/R17 set the gain and R1 sets the DC reference level. The output of U9C is applied to J2, pin 2 and also to output level adjust control R4. When the loader board is used, jumper R219 must be installed on the RF board to connect the data signal from pin 6 to pin 7 of P201.

4.5.6 GATES (U4A-C), DE-EMPHASIS FILTER (U11A), AMPLIFIER (U11B)

Mute gate U4A is controlled by the carrier detect circuit described in the next section. The output of U4A is routed to de-emphasis stage U11A or bypassed around that stage by gates U4B and U4C. The operation of these gates is controlled by Loader board programming.

U11A provides 6 dB of de-emphasis to the receive data signal. This and the pre-emphasis at the transmitting end improve the signal to noise ratio. When U11A is bypassed, the data signal has a flat response characteristic. U11B provides amplification of the data signal, and the output is fed out on J2, pin 10 to the customer data equipment.

4.5.7 BUFFER (U9A), AMPLIFIER (U9B), GATE (U4A)

The RSSI from the receiver is on P1, pin 12. When the Loader board is used, jumper R218 is installed on the RF board to connect this signal from P201, pin 4 to pin 2. The RSSI signal is a voltage that increases in proportion to increases in the strength of the 450 kHz IF signal. U9A provides buffering of the RSSI signal.

The RSSI signal is also applied to carrier detect amplifier U9B. When this signal reaches the reference level on pin 5, the output on pin 7 goes low. Therefore, a low output indicates a carrier of significant strength, and a high output indicates no carrier. The reference voltage on pin 5 is provided by R5, R9, and R8. Potentiometer R5 sets the carrier detect threshold by adjusting the input level. R13 provides hysteresis to prevent an intermittent carrier detect indication when receiving a weak or fading signal.

When a carrier is indicated, pin 7 of user interface connector J2 goes low and transistor Q7 also turns off. The control input of gate U4A then goes high and it passes the audio signal. When no carrier is detected, the opposite occurs.

4.5.8 PUSH-TO-TALK, RECEIVE/TRANSMIT SWITCHING

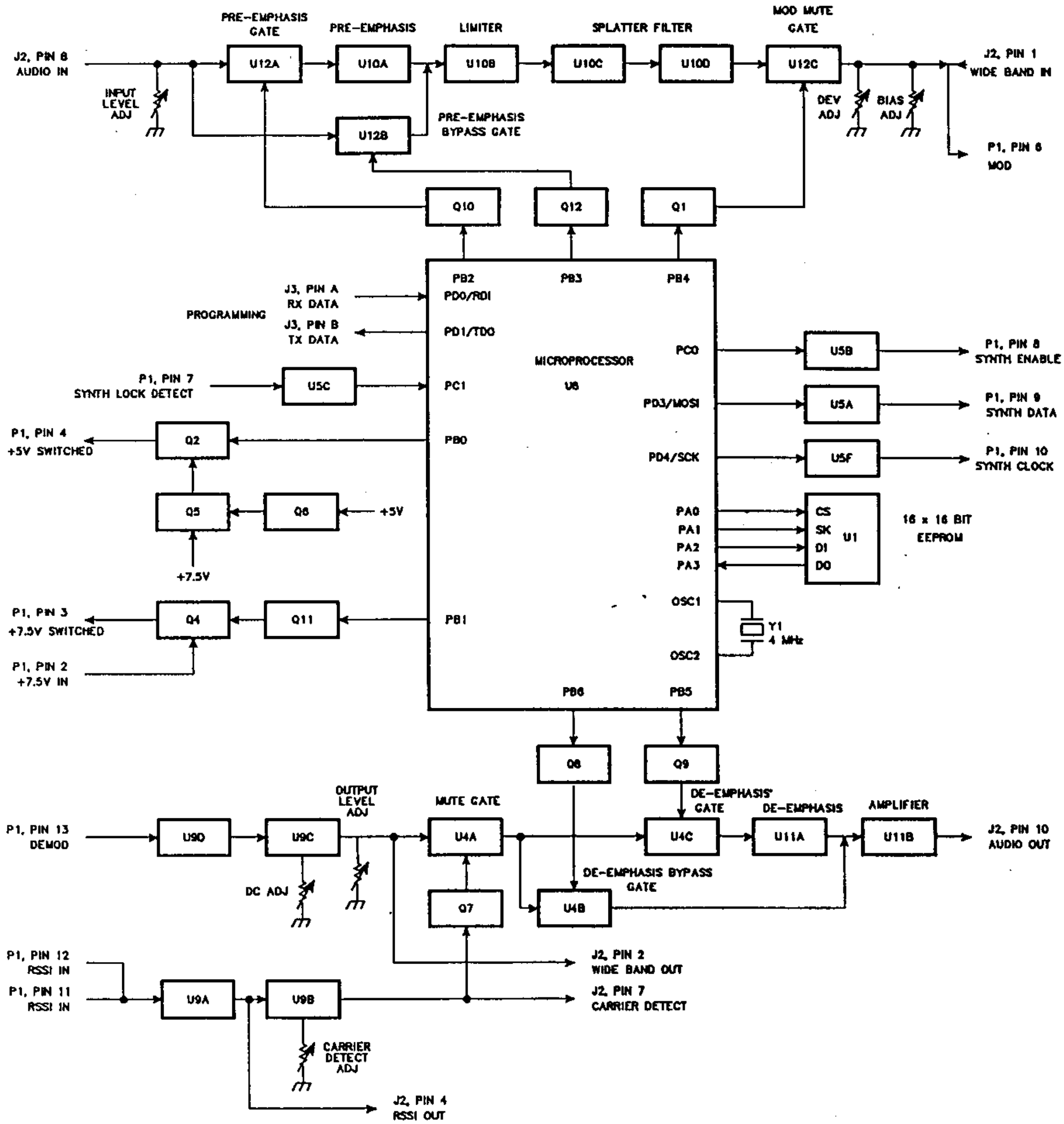
The PTT input from the user equipment is J2, pin 6. This line goes low when the transmitter is to be enabled and high when it is to be disabled. When a low input is detected by the microprocessor on pin 29, it brings the output on pin 13 high. This turns off Q2 which removes the 5V receive supply on the collector and disables the receiver.

A low signal on pin 29 of U8 also causes the output on 14 to go high. This turns on both Q11 and Q4 which enables the transmit 7.5V supply. This supply controls the transmitter. When the PTT input on pin 29 of U8 goes high, the opposite occurs (the 5V receive supply is enabled and the 7.5V transmit supply is disabled).

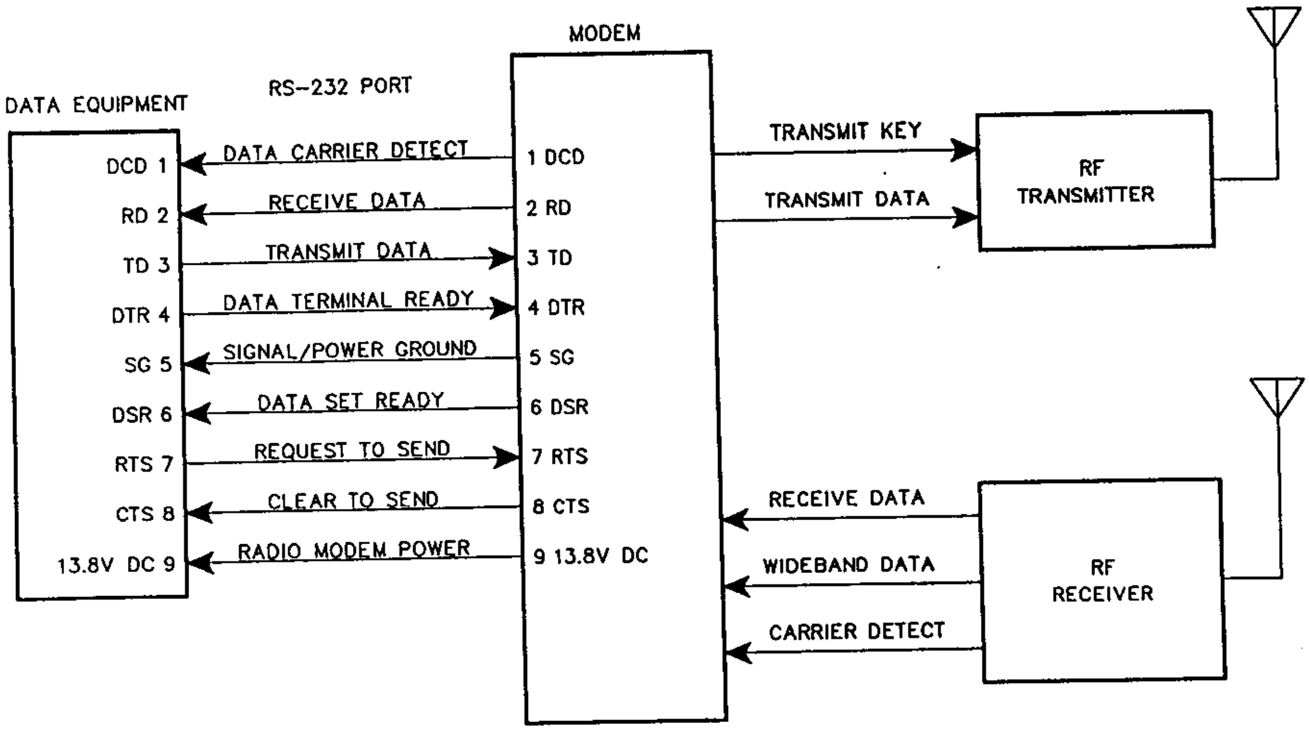
4.5.9 FREQUENCY SELECT, SYNTHESIZER LOCK DETECT

A high-low or low-high transition on U8, pin 29 also causes the microprocessor to load the synthesizer with frequency data. However, before this data is loaded, the microprocessor checks pin 28 to determine if channel 1 or 2 is selected. A low indicates channel 1 and a high indicates channel 2.

Pin 30 is the lock detect input to U8. When the synthesizer is locked on frequency, the lock detect input on P1, pin 7 is a high voltage with only very narrow negative-going pulses. Conversely, when it is unlocked, the negative-going pulses become much wider. If the microprocessor detects an out-of-lock condition, it disables both the 5V receive and 7.5V transmit supplies. This disables the receiver and transmitter to prevent the transmission or reception of an improper frequency.



LOADER BOARD BLOCK DIAGRAM
FIGURE 4–4



TELEMETRY EQUIPMENT BLOCK DIAGRAM
FIGURE 4–5

4.6 DL3472 RADIO MODEM THEORY OF OPERATION

4.6.1 INTRODUCTION

The function of a modem is to convert digital data into tones that can be transmitted using an RF link. It also converts these tones back into digital data when the signal is received. A block diagram showing the telemetry receiver and transmitter, modem, and data equipment is shown in Figure 4–5.

4.6.2 HALF DUPLEX OPERATION

Half duplex means that data can be both received and transmitted but not simultaneously. This type of operation requires only a half–duplex transceiver and one RF channel. If the modem is connected to only a transmitter or receiver, data transmission is only one way. For example, if only a transmitter is used, data can be sent from a site but not received.

4.6.3 RS–232 PORT

The 9600 Baud Modem is designed to be compatible with the RS–232 standard of the Electronic Industries Association (EIA). This standard specifies pin assignments and voltage levels associated with the interface between data terminals and data communication equipment. Equipment connected to this modem should be compatible with this standard. The RS–232 port uses a standard DB–25 female connector.

The modem can be programmed to work with either TTL or RS–232 signal levels on this port. TTL levels are represented by voltages of 0 and 5V, and RS–232 logic levels are as follows:

+3 to +25 V = Space (logic 0) for data lines; ON for control lines (RTS, etc).

−3 to −25 V = Mark (logic 1) for data lines; OFF for control lines.

MNT _ PC _ UC

The RS-232 standard also provides for two basic port configurations: DTE (Data Terminal Equipment) and DCE (Data Communication Equipment). The port of this modem is always configured as DCE. A DCE port transmits data on J13, pin 3 and receives data on J13, pin 2 (see Figure 4-5). DTE ports have the direction of these signals reversed to allow direct connection of a DCE to a DTE port. The direction of the RTS/CTS and DSR/DTR signals is also reversed on DCE and DTE ports.

4.7 SENDING DATA USING DCE/DTE PROTOCOL

NOTE: Data handshake protocol is described in Section 2.3.14.

4.7.1 INITIATING A TRANSMISSION

A data transmission is initiated by a data terminal or computer connected to the modem. Before data can be transmitted, the DTR (Data Terminal Ready) signal from this equipment must be high. This tells the modem that the equipment is ready to receive or transmit data. When the DTR signal is high, the other inputs and outputs of the port are functional. The DTR line may also remain unused if desired. Before data can be transmitted, the DSR (Data Set Ready) line from the modem must also be high. This line is high whenever the modem is powered up.

If the DTR and DSR lines are high, the data equipment brings the RTS (Request To Send) line high when it is ready to send data. This line must remain high until the data transmission is finished. When the RTS line goes high, the transmitter is keyed.

4.7.2 RECEIVING THE DATA

The receiver receives a carrier after the RTS line goes high. The carrier detect output of the receiver is triggered after receiving a carrier. At the same time carrier detect occurs, the modem brings the DCD (Data Carrier Detect) line high. The data is then fed to the data equipment on the RD (Receive Data) line.

4.7.3 ENDING THE DATA TRANSMISSION

When the data equipment finishes sending data, it brings the RTS line back low. The transmit keying, CTS, and TD lines then also go to the inactive state.

When the receiver no longer receives a carrier, the receiver carrier detect and audio signals remain enabled for approximately 20 ms due to RF noise and squelch delay. Then after another short delay, the modem DCD and RD lines go to the inactive state. Trailer bits may be sent at the end of a transmission to ensure that data is not lost in the RF noise that occurs when the transmitter unkeys.

4.8 SENDING DATA USING DATA ACTIVATION PROTOCOL

NOTE: Data handshake protocol is described in Section 2.3.14.

With data activation protocol, only the RD and TD lines are used. The DSR and CTS lines are active whenever the modem is powered up and the DTR and RTS lines are not used.

When a rising edge is detected by the modem on the TD line (pin 2), the transmitter is keyed. It remains keyed until there is no activity on the TD line for 100 ms or until the time-out timer expires (if used). Since the same delay occurs before the receiving modem can receive data, a transmission must begin with fill characters for the length of the RTS-CTS delay. When the receiving modem detects the carrier detect signal from the receiver, it brings the DCD line high.

4.9 MODEM CIRCUIT DESCRIPTION

NOTE: A Modem board block diagram is located in Figure 4-6.

4.9.1 TRANSMIT DATA PROCESSING

Transmit data comes into the modem through the serial port connector on J1, pin 3 and is buffered through the serial port buffer U7A. The data is then fed into microprocessor U9 which operates off an 8 MHz crystal. The microprocessor processes and stores the transmit data until transmission begins. The incoming data arrives as synchronous

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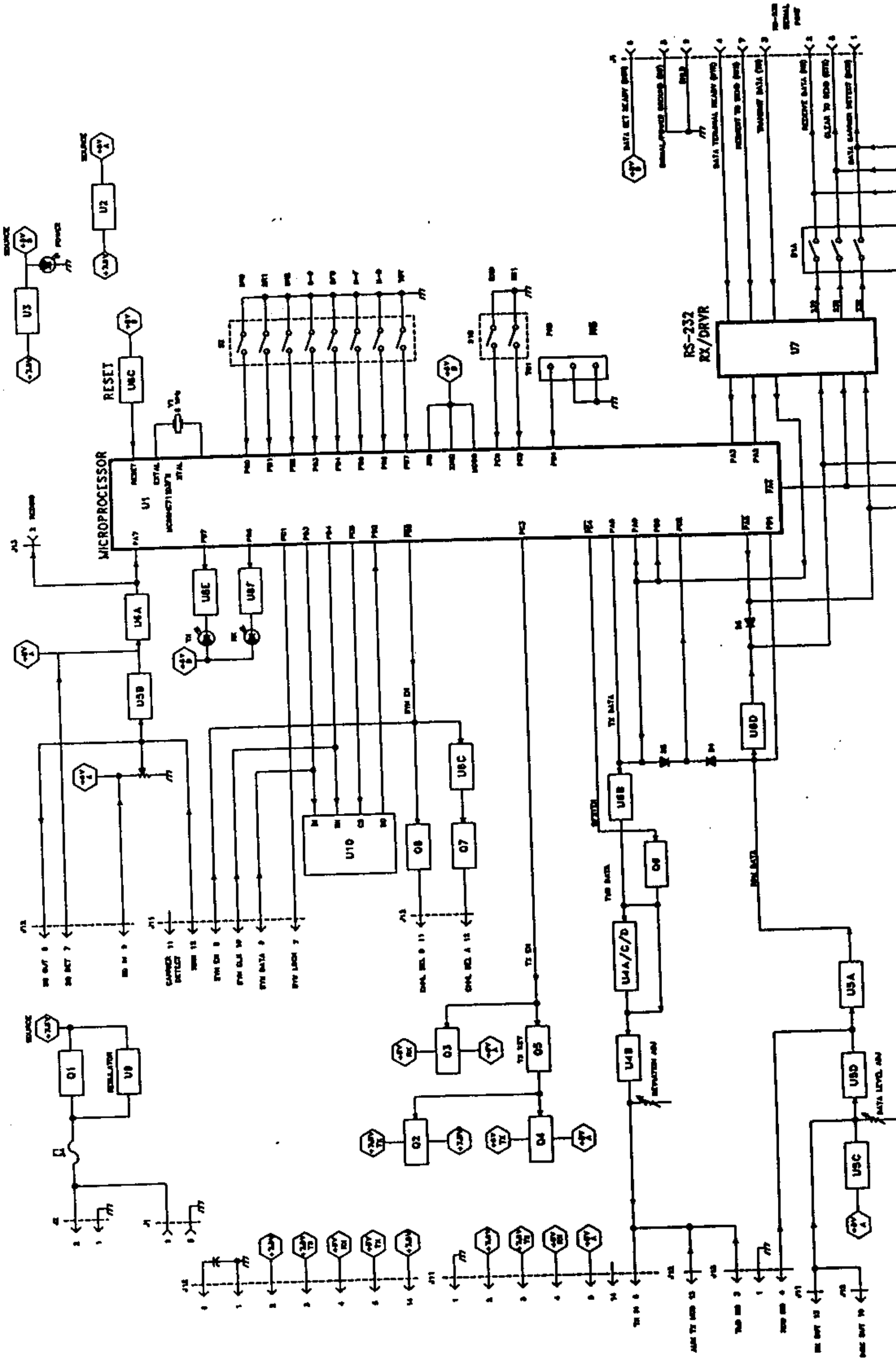


MODEM BOARD BLOCK DIAGRAM
FIGURE 4–6

characters with 1-start bit, 1-stop bit, and 8- or 9-data bits. When ready for transmission, the microprocessor scrambles the data with a pseudo-random sequence and feeds the data out as asynchronous characters. Transmit data out of the microprocessor is buffered through U6B before being sent to the limiter and filter circuitry.

After buffering through U6B, the data has rail-to-rail CMOS voltage levels (0 and 5V). These voltage levels are then limited with operation amplifier U4C. U4C also biases the signal to 2.5V (±0.1V) as specified by the RF transceiver module. This bias is ensured to be within the range specified by the RF transceiver due to the accuracy of voltage regulator U2 and resistors R8 and R9. The limited data out of U4C is filtered with an active filter utilizing op amps U4D and U4A. After filtering, the data is buffered with U4B. Transmit deviation is adjusted with trim pot R19. The limited, filtered and buffered transmit data is provided to the audio input of the RF transceiver through J11, pin 6.

4.9.2 POWER REGULATION AND SWITCHING

Regulator U1 and transistor Q1 form the primary voltage regulator which regulates the input voltage down to +7.5V DC. This voltage is used as the +7.5V DC continuous power into the RF transceiver (J11, pin 2). Regulators U2 and U3 further regulate this voltage down to +5V. The regulated +5V out of U2 is used as the +5V DC continuous power into the RF transceiver (J11, pin 5).

Transistors Q2, Q3 and Q5 are controlled by the microprocessor U9 in order to switch the RF transceiver between receive and transmit operation. Q3 switches the +5V DC receive voltage into the RF transceiver (J11, pin 4). Q2 and Q5 switch the +7.5V DC transmit voltage into the RF transceiver (J11, pin 3).

4.9.3 FREQUENCY SWITCHING

Receive and transmit frequencies are programmed into the modem through the serial port with a PC or dumb terminal. Frequencies can only be programmed when the program jumper TB1 is installed in the program location. Up to 15 transmit and receive frequency pairs are permanently stored in EEPROM U10. During normal operation, frequency pairs can be switched by sending the correct control string to the modem through the serial port. The synthesizer on the RF transceiver must be programmed whenever the modem transitions between receive and transmit operation or when a new frequency pair is selected. To program the synthesizer, processor U9 retrieves the program data from EEPROM U10 and controls the clock, data and enable synthesizer programming signals (J11, pins 8, 9 and 10).

Microprocessor U9 also monitors the RF transceiver's synthesizer lock detect on J11, pin 7. When the synthesizer is locked, this signal is high with narrow negative pulses. When the synthesizer is unlocked, the negative pulses are wide. The processor inhibits transmission when the synthesizer is unlocked.

4.9.4 RECEIVE DATA PROCESSING

The receive audio signal is passed from the RF board to the Modem board on J11, pin 13. The receive level into the data detector is adjusted with R22. The receive data is detected with U5D. The detected data is level shifted with U5A and U5C.

The detected receive data is fed into microprocessor U9 for data processing. Once processed, the data is fed out of the microprocessor and buffered through either the RS-232 buffer U7 or the TTL buffer U8.

4.9.5 RECEIVER RSSI

The RSSI signal from the RF board is passed to the Modem board on J11, pin 12. U5B compares the RSSI signal level with a reference RSSI carrier detect level set with R31. The carrier detect signal is buffered through U6A and sent to microprocessor U9. The carrier detect signal indicates to the microprocessor that there is valid incoming receive data to process.

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 crystal 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 usually not locked on frequency. When an unlocked VCO is detected by the lock detector circuit, U801, pin 14 goes low (0V).

NOTE: If not using the loader board, the user-supplied circuitry must disable the transmitter and receiver when an out-of-lock condition is indicated.

When the VCO is unlocked, the fR and fV inputs to the phase detector are usually not in phase (see Section 4.1.2). The phase detector in U801 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 Q826, prescaler U802, and the N counter and phase detector in U801. 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 U801, pin 2. It should be 14.5 MHz at a level of approximately 1.5V P-P. If the 2.5 TCXO module is defective, it is not serviceable and must be replaced with a new module as described in Section 5.1.5.

MNT_ PC _ VC

5.2.3 VCO

Output Level

The output level of Q801 can be measured with an RF voltmeter or some other type of high impedance meter. The minimum output level on the collector should be −5 dBm.

Control Voltage

Check the DC voltage across U801, pins 12 and 13 with a channel near the center of the band. If the VCO is locked on frequency, this should be a steady DC voltage near 3V. If it is not locked on frequency, it should be near the lower or upper end of its range (0V or 9V).

Output Frequency

Check the VCO frequency at the collector of Q801. If the VCO is locked on frequency, it should be stable on the transmit channel frequency. If the VCO is not locked on frequency, the VCO control voltage is probably near 0V or 9V.

5.2.4 SYNTHESIZER (U801)

Lock Detector

When the VCO is locked on frequency, the lock detect output on J1, pin 7 should be high (see waveform in Figure 3−4). When the VCO is unlocked, the negative−going pulses should be much wider and the output on J1, pin 7 should be low.

Modulus Control Signal

The frequency of the modulus control output on U801, pin 7, when the VCO is in lock should be 12.5 kHz.

The duty cycle of the modulus control signal determines the divide number of the prescaler. The duty cycle is equal to the A counter divide number ÷ N counter divide number. If the modulus control signal is not correct, U801 may be defective or the logic may not be programming the correct divide number.

5.2.5 PRESCALER (U802)

The prescaler divide number can be checked by measuring the input and output frequencies. The prescaler divide number is calculated as follows.

64 + (A counter divide number ÷ N counter divide number).

For example, at frequency 421.500 MHz: Prescaler divide number = 64 + (56 ÷ 526) or 64.106. Refer to Section 5.2.6 to calculate A and N counter divide numbers.

Measure the prescaler input frequency at U802, pin 8. Then measure the output frequency at U802, pin 4 and calculate the divide number. If the VCO is not locked on frequency, the divide number should still be correct. The measured frequencies may not be exactly as calculated due to counter accuracy and resolution limitations. For example, for frequency 421.500 MHz with the VCO locked on frequency, the following frequencies should be measured: 421.500 MHz (pin 8) ÷ 6.575 MHz (pin 4) = 64.106.

If the divide number is not correct, the modulus control signal from U801 may not be correct. To override this signal, tie U802, pin 6 high and then low and check the divide numbers.

High (+5V) = ÷ 64
Low (0V) = ÷ 65

If the divide number is now correct, U802 is probably operating normally and the problem may be with U801.

5.2.6 CALCULATING "N" AND "A" COUNTER DIVIDE NUMBERS

"N" Counter Divide Number

"N" = INT [VCO Freq MHz ÷ (64 x .0125)]

For example, for transmit frequency 421.500 MHz:

"N" = INT (421.500 ÷ 0.8) = INT (526.875) = 526

"A" Counter Divide Number

"A" = (VCO Freq MHz ÷ 0.0125) − ("N" x 64)

For example, for transmit frequency 421.500 MHz:

"A" = (421.500 ÷ 0.0125) − (526 x 64)

"A" = 33, 720 − 33,664 = 56

5.3 RECEIVER SERVICING

To isolate a receiver problem to a specific section, refer to the troubleshooting flowchart in Figure 5-1. Tests referenced in the flowchart are described in the following information.

NOTE: Supply voltages are provided by the user.

5.3.1 SUPPLY VOLTAGES AND CURRENT

Measure the supply voltages on the following pins at interface connector J1:

Pin 4 − 5.0V DC Receive
Pin 5 − 5.0V DC

If the loader board is not being used, place a DC ammeter in the supply line to the transceiver and the following maximum currents should be measured:

Pin 4 − 10 mA
Pin 5 − 50 mA

5.3.2 MIXER/DETECTOR (U201)

Data Output

Using a .01 μF coupling capacitor, inject at U201, pin 16, a 45 MHz, 1 mV signal, modulated with 1 kHz at ± 3 kHz deviation. The audio output level at U201, pin 9 should be approximately 400 mV RMS.

Make sure R301 is adjusted as described in Section 6.2.5. The data output on J1, pin 13 should be 600 mV to 1.2V P-P or 212 mV to 424 mV RMS with the preceding injection signal.

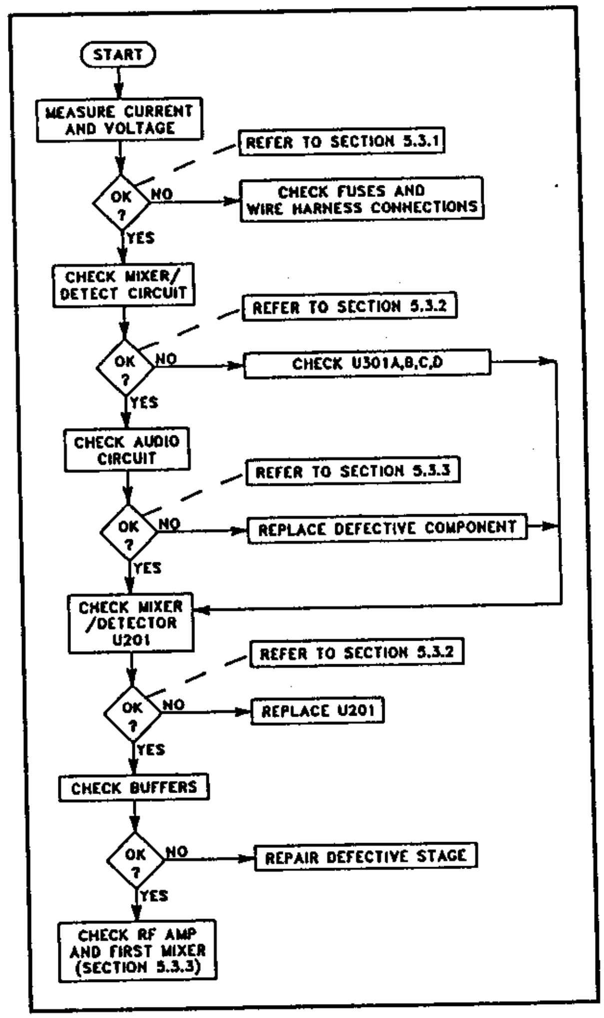
RSSI Output

The RSSI output on J1, pin 12 should be greater than 100 mV at 12 dB SINAD and less than 2.5V with 1 mV input.

If either of the preceding measurements is not correct, there may be a problem with U201 or the Data/RSSI module.

5.3.3 RF AMPLIFIER (Q201) AND FIRST MIXER (Q202)

Refer to the schematic diagram for signal levels and locations to measure levels.



RECEIVER SERVICING FLOWCHART
FIGURE 5−1

MNT _ PC _ UC

5.3.4 RF AND IF AMPLIFIERS, FIRST MIXER (Q201-Q202)

Check the DC voltages shown on the schematic diagram. If they are normal, inject a signal at the input and output of each stage using a .01 µF coupling capacitor. If the stage is producing gain, the injection level on the input of a stage should be less than that required on the output to produce the same audio output level at U201, pin 9.

5.4 TRANSMITTER SERVICING

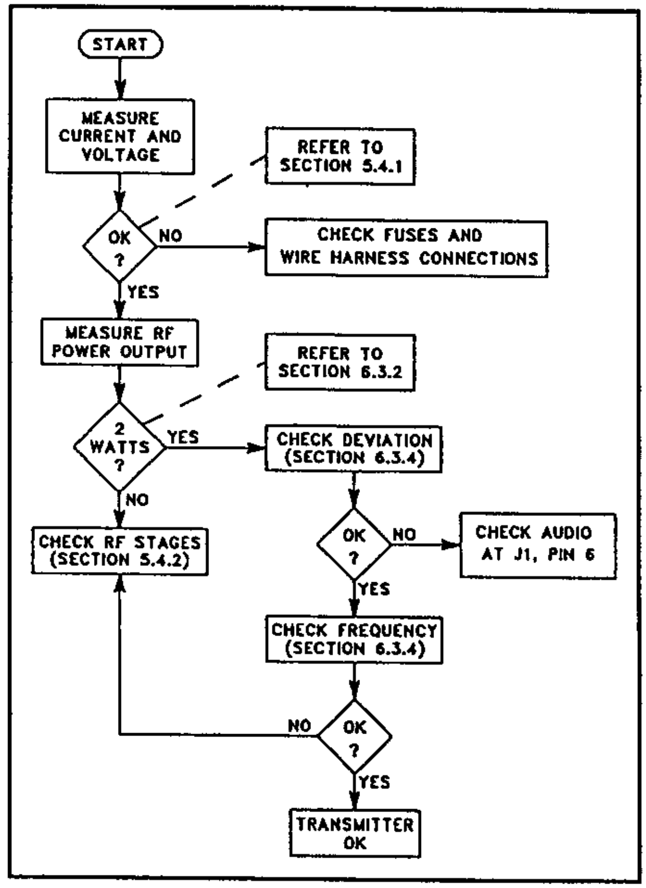
5.4.1 SUPPLY VOLTAGES AND CURRENT

Measure the supply voltages on the following pins of interface connector J1:

Pin 2 - 7.5V DC
Pin 3 - 7.5V DC
Pin 5 - 5.0V DC
Pin 6 - 2.5V DC Transmit In/1.5V P-P max

If the loader board is not being used, place a DC ammeter in the supply line to the transceiver and the following maximum currents should be measured:

Pin 2 - 1.5A
Pin 3 - 75 mA
Pin 5 - 50 mA



TRANSMITTER SERVICING FLOWCHART
FIGURE 5-2

SECTION 6
ALIGNMENT PROCEDURE AND PERFORMANCE TESTS

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 6–11 or component layouts are located in Section 8.

Fabricate test cables by referring to Figures 2–1, 2–2 and 2–3. These cables should include power and ground, a transmit keying switch that shorts the keying line to ground, data input, data output, and carrier detect output.

If the Loader board or Modem are used, an extension cable is required to allow the transceiver to be operated with the loader board unplugged. This is required in order to access adjustment points on the RF board. A test cable can be fabricated or ordered from the accessories (see Table 1–1 and see Figure 6–12).

If the Loader board or Modem are not used, the test setup must also apply the various supply voltages and load the synthesizer with channel information.

6.2 DL3472 TRANSCEIVER ONLY

6.2.1 FREQUENCY AND CONTROL LINE VOLTAGE ALIGNMENT

1. Connect the test setup shown in Figure 6–1. Set the power supply for +7.5V DC. See Figure 2–1 for interface cable.

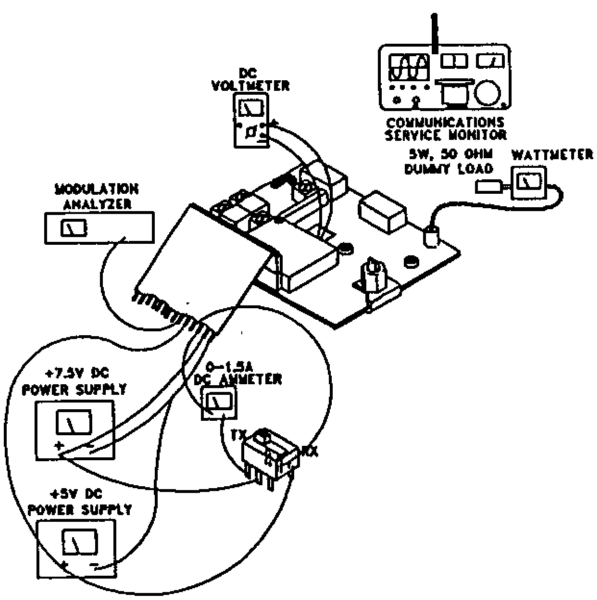
2. Load the synthesizer with the test frequency for the frequency band in Table 6–1 (see Section 3.2).

3. Connect a DC voltmeter across pins 12 and 13 of U801 to measure the VCO control line voltage. If necessary, adjust C830 in the VCO for a meter reading of 4.5–7.0V DC (see Figure 6–11).

4. Measure the LO injection frequency signal with a frequency meter and an RF frequency "sniffer" pickup loop near L203/L204. With 5 PPM models, adjust C851 for the LO injection frequency for the frequency band in Table 6–1. With 2.5 PPM models, adjust the capacitor in the TCXO module.

TABLE 6–1
HIGH END TEST FREQUENCIES

BAND	FREQ	LO INJ FREQ
403–416	416.250	371.250
416–430	430.250	385.250
430–450	450.250	405.250
450–470	470.250	425.250
470–480	480.250	435.250
480–496	496.250	451.250
496–512	512.250	467.250



TRANSMITTER TEST SETUP
FIGURE 6–1

5. Load the synthesizer with the test frequency for the frequency band in Table 6-2 (see Section 3.2).

6. Key the transmitter and adjust C830 for the voltage listed for the frequency band in Table 6-2. Unkey the transmitter.

TABLE 6-2
CONTROL LINE VOLTAGES

BAND	FREQ	CONTROL LINE
403-416	416.250	5.9-6.1V DC
416-430	430.250	5.9-6.1V DC
430-450	450.250	7.0-7.2V DC
450-470	470.250	7.0-7.2V DC
470-480	480.250	5.4-5.6V DC
480-496	496.250	5.9-6.1V DC
496-512	512.250	5.9-6.1V DC

7. Load the synthesizer with the test frequency for the frequency band in Table 6-1.

8. Measure the control line voltage. If the control line voltage is greater than 7.2V DC, readjust C830 for 7.0-7.2V DC.

TABLE 6-3
LOW END TEST FREQUENCIES

BAND	FREQ	LO INJ FREQ
403-416	402.750	357.750
416-430	415.750	370.750
430-450	429.750	384.750
450-470	449.750	404.750
470-480	469.750	424.750
480-496	479.750	434.750
496-512	495.750	450.750

9. Load the synthesizer with test frequency for the frequency band in Table 6-3.

10. Measure the control line voltage. If the control line voltage is less than 0.75V DC, readjust C830 for 0.75-1.2V DC.

11. Load the synthesizer with the test frequency for the frequency band in Table 6-1.

12. Measure the control line voltage. The control line voltage should be less than 7.5V DC.

13. Load the synthesizer with test frequency for the frequency band in Table 6-2.

14. Key the transmitter and measure the control line voltage. The control line voltage should be less than 7.5V DC.

6.2.2 TRANSMITTER POWER ALIGNMENT

1. Connect the test setup shown in Figure 6-1. A DC ammeter capable of measuring up to 1.5A should be installed in the supply line.

2. Load the synthesizer with the test frequency in the "LOW" frequency column for the frequency band in Table 6-4.

3. Key the transmitter and make sure that the supply voltage at the RF board is 7.5V. (Do not transmit for extended periods.)

4. Adjust C523 counterclockwise for maximum current (should be greater than 800 mA).

5. Adjust C523 clockwise for 785-800 mA.

6. Power should be 1.6-2.4W. If power or current exceed these levels, continue adjusting C523 clockwise until these limits are not exceeded. Also check the middle and high frequencies.

TABLE 6-4
TEST FREQUENCIES

	FREQUENCY		
BAND	LOW	MED	HIGH
403-416	402.750	409.250	416.250
416-430	415.750	422.250	430.250
430-450	429.750	440.250	450.250
450-470	449.750	460.250	470.250
470-480	469.750	475.250	480.250
480-496	479.750	488.250	496.250
496-512	495.750	504.250	512.250

6.2.3 TRANSMIT MODULATION ALIGNMENT

1. Load the synthesizer with Transmit frequency for the frequency band in Table 6-5.

2. Inject a 200 Hz square-wave tone at approximately 0.35V P-P, biased at 2.5V DC on J1, pin 6.

3. Transmit into the modulation analyzer and observe modulation output on the oscilloscope. The modulation analyzer should NOT have high pass filtering selected and no less than a 15 kHz low pass filter.

4. Adjust R814 for a flat square-wave on the oscilloscope.

TABLE 6-5
MODULATION TEST FREQUENCY

BAND	FREQ
403-416	409.250
416-430	422.250
430-450	440.250
450-470	460.250
470-480	475.250
480-496	488.250
496-512	504.250

5. Inject a 1 kHz sine-wave on J1, pin 6, biased at 2.5V DC, at a level of 0.4V RMS (403-430 MHz) or 0.32V RMS (430-512 MHz). The modulation analyzer should have the 3 kHz low pass filter selected.

6. Load in the transmit channel frequency and adjust the audio input level to produce ±3 kHz deviation.

6.2.4 RECEIVER ALIGNMENT

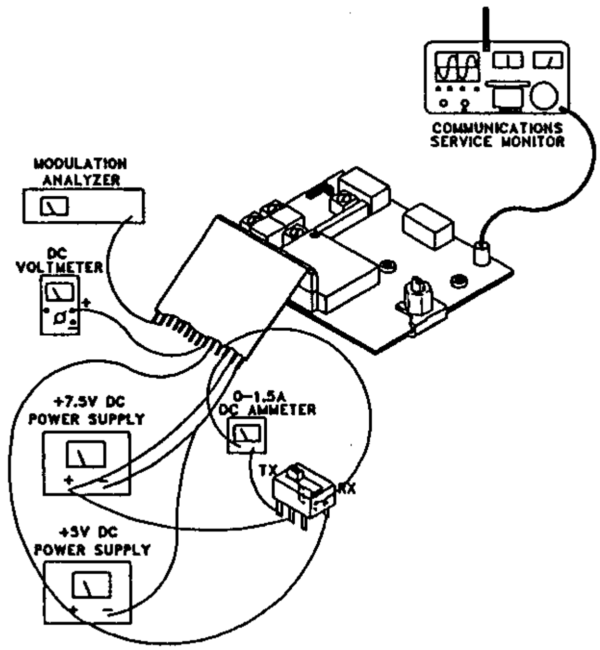
CAUTION

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

1. Connect the test setup shown in Figure 6-2. Adjust the power supply for +13.8V DC (see Figure 6-11).

2. Preset the Z201/Z202 tuning screws flush with the top of the helical cavities for 450-512 MHz or 1/16" above the top for 403-450 MHz.

3. Preset the tuning screws of L205, L206, L207, and L208 two complete turns up (CCW) from the bottom. (Install the Audio/RSSI board into P201, if used.)



RECEIVER TEST SETUP
FIGURE 6-2

6.2.5 IF AND AUDIO ADJUSTMENTS

1. Load the synthesizer with the "mid" frequency for the frequency band in Table 6-6.

2. Set the RF signal generator for this frequency with an unmodulated output at a level of -47 dBm (1000 µV) and inject into J501.

TABLE 6-6
MID TEST FREQUENCIES

BAND	RX FREQ	LO INJ FREQ
403-416	409.250	364.250
416-430	422.250	377.250
430-450	440.250	495.250
450-470	460.250	415.250
470-480	475.250	430.250
480-496	488.250	443.250
496-512	504.250	459.250

3. Connect a DC voltmeter between J201, pin 6 and ground on the RF board. Adjust L208 for a meter reading of 1.4V ±0.05V.

   If the Audio/ RSSI board is used:

   a. Connect a DC voltmeter to J1, pin 13 on the RF board.

   b. Adjust R301 on the Audio/RSSI board for a meter reading of 2.70V ±0.05V.

4. Set the signal generator modulation for 1 kHz at ±3 kHz deviation. Connect a DC voltmeter to the RSSI output J1, pin 12.

5. Adjust the RF signal generator output level for a meter reading of approximately 1V DC. Adjust L206 for a maximum meter reading.

6. Connect a distortion and SINAD meter to the receive audio output J1, pin 13. Increase the signal generator output to −47 dBm (1000 μV).

7. Adjust L205 for minimum distortion.

6.2.6 FRONT END ADJUSTMENTS

1. Adjust the signal generator output for 12 dB SINAD with 1 kHz at ±3 kHz deviation.

2. Tune Z201A for best SINAD. Then readjust the signal generator for 12 dB SINAD. Repeat for Z201B, Z202A, and Z202B. Do not go back and readjust a section once it is set. RF level for 12 dB SINAD should be < 0.35 μV.

3. Turn the adjustment screws of both sections of Z201 and Z202 in (clockwise) a half turn (skip this step for 403–430 MHz).

6.2.7 SENSITIVITY BALANCE

1. Load the synthesizer with the "low" frequency for the frequency band in Table 6–3. Adjust the RF signal level to measure 12 dB SINAD sensitivity. Note this level ________.

2. Load the synthesizer with the "high" frequency for the frequency band in Table 6–1. Adjust the RF signal level to measure 12 dB SINAD sensitivity. Note this level ________.

3. If the high and low channel sensitivities are within 0.02 μV and less than 0.35 μV, proceed to Section 6.2.8.

4. If the high channel sensitivity is a higher level, equally adjust the screws of Z201A/B and Z202A/B "out" (CCW) approximately 1/8 turn.

5. If the low channel sensitivity is a higher level, equally adjust the screws of Z201A/B and Z202A/B "in" (CW) approximately 1/8 turn.

6. Recheck the high and low channel sensitivities and repeat Step 4 or 5 until the conditions in Step 3 are met.

6.2.8 CARRIER DETECT AND OUTPUT LEVEL ALIGNMENT

1. Load the synthesizer with the "mid" frequency for the frequency band in Table 6–6. Set the signal generator output for the channel frequency at a level of −112 dBm (0.56 μV), modulated with 1 kHz at ±3 kHz deviation.

   If the Audio/RSSI board is being used:

   a. Connect a DC voltmeter or oscilloscope to J1, pin 11.

   b. The carrier detect adjustment is R311 on the Audio/RSSI board. Turn this control fully counterclockwise.

   c. Carefully turn this control clockwise until the voltage changes states (goes from approximately 4.9V to 0.1V).

   d. When a signal is received (on the receive frequency loaded) at a level of −110 dBm (0.71 μV), the Carrier Detect goes to a low state in 2 ms or less. Then inject a −114 dBm signal and the Carrier Detect goes high.

2. Monitor J1, pin 12 (RSSI) with a DC voltmeter.

3. Set the RF signal level to −110 dBm (0.71 μV). The voltage should measure between 0.65 and 1.35V DC.

4. Set the RF signal level to -70 dBm (71 µV). The voltage should measure between 2.25 and 2.95V DC.

6.3 DL3472 WITH LOADER ALIGNMENT

6.3.1 FREQUENCY AND CONTROL LINE VOLTAGE ALIGNMENT

CAUTION

The +7.5V regulator is attached to the front panel inside the case. Remove the front panel and regulator along with the transceiver and Loader board.

1. Connect the test setup shown in Figure 6-3. Set the power supply for +13.8V DC. See Figure 2-2 for interface cable.

2. Program the Loader board with Channel 1 on the High frequency and Channel 2 on the Low frequency for the frequency band in Table 6-4 (see Section 3.3).

3. Connect a DC voltmeter across pins 12 and 13 of U801 to measure the VCO control line voltage on Channel 1. If necessary, adjust C830 in the VCO for a meter reading of 4.5-7.0V DC (see Figure 6-11).

4. Measure the Local Oscillator (LO) injection frequency signal with a frequency meter and an RF frequency "sniffer" pickup loop near L203/L204. With 5 PPM models, adjust C851 for the LO injection frequency for the frequency band in Table 6-1. With 2.5 PPM models, adjust the capacitor in the TCXO module.

5. Key the transmitter and adjust C830 for the voltage listed for the frequency band in Table 6-2. Unkey the transmitter.

6. Measure the control line voltage. If the control line voltage is greater than 7.2V DC, readjust C830 for 7.0-7.2V DC.

7. Switch to Channel 2. Measure the control line voltage. If the control line voltage is less than 0.75V DC, readjust C830 for 0.75-1.2V DC.

8. Switch to Channel 1. Measure the control line voltage. The control line voltage should be less than 7.5V DC.

9. Key the transmitter and measure the control line voltage. The control line voltage should be less than 7.5V DC.

6.3.2 TRANSMITTER ALIGNMENT

1. Connect the test setup shown in Figure 6-3. A DC ammeter capable of measuring up to 1.5A should be installed in the supply line.

2. Edit the Loader board (see Section 3.3) for the test frequencies in Table 6-4. Program the "low" frequency in Channel 1 and the "high" frequency in Channel 2.

3. Apply +13.8V DC to J2, pin 5 and ground to J2, pin 8. (Transmit only for short periods.)

4. Connect a 50 ohm attenuator, power meter and Modulation Analyzer to J501.

5. Key the transmitter.

6. Adjust C523 counterclockwise for maximum current (should be greater than 800 mA).

7. Adjust C523 clockwise for 785-800 mA.

8. Power should be 1.6-2.4W. If power or current exceed these levels, continue adjusting C523 clockwise until these limits are not exceeded. Also check the high frequency on Channel 2.

6.3.3 LOADER TRANSMIT ALIGNMENT

1. Program the Loader board to the channel frequency, with External Mod Input = No, Pre-emphasis = Yes and De-emphasis = Yes.

NOTE: It is necessary to cycle power on the 7.5V supply to load information changes to the EEPROM into the microprocessor anytime the programming parameters change.

MNT _ PC _ JC

5. Adjust the RF signal generator output level for a meter reading of approximately 1V DC. Adjust L206 for a maximum meter reading.

6. Connect a distortion and SINAD meter to the receive audio output J1, pin 13. Increase the signal generator output to −47 dBm (1000 μV).

7. Adjust L205 for minimum distortion.

6.3.7 FRONT END ADJUSTMENTS

1. Adjust the signal generator output level for 12 dB SINAD (the modulation should be as in Step 4 above).

2. Tune Z201A for best SINAD. Then readjust the signal generator for 12 dB SINAD. Repeat for Z201B, Z202A, and Z202B. Do not go back and readjust a section once it is set. RF level for 12 dB SINAD should be < 0.35 μV.

3. Turn the adjustment screws of both sections of Z201 and Z202 in (clockwise) a half turn (skip this step for 403–430 MHz).

6.3.8 SENSITIVITY BALANCE

1. Program the Loader board with the "low" frequency for the frequency band in Table 6–4. Adjust the RF signal level to measure 12 dB SINAD sensitivity. Note this level ________.

2. Program the Loader board with the "high" test frequency for the frequency band in Table 6–4. Adjust the RF signal level to measure 12 dB SINAD sensitivity. Note this level ________.

3. If the high and low channel sensitivities are within 0.02 μV and less than 0.45 μV, proceed to Section 6.3.9.

4. If the high channel sensitivity is a higher level, equally adjust the screws of Z201A/B and Z202A/B "out" (CCW) approximately 1/8 turn.

5. If the low channel sensitivity is a higher level, equally adjust the screws of Z201A/B and Z202A/B "in" (CCW) approximately 1/8 turn.

6. Recheck the high and low channel sensitivities and repeat Step 4 or 5 until the conditions in Step 3 are met.

6.3.9 CARRIER DETECT AND OUTPUT LEVEL ALIGNMENT

1. Program the Loader board with the "mid" test frequency for the frequency band in Table 6–4. Set the signal generator output for the channel frequency at a level of −112 dBm (0.56 μV), modulated with 1 kHz at ±3 kHz deviation.

If the Audio/RSSI board is being used:

a. Connect a DC voltmeter or oscilloscope to J1, pin 11.

b. The carrier detect adjustment is R311 on the Audio/RSSI board. Turn this control fully counterclockwise.

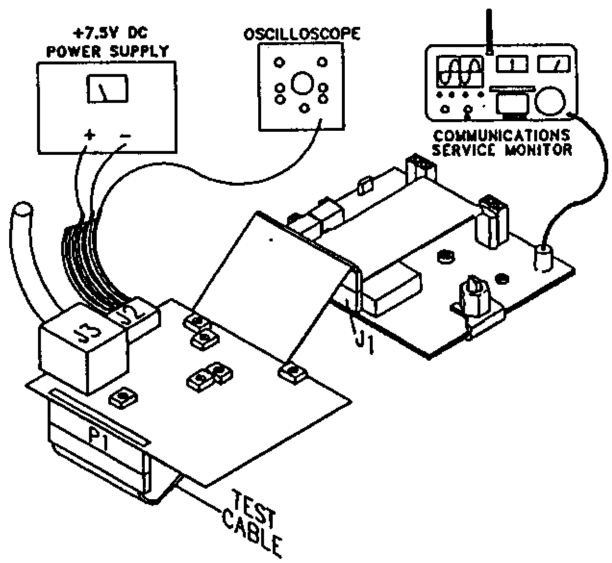
c. Carefully turn this control clockwise until the voltage changes states (goes from approximately 4.9V to 0.1V).

d. When a signal on receive frequency loaded is received at a level of −110 dBm (0.71 μV), the Carrier Detect goes to a low state in 2 ms or less. Then inject a −114 dBm signal and the Carrier Detect goes high.

2. Monitor J1, pin 12 (RSSI) with a DC voltmeter.

3. Set the RF signal level to −110 dBm (0.71 μV). The voltage should measure between 0.65 and 1.35V DC.

4. Set the RF signal level to −70 dBm (71 μV). The voltage should measure between 2.25 and 2.95V DC.



RECEIVER TEST SETUP
FIGURE 6–4

6.3.10 LOADER RECEIVE ALIGNMENT

1. Adjust R5 (carrier detect) fully clockwise. Cycle the power to the transceiver.

2. Connect an RF signal generator to J501, set to the channel frequency with 1 kHz modulation, ±3 kHz deviation and −50 dB RF input.

3. Connect an oscilloscope and Audio Analyzer to J2, pin 10.

4. Adjust R1 for +2.7V DC at J2, pin 2.

5. Adjust R4 (audio out) for 375 mV RMS ±50 mV (1V P-P) at J2, pin 10.

6.4 DL3472 RADIO MODEM ALIGNMENT

The radio modem is aligned and tested at the factory prior to shipment. If either the modem board or radio module is replaced in the field, the new radio modem will require realignment in order to provide optimum performance. Refer to Figure 6-10 for the location of configuration switches, alignment controls and test points.

CAUTION

The +7.5V regulator is attached to the rear panel inside the case. Remove the rear panel and the regulator along with the transceiver and modem.

6.4.1 FREQUENCY AND CONTROL LINE VOLTAGE ALIGNMENT

1. Connect the test setup shown in Figure 6-5. Set the power supply for +13.8V DC. See Figure 6-12 for test cable.

2. Program the Modem with Channel 1 on the High frequency and Channel 2 on the Low frequency for the frequency band in Table 6-4 (see Section 3.4).

3. Connect a DC voltmeter across pins 12 and 13 of U801 to measure the VCO control line voltage on Channel 1. If necessary, adjust C830 in the VCO for a meter reading of 4.5-7.0V DC (see Figure 6-11).

4. Measure the Local Oscillator (LO) injection frequency signal with a frequency meter and an RF frequency "sniffer" pickup loop near L203/L204. With 5 PPM models, adjust C851 for the LO injection frequency for the frequency band in Table 6-1. With 2.5 PPM models, adjust the capacitor in the TCXO module.

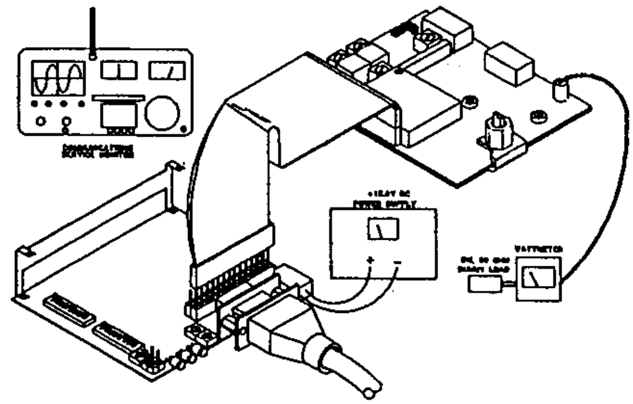
5. Key the transmitter and adjust C830 for the voltage listed for the frequency band in Table 6-2. Unkey the transmitter.

6. Measure the control line voltage. If the control line voltage is greater than 7.2V DC, readjust C830 for 7.0-7.2V DC.

7. Switch to Channel 2. Measure the control line voltage. If the control line voltage is less than 0.75V DC, readjust C830 for 0.75-1.2V DC.

8. Switch to Channel 1. Measure the control line voltage. The control line voltage should be less than 7.5V DC.

9. Key the transmitter and measure the control line voltage. The control line voltage should be less than 7.5V DC.



TRANSMITTER TEST SETUP
FIGURE 6-5

6.4.2 TRANSMITTER ALIGNMENT

1. Connect the test setup shown in Figure 6-5. A DC ammeter capable of measuring up to 1.5A should be installed in the supply line.

2. Program the Modem (see Section 3.4) for the test frequencies in Table 6-4. Program the "low" frequency in Channel 1 and the "high" frequency in Channel 2.

3. Apply +13.8V DC to J2, pin 2 and ground to J2, pin 1 (or +13.8V to J1, pin 9 and ground to J1, pin 5). Do not transmit for extended periods.

4. Connect a 50 ohm attenuator, power meter and Modulation Analyzer to antenna connector J501.

5. Key the transmitter.

6. Adjust C523 counterclockwise for maximum current (should be greater than 800 mA).

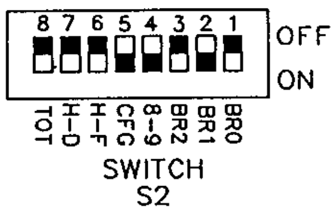
7. Adjust C523 clockwise for 785-800 mA.

MNT - PC - UC

8. Power should be 1.6–2.4W. If power or current exceed these levels, continue adjusting C523 clockwise until these limits are not exceeded. Also check the high frequency on Channel 2.

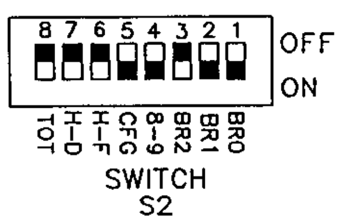
6.4.3 MODEM TRANSMIT ALIGNMENT

1. Program the modem for a mid-range transmit frequency on Channel 1 (see Table 6-4).
2. Configure the Modem to transmit a continuous data signal by setting the baud rate select switches for "Tx Test Mode". Set Switch S2, sections 1 and 3 OFF and section 2 ON (see Figure 6-6).
3. Monitor the transmit output power and frequency on a communications monitor.

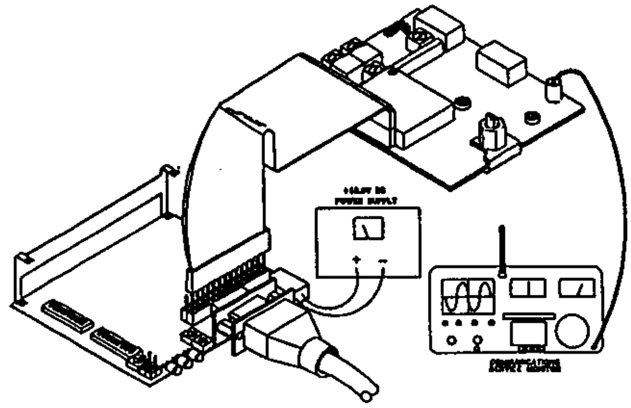


TX TEST MODE
FIGURE 6-6

4. Monitor the transmitter's demodulated signal on the CRT of a communications monitor.
5. Adjust the modulation balance control on the radio module (R814) for a signal that best approximates a rectangular data waveform with minimal tilt and overshoot.
6. Adjust the deviation level control labeled "DEV" on the modem board for a peak deviation of ±3 kHz (see Figure 6-10).
7. Reconfigure the baud rate select switches for normal operation. Set Switch S2, sections 1 and 2 ON and section 3 OFF.



NORMAL MODE
FIGURE 6-7



RECEIVER TEST SETUP
FIGURE 6-8

6.4.4 RECEIVER ALIGNMENT

CAUTION

Do not connect the generator to the radio until power is applied because the transmitter may key up when power is applied and severe generator damage may result.

1. Connect the test setup shown in Figure 6-8. Adjust the power supply for +13.8V DC.
2. Preset the Z201/Z202 tuning screws flush with the top of the helical cavities for 450–512 MHz or 1/16" above the top for 403–450 MHz (see Figure 6-11).
3. Preset the tuning screws of L205, L206, L207, and L208 two complete turns up (CCW) from the bottom. (Install the Audio/RSSI board into P201, if used.)

6.4.5 IF AND AUDIO ADJUSTMENTS

1. Program the Modem with the "mid" test frequency for the frequency band in Table 6-6.
2. Set the RF signal generator for this frequency with an unmodulated output at a level of −47 dBm (1000 μV) and inject into J501.
3. Connect a DC voltmeter between J201, pin 6 and ground on the RF board. Adjust L208 for a meter reading of 1.4V ±0.05V.

   If the Audio/ RSSI board is used:

   a. Connect a DC voltmeter to J11, pin 13 on the RF board.
   b. Adjust R301 on the Audio/RSSI board for a meter reading of 2.70V ±0.05V.

4. Set the signal generator modulation for 1 kHz at ±3 kHz deviation. Connect a DC voltmeter to the RSSI output J1, pin 12.

5. Adjust the RF signal generator output level for a meter reading of approximately 1V DC. Adjust L206 for a maximum meter reading.

6. Connect a distortion and SINAD meter to the receive audio output J1, pin 13. Increase the signal generator output level to −47 dBm (1000 µV).

7. Adjust L205 for minimum distortion.

6.4.6 FRONT END ADJUSTMENTS

1. Adjust the signal generator output level for 12 dB SINAD (the modulation should be as in Step 4 above).

2. Tune Z201A for best SINAD. Then readjust the signal generator for 12 dB SINAD. Repeat for Z201B, Z202A, and Z202B. Do not go back and readjust a section once it is set. RF level for 12 dB SINAD should be < 0.35 µV.

3. Turn the adjustment screws of both sections of Z201 and Z202 in (clockwise) a half turn (skip this step for 403–430 MHz).

6.4.7 SENSITIVITY BALANCE

1. Program the Modem with the "low" frequency for the frequency band in Table 6–4. Adjust the RF signal level to measure 12 dB SINAD sensitivity. Note this level ________.

2. Program the Modem with the "high" test frequency for the frequency band in Table 6–4. Adjust the RF signal level to measure 12 dB SINAD sensitivity. Note this level ________.

3. If the high and low channel sensitivities are within 0.02 µV and less than 0.45 µV, proceed to Section 6.4.8.

4. If the high channel sensitivity is a higher level, equally adjust the screws of Z201A/B and Z202A/B "out" (CCW) approximately 1/8 turn.

5. If the low channel sensitivity is a higher level, equally adjust the screws of Z201A/B and Z202A/B "in" (CCW) approximately 1/8 turn.

6. Recheck the high and low channel sensitivities and repeat Step 4 or 5 until the conditions in Step 3 are met.

6.4.8 CARRIER DETECT AND OUTPUT LEVEL ALIGNMENT

1. Program the Modem with the "mid" test frequency for the frequency band in Table 6–4. Set the signal generator output for the channel frequency at a level of −112 dBm (0.56 µV), modulated with 1 kHz at ±3 kHz deviation.

   If the Audio/RSSI board is being used:

   a. Connect a DC voltmeter or oscilloscope to J1, pin 1.

   b. The carrier detect adjustment is R311 on the Audio/RSSI board. Turn this control fully counterclockwise.

   c. Carefully turn this control clockwise until the voltage changes states (goes from approximately 4.9V to 0.1V).

   d. When a signal on receive frequency loaded is received at a level of −110 dBm (0.71 µV), the Carrier Detect goes to a low state in 2 ms or less. Then inject a −114 dBm signal and the Carrier Detect goes high.

2. Monitor J11, pin 12 (RSSI) with a DC voltmeter.

3. Set the RF signal level to −110 dBm (0.71 µV). The voltage should measure between 0.65 and 1.35V DC.

4. Set the RF signal level to −70 dBm (71 µV). The voltage should measure between 2.25 and 2.95V DC.

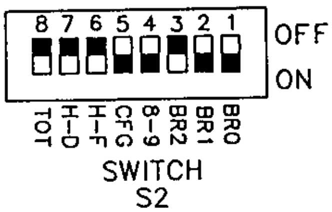
6.4.9 MODEM RECEIVE DATA LEVEL ALIGNMENT

The receive data level used by the modem must be aligned when the modem board is connected to a new radio. The receive data level control on the modem board is used to adjust the data input level to the modem's receive data circuitry. This signal is provided on J13, pin 4 on the modem test connector. The modem board provides adjustment for receive data levels from 90 mV to 1.8V P–P. When this level requires adjustment proceed as follows:

1. Program the modem for a mid-range receive frequency on Channel 1 (see Table 6–4 and Figure 6–8).

2. Configure a companion Radio Modem to transmit a continuous data signal on the same frequency at ±3 kHz deviation (see Section 6.4.3, Steps 1–3).

3. Configure the modem to the "Rx Test Mode" by setting the baud rate select switches. Set Switch S2, sections 1 and 2 ON and section 3 OFF.



RX TEST MODE
FIGURE 6–9

Alternative setup:

a. Set Switch S2, sections 1 and 2 ON and section 3 OFF.

b. Connect a signal generator set to –50 dBm ±3 kHz deviation with a 5 kHz tone to the RF input.

4. Monitor the AC voltage at J13, pin 4 for 1V P-P (see Figure 6–10).

5. Adjust RDL (Receive Data Level) control for 1V P–P.

6. Deactivate the test transmitter by reconfiguring its baud rate select switches for normal operation (see Figure 6–7).

6.4.10 RECEIVE CARRIER DETECT ADJUSTMENT

The 3472 transceiver module provides an RSSI output signal which indicates the relative receive carrier level of an on channel signal. The radio modem utilizes this signal to detect the presence or absence of a receive carrier. The threshold level for the detection of an on channel carrier is factory set to –109 dBm (0.8 μV). If this level requires adjustment, proceed as follows:

1. Program the Modem for a mid–range receive frequency on Channel 1 (see Table 6–4).

2. Configure the modem to the "Rx Test Mode" by setting the baud rate select switches. Set Switch S2, sections 1 and 2 off and section 3 on (see Figure 6–9).

3. Configure a communications monitor to transmit on this frequency with a 1 kHz tone at ±3 kHz deviation.

4. Adjust the output of the communications monitor for a signal level of –109 dBm.

5. Set Adjust RCD (Receive Carrier Detect) control fully CCW (see Figure 6–10).

6. Monitor the DC voltage on J13, pin 2 for a logic low level <2V.

7. Adjust the RCD control clockwise to the point where the logic level transitions from a low logic level to a high logic level.

6.5 RECEIVER PERFORMANCE TESTS

CAUTION

Make sure that the transmitter is not keyed with the signal generator connected to the antenna jack because severe generator damage may result.

6.5.1 RADIO WITH LOADER

1. Measure distortion on audio output, J2, pin 10. The distortion should be <5% at –50 dBm (psophometric filter off).

2. Reduce signal strength and measure SINAD at 12 dB. The level should be <0.45 μV at J2, pin 2 (psophometric filter on).

3. Adjust signal generator for 20 dB SINAD (psophometric filter on).

4. Adjust R5 (carrier detect) until the audio is squelched.

5. Increase the signal level until the unit unsquelches. The unit should unsquelch before 25 dB SINAD.

6. Increase the RF signal generator to –50 dBm.

7. Reduce the modulating frequency to 500 Hz. With de–emphasis, the output level on J2, pin 10 should be >135 mV RMS (0.5V P–P).

NOTE: All audio filtering should be off the Audio Analyzer when performing this test.

8. Increase the modulating frequency to 1 kHz.

9. Program the Loader board to the channel frequency, with External Mod Input = No, Pre–emphasis = Yes and De–emphasis = Yes. Cycle power to the transceiver.

MAT - PC - VC

10. Reduce the modulating frequency to 500 Hz. Without de-emphasis the output level on J2, pin 10 should not change (375 mV RMS, ±50 mV RMS or 1V P-P).

6.5.2 RADIO MODEM

Refer to Figure 6-8 for test setup details and proceed as follows.

SINAD Sensitivity

1. Set the generator for the channel frequency with an output modulated with 1 kHz at ± 3 kHz deviation.
2. Decrease the generator output to obtain a 12 dB reading on the SINAD meter. The generator output should be 0.45 µV maximum.

Data Output Level

1. Set the generator for the channel frequency with an output level of 1000 µV, modulated with 1 kHz at ±3 kHz deviation.
2. The data level at the data output of the test cable should be 600-1200 mV P-P (200-400 mV RMS). The load on the data output should be 10k-100k ohms to obtain an accurate reading.

6.6 TRANSMITTER PERFORMANCE TESTS

6.6.1 RADIO WITH LOADER

1. Input 1V RMS. Deviation should not exceed ±4.5 kHz.
2. Reduce the input level to 320 mV RMS.
3. Decrease the audio frequency to 500 Hz. With pre-emphasis the transmit deviation should be less than ±2 kHz.
4. Return the input frequency to 1 kHz.
5. Program the Loader board to the channel frequency, with External Mod Input = No, Pre-emphasis = No and De-emphasis = No.
6. Unkey the transmitter, cycle power to the transceiver, rekey the transmitter.
7. Without pre-emphasis the transmit deviation should be less than ±1 kHz.
8. Program the Loader board to the channel frequency, with External Mod Input = Yes, Pre-emphasis = No and De-emphasis = No.
9. Unkey the transmitter, cycle power to the transceiver, rekey the transmitter.
10. With the modulation muted, there should be no audio output.

6.6.2 RADIO MODEM

Refer to Figure 6-8 for test setup details and proceed as follows.

Power Output

Key the transmitter, transceiver current and power output should be as follows at the nominal supply voltage of +7.5V DC:

Nominal Power Output of Xcvr	Maximum Tx Current	Minimum Power Out
2 W	850 mA (w/ldr bd) 800 mA (w/o ldr bd)	1.6 W

Modulation Sensitivity

Connect an audio generator to the data input of the test cable and key the transmitter. Modulation sensitivity should be 5 kHz per volt ±20%.

Transmit Frequency

Key the transmitter and monitor the frequency with a communications monitor. The frequency should be within ±5 PPM or ±2.5 PPM. Refer to Section 6.4.3 for more information.

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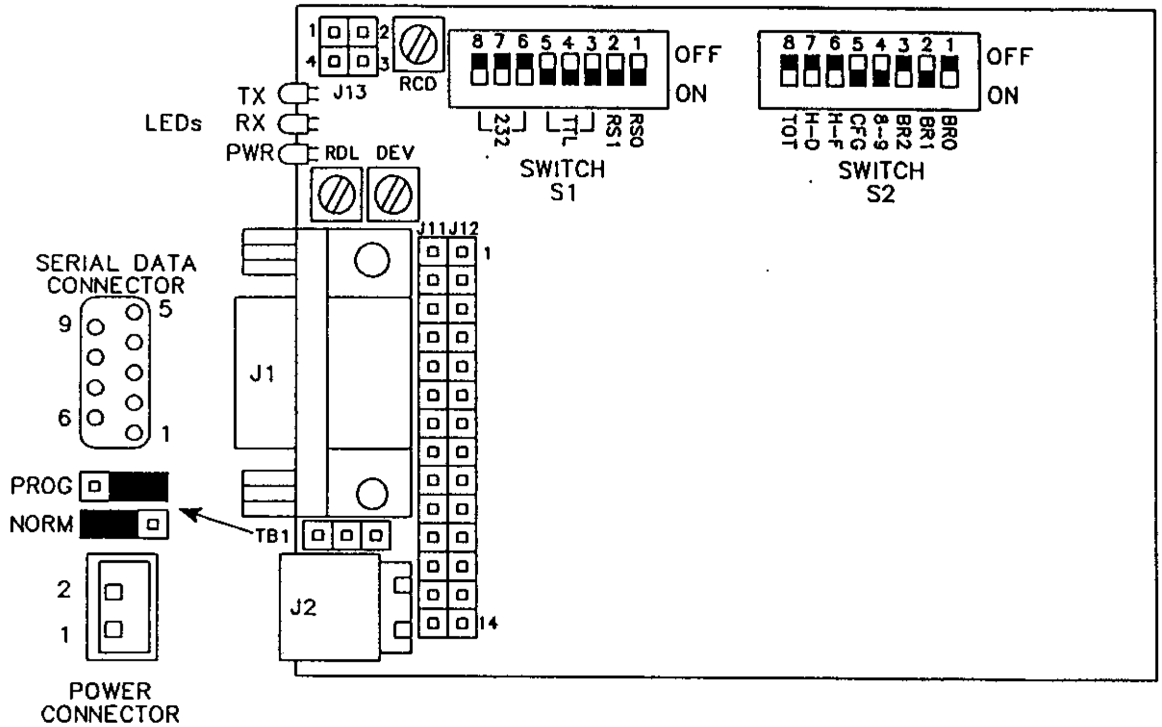


MODEM BOARD ADJUSTMENTS
FIGURE 6–10

TABLE 6–7
PIN ASSIGNMENTS

SERIAL DATA CONNECTOR PIN ASSIGNMENTS

Signal Name	J1 Pin No.
Data Carrier Detect (DCD)	1
Receive Data (RD)	2
Transmit Data (TD)	3
Data Terminal Ready (DTR)	4
Signal/Power Ground (SG)	5
Data Set Ready (DSR)	6
Request–to–Send (RTS)	7
Clear–to–Send (CTS)	8
Radio Modem Power (9–16V)	9

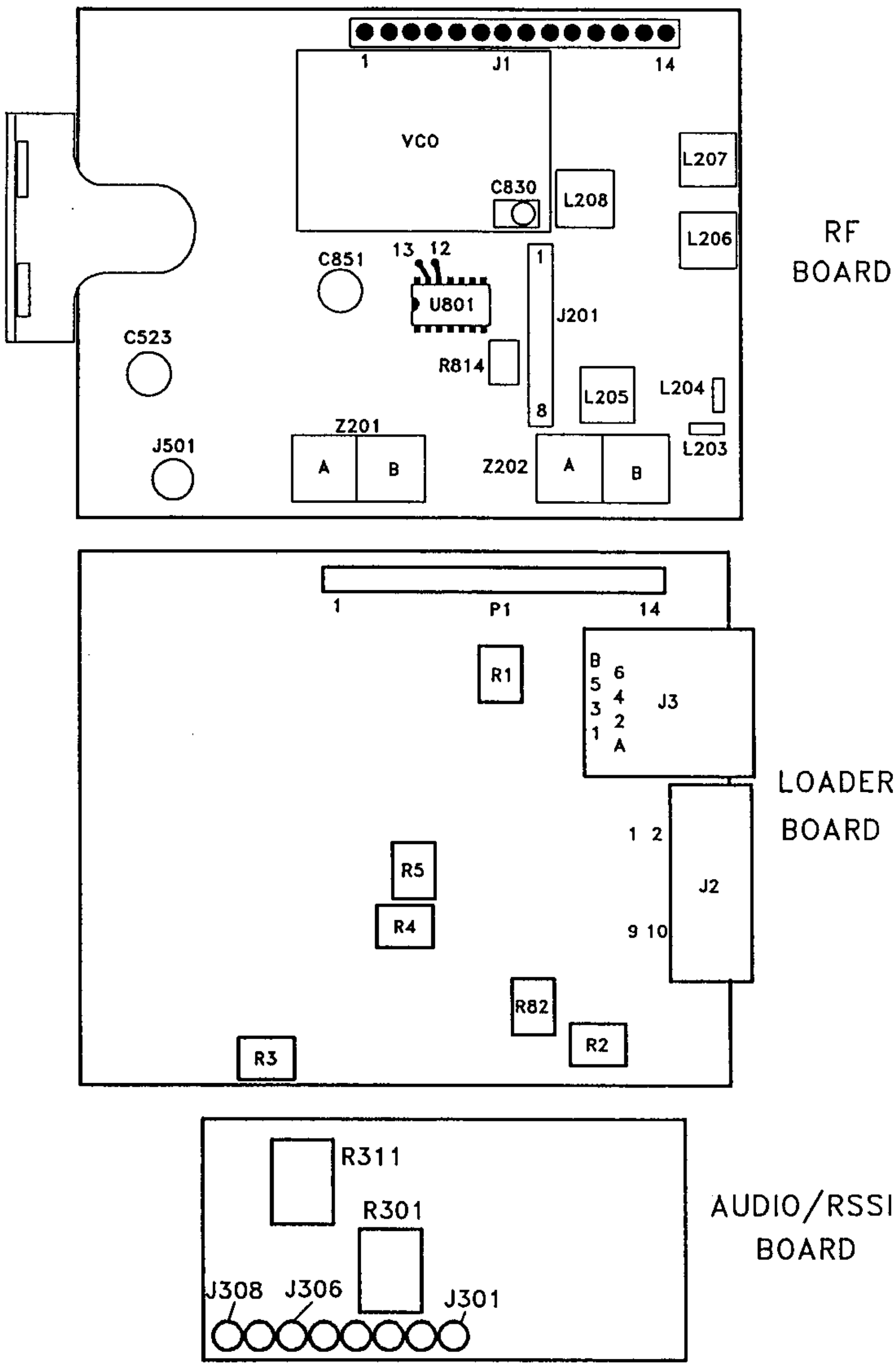
POWER CONNECTOR J2

Ground Return (Negative)	1
Radio Modem Power (9–16V)	2

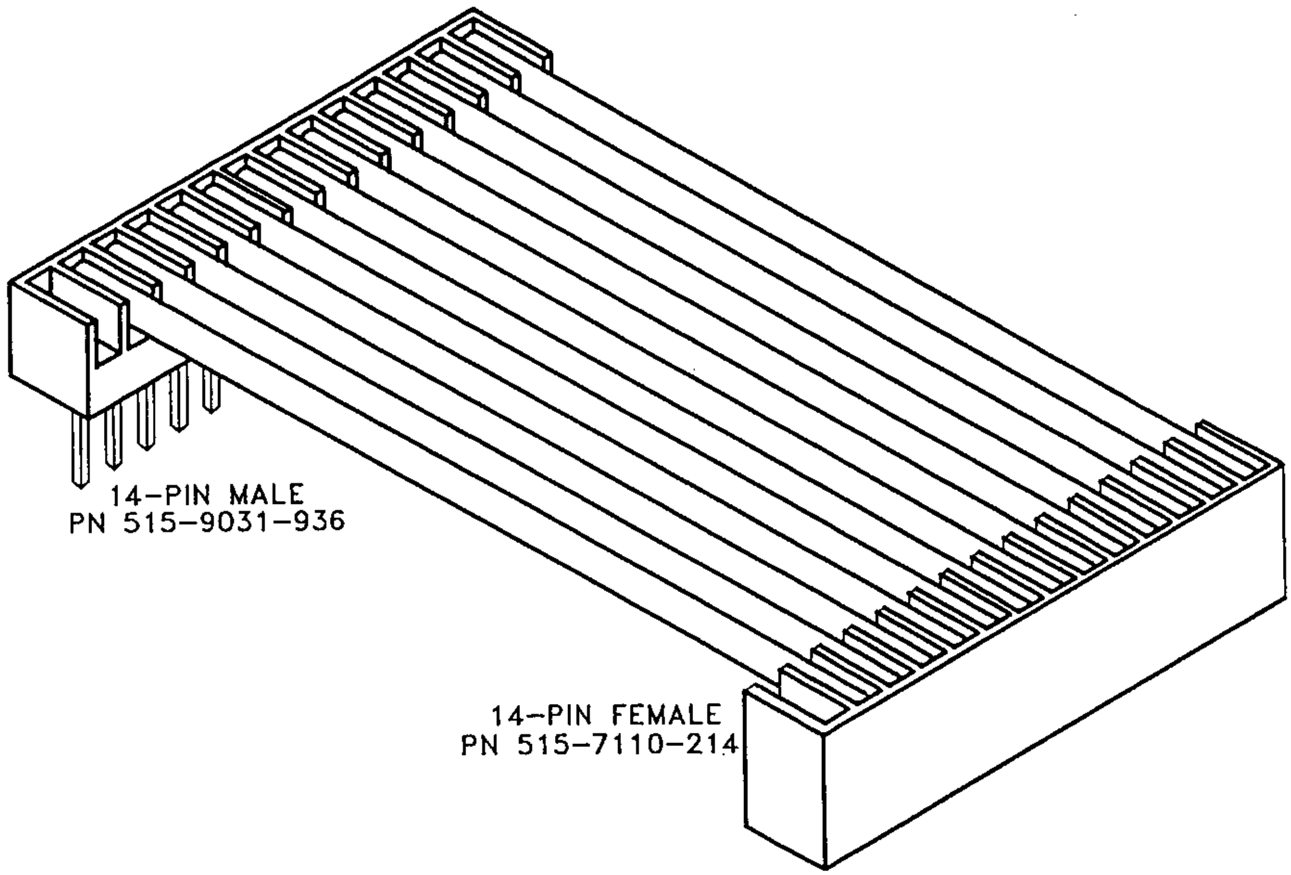
TELEMETRY MODULE CONNECTOR PIN ASSIGNMENTS

Signal Name	J11 Pin No.
Signal and Power Ground	1
Telemetry Module +7.5V DC	2
Transmit +7.5V DC	3
Receive +5V DC	4
Telemetry Module +5V DC	5
Transmit Modulation	6
Synthesizer Lock	7
Synthesizer Enable	8
Synthesizer Data	9
Synthesizer Clock	10
Unused	11
RSSI Output	12
Receive Demodulation	13
Unused	14

MNT_PC_VC



ALIGNMENT POINTS DIAGRAMS
FIGURE 6–11



14-PIN TEST CABLE (PN 023-3472-007)
FIGURE 6-12