SYNTHESIZED UHF TELEMETRY UNIT
PART NO. 242-3412-XX0

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SYNTHESIZED UHF TELEMETRY UNIT
PART NO. 242-3412-XYZ

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

DATA TELEMETRY PRODUCT WARRANTY

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

WARNING

This device complies with Part 15 of the FCC rules and Industry Canada RSS-119, issue 5. 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 the Johnson Data Telemetry Corporation could void the user's authority to operate this equipment (FCC rules, 47CFR Part 15.19).

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

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

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

DO NOT allow children to operate transmitter equipped radio equipment.

SAFETY INFORMATION

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

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

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SECTION 1 GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This service manual contains alignment and service information for the Johnson Data Telemetry (JDT) DM-3412 UHF Synthesized Telemetry Unit.

This manual concentrates on the RF section of the data link which may be paired with an internal Loader board or 9600 baud Modem board.

Service manuals addressing items specific to the Loader board (Part No. 001-3240-001) and the Modem boards (Part No. 001-3276-001/001-3296-001) should be referenced for the users specific configuration.

1.2 EQUIPMENT DESCRIPTION

1.2.1 GENERAL

The JDT DM-3412 is a synthesized data transceiver (transmitter and receiver) which operates in the 380-512 MHz UHF frequency range. Transmitter power output is 5 watts nominal at 13.3V DC in simplex or half duplex modes.

Versions of the DM-3412 covered in this manual are indicated in Section 1.5. The DM-3412 has a frequency stability of ± 1.5 PPM (see Section 3) and is available with or without the Loader/Modem boards.

The number of channels that can be selected with the DM-3412 model is determined by the customer supplied synthesizer loading circuitry. The DL-3412 model is 8-Channels when supplied with the DL-3240 Loader board, the DL-3276 modem kit or the DL-3296 modem kit.

In addition to this UHF radio, JDT has a full line of radios and radio modems to meet wireless data communication needs. Both OEM RF decks and complete FCC and Industry Canada type approved radios and radio modems are available from 132-174 MHz at VHF, 380-512 MHz at UHF and 928-960 MHz at 900 MHz in both 5W and 2W units (VHF and UHF). High Specification units are available to meet International requirements and bandwidths to meet U.S.A. refarming requirements. To learn more about the other JDT products, call 1-800-992-7774 or 1-612-890-8155 to speak to a sales representative.

1.2.2 DL-3412 WITH LOADER BOARD

The DL-3412 (Part No. 242-3412-xxx) can be ordered with the 8-channel Loader board (Part No. 023-3240-001). The Loader board performs synthesizer loading through an RS-232 DB-9 interface. In addition, this board has circuitry which provides electronic control of the following:

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

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

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

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

1.2.3 DL-3412 WITH RNET™ MODEM

The DL-3412 (Part No. 242-3412-xxx) can be ordered with the 9600 baud Modem (Part No. 023-3276-001), which supports the RNET™ communication protocol. This modem allows data communication between the Johnson Data Telemetry high specification synthesized products and the Motorola RNET radio/modems.

The Modem features include:

- User Programmable Data Rates:
  9600/4800/2400/1200 baud in a 25 kHz bandwidth
  OR
  1200/2400/4800 baud in a 12.5 kHz bandwidth.
- RS-232 compatible using DE-15 15-pin connector.
- Simplex or Half-Duplex operation.
- RTS-CTS handshaking protocol with option for configuring any two units as a digital repeater (Half-Duplex or Simplex).
- Supports asynchronous, serial or transparent data formats.
- Front panel LEDs provide indication for Transmit, Receive and Power.
- Built-In Diagnostics reported both locally and "Over-The-Air":
  Reports specific unit programming
  Loopback test feature
  RSSI
  Forward and Reflected Power
  Temperature
  Supply Voltage
- 8-Channels programmable with option to switch channels remotely "Over-The-Air".

This board is programmed using an IBM PC or compatible computer using MS-DOS and the RSS programming software (Part No. 023-3276-005). Programming instructions contained in the RSS Manual included in the part number listed in Table 1-1.

1.2.4 DL3412 WITH DL3296 MODEM

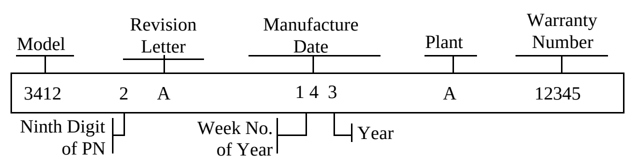
The DL3296 modem (Part No. 023-3296-001) provides digital data transmission at data rates up to 9600 baud. The DL3296 operates in Half-Duplex mode. However, two transceivers can be combined to provide Full-Duplex operation. The user interface is a serial port through a 9-pin D-connector configurable to either RS-232 or TTL signal levels. The data format is asynchronous with either 8 or 9 data bits. The modem can operate in either standard DTE/DCE handshake protocol or in Data Activation mode which requires only receive and transmit data lines. The baud rates are user selectable from 300 to 9600 baud in a 25 kHz bandwidth or 300 to 4800 baud in a 12.5 kHz bandwidth.

1.2.5 DM-3412 SYNTHESIZER PROGRAMMING

The DM-3412, when used ***without*** the Universal Loader Board (Part No. 023-3240-001) or DL-3276/DL-3296 modem kits, requires customer supplied circuitry to load the synthesizer with channel information. The protocol that this circuitry must follow is described in Section 3.

1.3 TRANSCEIVER IDENTIFICATION

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



1.4 ACCESSORIES

Accessories available for the DL-3412 data transceiver are listed in Table 1-1.

Table 1-1 ACCESSORIES

Accessory	Part No.
DL-3240 Loader Kit	023-3240-001
DL-3296 Modem Kit	023-3296-001
DL-3276 Modem Kit	023-3276-001
DL-3295 Telemetry Modem	250-3295-001/101
DL-3282 Modem*	250-3282-001
DL-3276 Service Manual	001-3276-001
DL-3240 Service Manual	001-3240-001
DL-3296 Service Manual	001-3296-001
Interface Cable	023-3276-007
Interface Cable	023-3276-008
* Must have Loader Kit installed in radio to make this modem compatible with radio.	

1.5 PART NUMBER BREAKDOWN

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

242-3412 - X Y Z

Z:
0 = Transceiver
6 = Transmit Only
8 = Receive Only

Y:
1 = 12.5 kHz
3 = 25 kHz

X:
1 = 380-403 MHz
2 = 403-419 MHz
3 = 419-435 MHz
4 = 435-451 MHz
5 = 450-470 MHz
6 = 464-480 MHz
7 = 480-496 MHz
8 = 496-512 MHz

1.6 FACTORY CUSTOMER SERVICE

The Customer Service Department of the Johnson Data Telemetry Corporation 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

1-800-992-7774

When your call is answered at the Johnson Data Telemetry Corporation, 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 "3", 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	(612) 882-5671
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:

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

1.7 PRODUCT WARRANTY

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

1.8 REPLACEMENT PARTS

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

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

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

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

1.9 FACTORY RETURNS

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

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

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

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

3412 UHF SYNTHESIZED TELEMETRY UNIT SPECIFICATIONS

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

GENERAL

Frequency Range	380-512 MHz
Frequency Control	Synthesized
Channel Spacing	12.5/25 kHz
Mode of Operation	Simplex or Half Duplex
Operating Voltage	+13.3V DC nominal (10-16V DC operational)
Regulated Supply Voltages	+5.5V DC, +9.6V DC
Transmit Enable	3-16V DC at 150 µA max
Receive Enable	3-16V DC ±5% at 150 µA nominal (150 µA during receive)
Transceiver Enable	3-16V DC at less than 150 µA
Power and Data Connector	14-pin in-line socket (Dupont 76308-14)
RF Input/Output	SMA Jack (female)
Operating Temperature	-30°C to +60°C (-22°C to +140°F)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Humidity	95% maximum RH at 40°C, non-condensing
Maximum Dimensions	4.585" L, 3.25" W, 2.212" H
FCC Compliance	
DM3412	Customer must apply
DL3412	Part 90, Part 15 (403-512 MHz), Industry Canada RSS119, Issue 5

RECEIVER

Bandwidth	16 MHz all bands except (20 MHz 308-403/450-470 MHz)
Frequency Stability	±1.5 PPM (-30°C to +60°C (-22°C to +140°F)
Sensitivity - 12 dB SINAD	≤ 0.35 µV
RF Input Impedance	50 ohms
Selectivity	-70 dB/-60 dB (tN/t/E) for 25 kHz, 60 dB/50 dB (tN/t/E) for 12.5 kHz
Spurious and Image Rejection	-70 dB
Conducted Spurious Emissions	< -57 dBm
Intermodulation	-70 dB
FM Hum and Noise	-40 dB 12.5/25 kHz
Receive Attack Time	< 5 ms
Total Receive On Time	7 mS maximum
Audio	
Distortion	< 3%
Buffered Output Level	150 mV RMS nominal at 2.5V DC bias
Discriminator Output	±1 dB from DC to 5 kHz (reference to 1 kHz)
Output Bias	2.5V DC ±10%
Output Impedance	>10k ohms
RSSI	0.9V to 2.4V DC output from -120 to -60 dBm, attack time < 2 ms

TRANSMITTER

Frequency Stability	±1.5 PPM (-30°C to +60°C (-22°C to +140°F)
Bandwidth	16 MHz without tuning
	20 MHz without tuning 380-403 and 450-470 MHz bands
Maximum System Deviation	5 kHz (25 kHz), 2.5 kHz (12.5 kHz)
Modulation	FM/DC coupled
Input Bias	2.5V DC ±1% temperature compensated to ±100 mV. Supplied in Tx/Rx.
Input Impedance	>40k ohms
Distortion	< 3% at 60% of maximum system deviation, 1 kHz tone
Capability	1.8V P-P ±2 dB produces ±5 kHz deviation with a 1 kHz tone
Flatness	±2 dB, DC-5 kHz at 1 kHz (Programmable to ±0.5 dB with diagnostic DAC
RF Power Output	1-5W ±20% adjustable (5W at 13.3Vnominal)
Deviation Symmetry	5%
RF Output Impedance	50 ohms
Duty Cycle	50% (30 sec. max transmit)
Adjacent Channel Power	-70 dB
Intermodulation Attenuation	-40 dB
Spurious and Harmonic FM	-26 dBm max.
FM Hum and Noise	-45 dB 25 kHz, -40 dB 12.5 kHz

SECTION 2 INSTALLATION

2.1 PRE-INSTALLATION CHECKS

Field alignment should not be required before the 3412 is installed. However, it is still good practice to check the performance to ensure that no damage occurred during shipment. Performance tests are located in Section 6.2.

2.2 INTERFACING WITH DATA EQUIPMENT

2.2.1 DM3412 (RF Board)

Connector J201 on the data transceiver PC board provides the interface with the data equipment. This is a 14-pin female connector with .025" square pins on 0.1" centers (Dupont 76308-114). The cable (Part No. 023-3472-007) is not included with the data transceiver. An interface cable diagram and pin designations are shown in Figure 2-1.

The following is a general description of the input and output signals on Transceiver Interface connector J201.

Pin 1 (Ground) - Chassis ground.

Pin 2 (+13.3V DC) - Input, transceiver main power. Input range 10-16V DC with ±3 dB variation in output power.

Pin 3 (Tx En) - Input +3-16V DC. Enables transmit circuitry. ≤ 0.3V DC in Rx mode.

Pin 4 (Rx En) - Input +3-16V DC. Enables receive circuitry. ≤ 0.3 V DC in Tx mode.

Pin 5 (RF En) - Input +3-16V DC. Shuts down on-board regulators. To be used as a power save mode.

Pin 6 (Mod In) - Provides a response of ±2 dB from DC to 5 kHz across the RF band (referenced to 1 kHz). It is programmable to 0.5 dB with the diagnostic DAC. The modulation capability is 250 mV RMS ±3 dB that produces ±5 kHz deviation with a 1 kHz tone. When this input is used, a temperature compensated 2.5V DC bias is required as variations in voltage cause the frequency to change. The transceiver regulatory compliance must be applied for with the customer supplied modulation limiting/filter circuit and chassis.

Pin 7 (Synth Lock) - Output from synthesizer lock detect circuit. Low (< 1V DC) = unlocked, high (>2.5V DC) = locked.

Pin 8 (Synth En) - TTL input. Latch enable signal for synthesizer. 250 ns min. for D, C and B words; 3 ms min. for A0 word. A rising edge latches the data loaded into the synthesizer IC..

Pin 9 (Data) - TTL input. Serial data line used for programming the synthesizer and diagnostic functions.

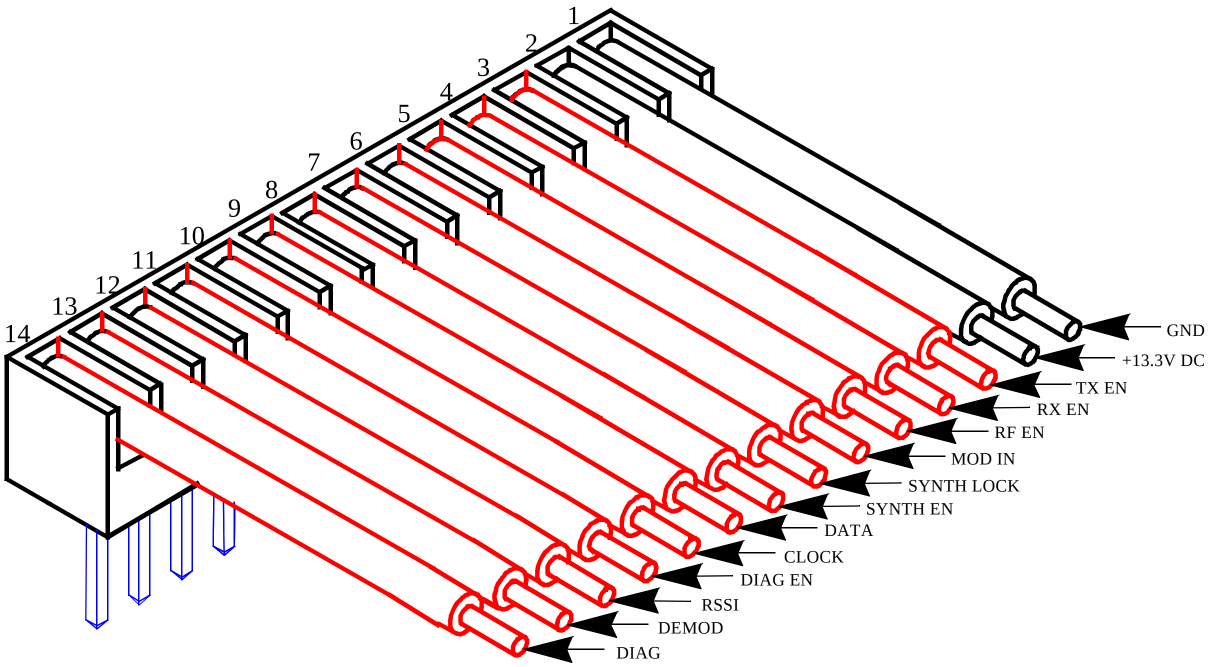
Pin 10 (Synth Clock) - TTL input. Clock signal for serial data input on Pin 9. Data is valid on the rising edge. 1 MHz max. frequency.

Pin 11 (Diag En) - TTL input. Loads programmed DAC values into DAC (U911) for modulation adjust and power set. Also provides the strobe signal for shift register (U901) for selecting Forward and Reverse power diagnostics. 250 ns min. activates on rising edge.

Pin 12 (RSSI) - Analog output (0.5-2V DC). The Receive Signal Strength Indicator output provides a voltage that increases in proportion to the strength of the RF input signal.

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

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



Part No. 023-3472-007

Figure 2-1 DM3412 INTERFACE CABLE

SECTION 3 PROGRAMMING

3.1 INTRODUCTION

DM3412 - The information in Section 3.2 describes synthesizer programming protocol. This information can be used as a basis for designing the synthesizer programming hardware and software required.

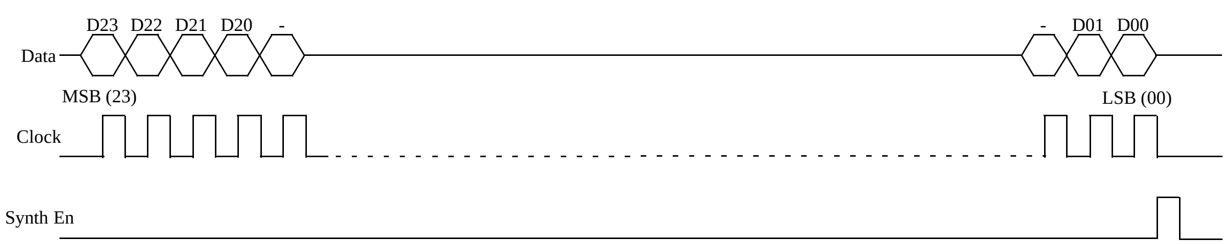
3.2 SYNTHESIZER DATA PROTOCOL

3.2.1 GENERAL

Programming of the SA-7025 Synthesizer IC (U811) is accomplished via the 3-line bus; DATA, CLOCK and SYNTH EN. Three 24-bit words (D, B and A0) are required to load the synthesizer. The D and B words contain four address bits each and the A0 has a 1-bit address. When the A0 word is loaded, the synthesizer frequency acquisition is initiated (see Figure 3-1).

Receive Bandwidth	380-512 MHz
Transmit Bandwidth	380-512 MHz
First IF	52.95 MHz
Second IF	450.0 kHz
First LO Injection	432.95-564.95 MHz*
Second LO Injection	52.5 MHz**
TCXO Frequency	17.50 MHz
Resolution	6.25 or 10 kHz
Loop Comparison Freq.	50 kHz (FCM)

* High Side Injection
** Low Side Injection



Clock (max.)	1 MHz
Synth Enable (min)	250 ns (for D, C, and B words)
D00 - D23	D, B and A0 words

Figure 3-1 24-BIT SYNTHESIZER SERIAL DATA STREAM

3.2.2 D-WORD CALCULATION (24-BITS)

The D-Word programs the Main, Reference and Auxiliary dividers, and sets the modulus.

NR = 350	Ftcxo/50 kHz=350 where Ftcxo=17.5 MHz
SM = 00	Reference select for main phase detector
EM = 1	Main divider enable flag
SA = 00	Reference select for aux. phase detector
EA = 0	Aux. divider enable flag
FMOD = 1	Selects modulo 8
LONG = 0	Send with 24 bit A0 format

D Word = 0xA1 0x5E 0x22

3.2.3 C-WORD CALCULATION (24-BITS)

The C-Word is not used in the DM-3412 synthesizer load.

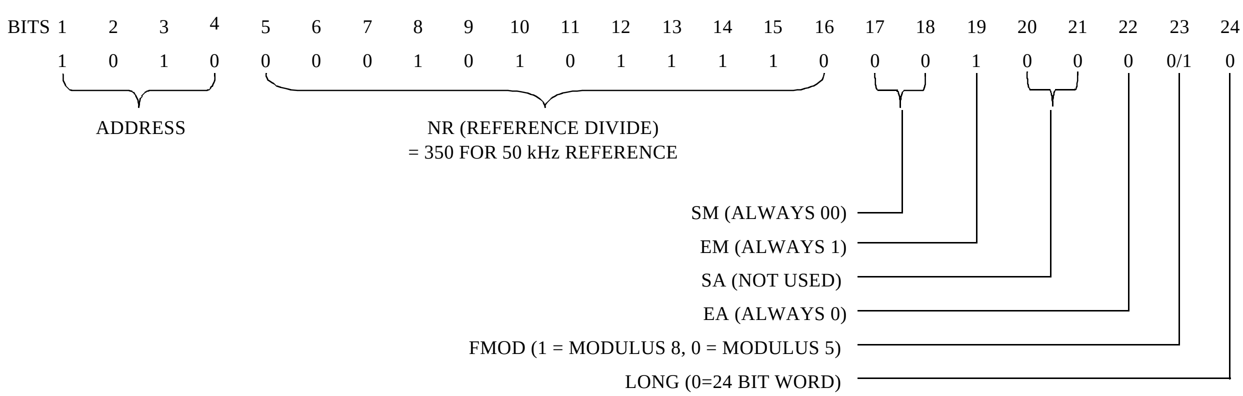


Figure 3-2 D-WORD

3.2.4 B-WORD CALCULATION (24-BITS)

The B-Word programs the Fractional-N charge pump current setting factor, the Binary acceleration factors (CL/CK) and prescaler modulus.

The value of CN should be interpolated for frequencies between the band edges. The recommended value range of CN provides the fractional spurious rejection required to meet adjacent channel specifications. The CN values could be changed on a channel-by-channel basis for ultimate rejection of the Fractional-N spurious responses close to the carrier frequency. The DM-3412 has an adjustment (R823) for fractional compensation current. The factory preset value of R823 allows CN to be set to the following ranges:

Lowest Tx Frequency	86
Highest Tx Frequency	90
Lowest Rx Frequency	96
Highest Rx Frequency	100

CN = (8-bit)	(Frequency dependent) (86-90 Tx) (96-100 Rx)
CK = 0000	Binary acceleration factor for integral charge pump
CL = 00	Binary acceleration factor for proportional charge pump
PR = 01	Select modulus 2 prescaler (64/65)

B-Word = 0x80 (8-bit CN) 0x02

BITS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1	0	0	0	0	0	0	0	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0	0	0	0	0	0	0	1
	ADDRESS				NOT USED (ALWAYS 0000)				CN (CHARGE PUMP CURRENT SETTING) (CHANNEL DEPENDENT)								CK				CL		PR (PRESCALER TYPE) (01=DUAL MODULUS)	

CK, CL: BINARY ACCELERATION FACTOR (ALWAYS 000000)

Figure 3-3 B-WORD

3.2.5 A0-WORD CALCULATION (24-BITS)

The A0-Word is sent last (see Figure 3-4). The A0-Word contains the data for the loop dividers and is programmed on a channel-by-channel basis. The Fractional-N (NF) word is a 3-bit word that programs the synthesizer to the fractional steps determined by the fractional modulus selection flag FMOD (1 = modulus 8) and the loop comparison frequency (50 kHz). The frequency resolution is:
50 kHz ÷ 8 = 6.25 kHz.

NF= (3-bits)* Fractional increment for modulus 8 (3-bits)

NM1=(12-bits)* Number of main divide cycles when prescaler modulus equals 64 (12-bits)

NM2=(8-bits)* Number of main divide cycles when prescaler modulus equals 65 (4-bits, PR=01)

NM3=(4-bits)* Number of main divide cycles when prescaler modulus equals 72 (4 bits, PR=10)
NOTE: NM3 is not used because dual modulus is selected by PR=01.

* Indicates frequency/channel dependant variable.

The Fractional-N increment (NF) is a 3-bit word that is channel dependant. NF is used to program the synthesizer to channels (frequency steps) that are below the comparison frequency (FCM), i.e. frequencies that are not divisible by FCM. When the D-word is programmed with FMOD = 8, and NR = 350 as described in Section 3.2.2, the fractional increment is:
50 kHz ÷ 8 = 6.25 kHz.
FCM = Ftcxo ÷ NR = 17.5 MHz ÷ 350 = 50 kHz
The synthesizer resolution (min. step) is 6.25 kHz.

Example Calculation:
Program the transceiver to receive at 457.01875 MHz:

RX = 457.01875 MHz
LO = RX + 52.95 MHz = 509.96875 MHz
(LO is high-side injection)

N = LO ÷ FCM = 509.96875 ÷ 0.05 = 10199 (integer)

NM2 = 64 x FRAC [N ÷ 64]
= 64 x FRAC [10199 ÷ 64]
= 64 x 0.359375
= 23

NM1 = INTEGER [N ÷ 64] - 2 - NM2
= 159 - 2 - 23
= 134

NF = 18.75 kHz ÷ 6.25 kHz = 3

NOTE: Channel steps of 10 kHz can also be achieved by setting the Fractional-N modulus flag (FMOD) in the D-word to "0" which sets FMOD to 5. NR remains set to 350. This produces 10 kHz steps as NF is incremented.

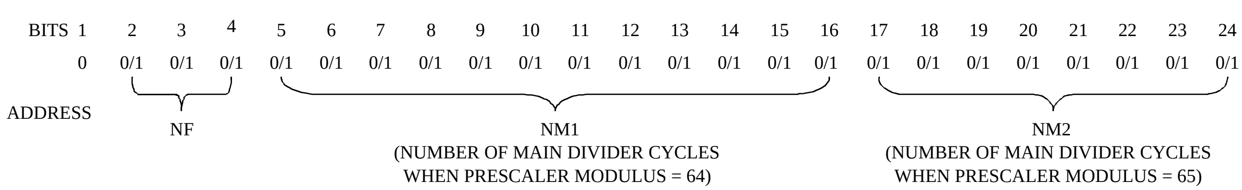
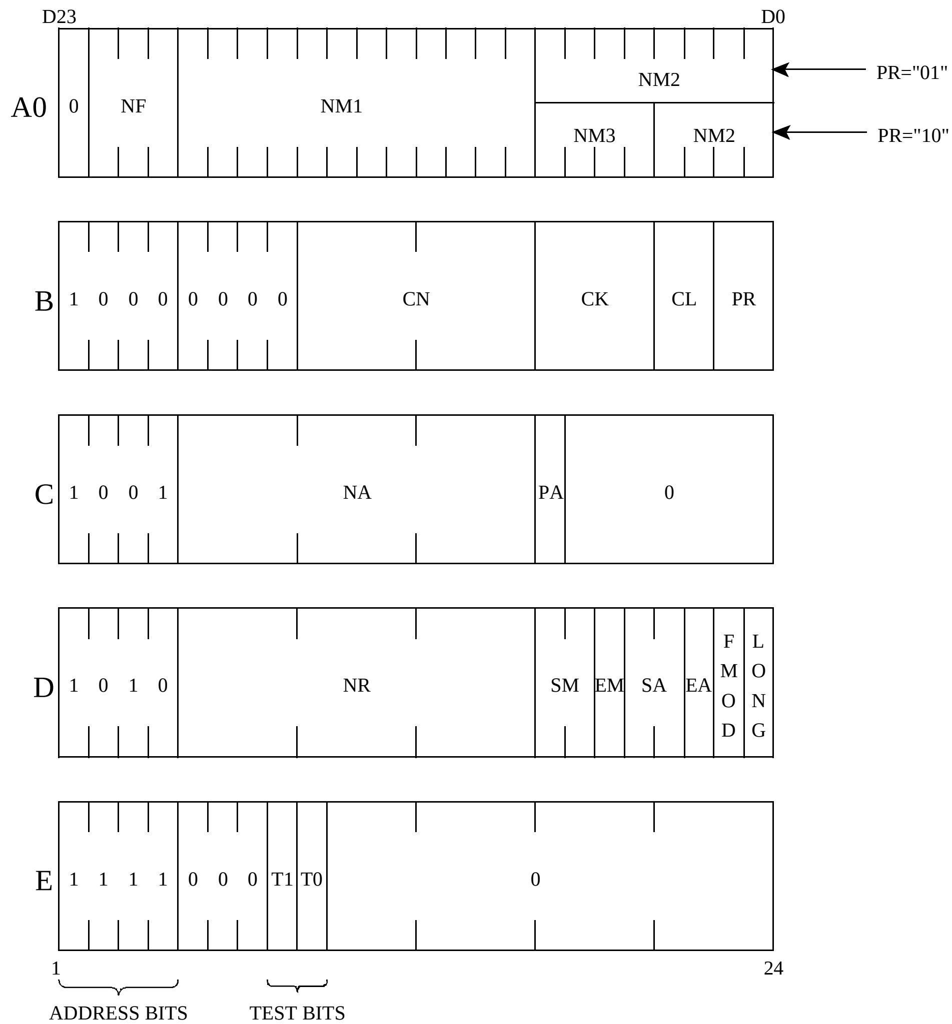


Figure 3-4 A0-WORD



NOTE: C-Word and E-Word are not used in Synthesizer load.
NOTE: Bit 24 is shifted out first.

Figure 3-5 SERIAL INPUT WORD FORMAT

3.3 RECEIVE TO TRANSMIT SEQUENCE

1. Synthesizer is loaded (24-bit D, B and A0). Refer to Figure 3-6.

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

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

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

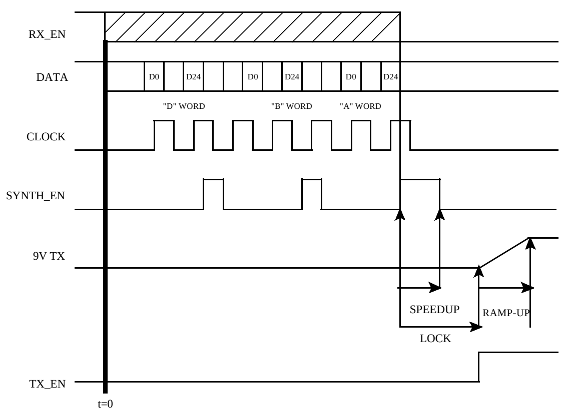


Figure 3-6 RX TO TX TIMING DIAGRAM

"Ramp-Up" is the amount of time required for the transmitter to reach full power once the TX EN has been applied. The Ramp-Up circuitry (located on the transceiver) minimizes adjacent channel interference caused by spectral spreading (sinx/x) when the transmitter is keyed. The Ramp-Up time is approximately 3 ms.

3.4 TRANSMIT TO RECEIVE SEQUENCE

1. TX_EN is turned OFF. This signal is shaped. Refer to Figure 3-7.

2. The synthesizer load process could begin slightly before, but when the last bit is strobed in the synthesizer it will become unlocked.

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

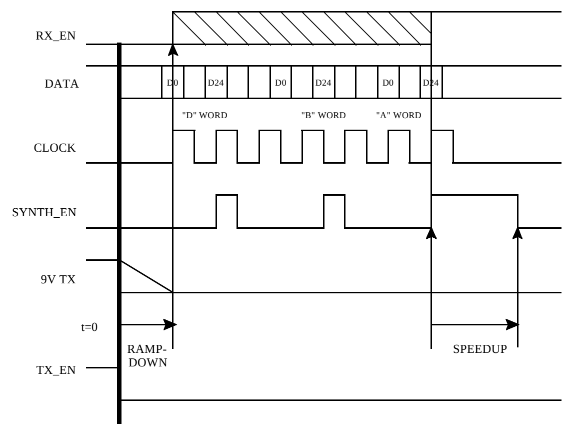


Figure 3-7 TX TO RX TIMING DIAGRAM

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

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

"Ramp-Down" is the amount of time required for the transmitter output power to be reduced before switching off the transmitter and enabling the receive with the RX_EN. The Ramp-Down circuitry (located on the transceiver) minimizes adjacent channel interference caused by spectral spreading (sinx/x) when the transmitter is un-keyed. The Ramp-Down time is approximately 3 ms.

IMPORTANT

If the receiver is to be operated at 510-512 MHz (-810), a spurious condition may occur to degrade the receiver sensitivity 2 to 3 dB. If this degradation is unacceptable, the synthesizer can be reprogrammed to a comparison frequency (FCM) of 31.25 kHz (so that a multiple of this would not be 52.95 MHz) and a modulus (FMOD) of 5 with a reference divide (NR) of 560. These parameters place the spurious at harmonics of 31.25 kHz (instead of 50 kHz) outside the passband of the IF filters where the sensitivity is not degraded.

3.5 RADIO DIAGNOSTICS

The diagnostic features allow the user to program a Digital-To-Analog Converter (DAC) to adjust RF output power and modulation flatness without removing the radio from the enclosure. Bit "ao" can be set to provide an analog voltage representative of the forward and reverse RF power at the radio interface connector J201, pin 14.

This feature can be used to monitor the condition of the transceiver and antenna/feedline. Figure 3-8 is a diagram of the Diagnostic Serial Data Stream with definitions of the bits. It is 19-bits long, the front (MSBs) can be padded with "Don't Cares" (XXs) to get to 24 bits.

Clock (max.)	1 MHz
Diag Enable (min)	250 ns (min)
XX	Don't Care

DAC Bits:

A1 - A0 = DAC Output Select
00=Power Set (Data=0xFF for now, RNG=1)
01=Mod Adj (Data=0xFF for now, RNG=1)
11=DAC Control Select (Data=0xFF for DAC Control)

RNG = Range Select (max. output) (Ref = 5.5V÷2)
0 = 1 x Ref
1 = 2 x Ref

D7 - D0 = D/A Data
0x00 = 0.0V
0xFF = 1 x Ref (RNG=0)
0xFF = approx. 2 x Ref (RNG=1)

Shift Register Bits:

a0 = Diagnostic Select to J201, pin 14 (Analog Voltage)
0 = Forward Power
1 = Reverse Power

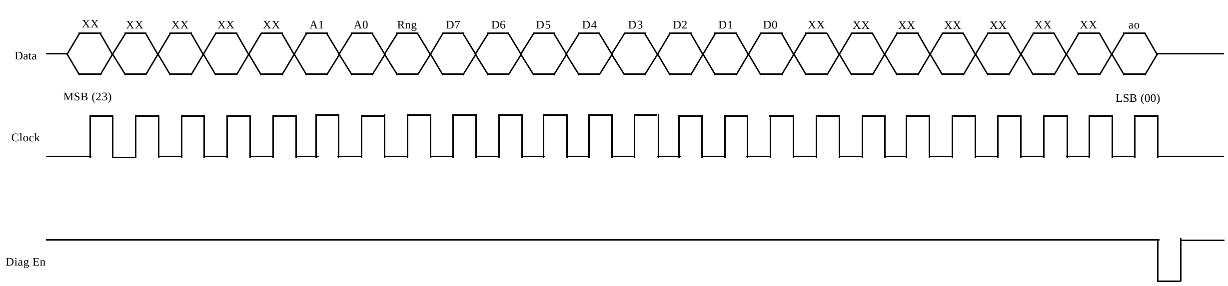


Figure 3-8 DIAGNOSTIC SERIAL DATA STREAM

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SECTION 4 CIRCUIT DESCRIPTION

4.1 GENERAL

4.1.1 INTRODUCTION

The main subassemblies of this transceiver are the RF board, VCO board, TCXO and Loader board. A block diagram of the transceiver is located in Figure 4-1. The 3412 is also available in transmit only and receive only models.

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

The 3412 has a reference oscillator stability of ±1.5 PPM. The 17.5 MHz TCXO (Temperature Compensated Crystal Oscillator) is soldered directly to the RF board. The TCXO is not serviceable.

4.1.2 SYNTHESIZER

The VCO (voltage-controlled oscillator) output signal is the receiver first injection frequency in the Receive mode and the transmit frequency in the Transmit mode. The first injection frequency is 52.95 MHz above the receive frequency. The frequency of this oscillator is controlled by a DC voltage produced by the phase detector in synthesizer chip U811.

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

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

4.1.3 RECEIVER

The receiver is a double-conversion type with intermediate frequencies of 52.95 MHz / 450 kHz. Two helical bandpass filters reject the image, half IF, injection, and other unwanted frequencies. A four-pole crystal filter and an 8-pole ceramic filter enhance receiver selectivity

4.1.4 TRANSMITTER

The transmitter produces a nominal RF power output of 5W at 13.6V DC, adjustable down to 1W. Frequency modulation of the transmit signal occurs in the synthesizer. Transmit audio processing circuitry is contained in the Loader board or customer-supplied equipment.

4.1.5 LOADER BOARD

The Loader board, Part No. 023-3240-330, is a plug-in circuit board used to load the synthesizer with a desired frequency and filters data/audio to and from the user interface connector. See Section 1.2.2.

4.2 SYNTHESIZER

A block diagram of the transceiver is shown in Figure 4-1 and a block diagram of Synthesizer IC U811 is shown in Figure 4-2. As stated previously, the synthesizer output signal is produced by a VCO (voltage controlled oscillator). The VCO frequency is controlled by a DC voltage produced by the phase detector in U811. The phase detector senses the phase and frequency of the two input signals and causes the VCO control voltage to increase or decrease if they are not the same. The VCO is then "locked" on frequency.

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

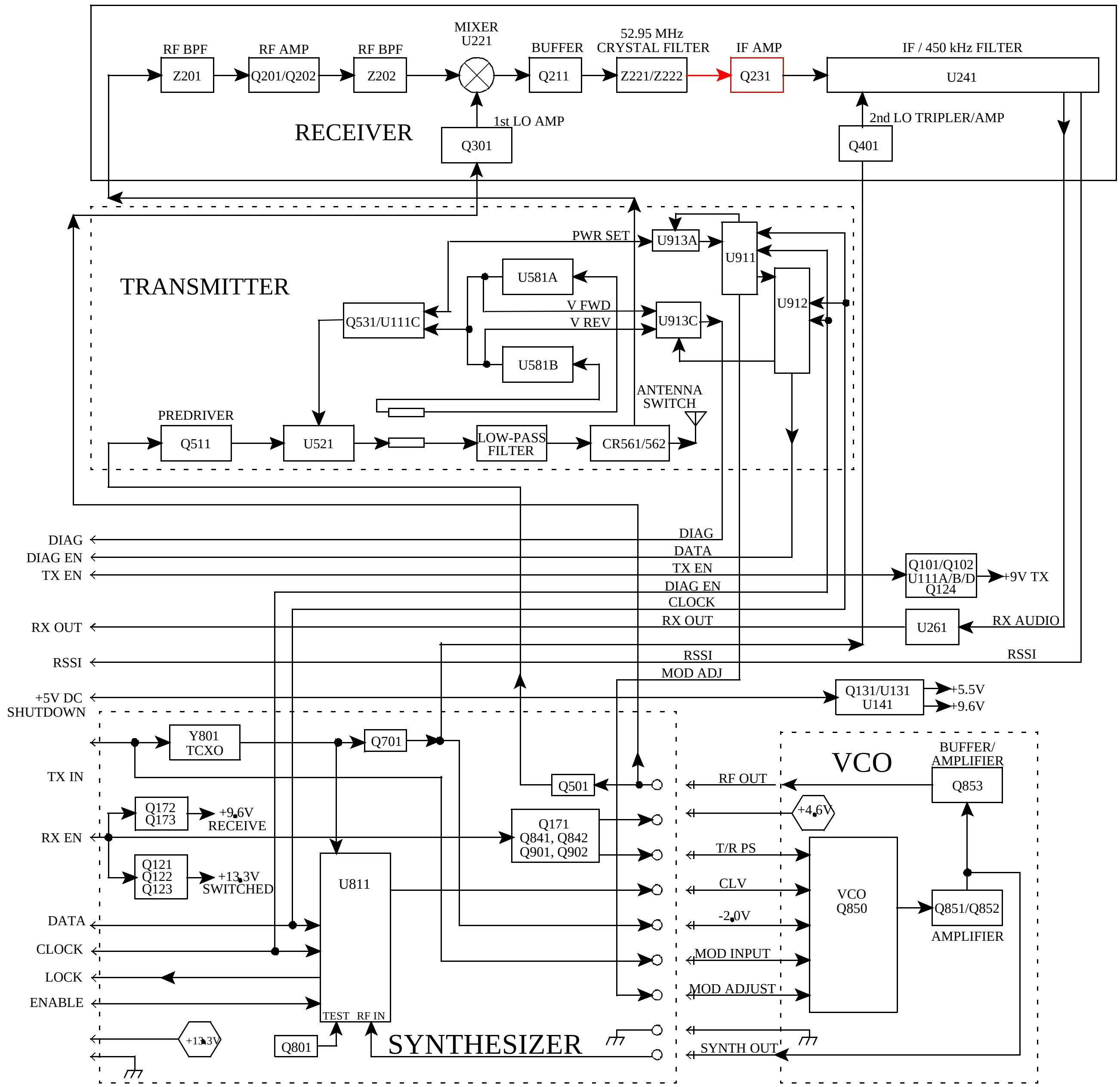

Figure 4-1 TRANSCEIVER BLOCK DIAGRAM

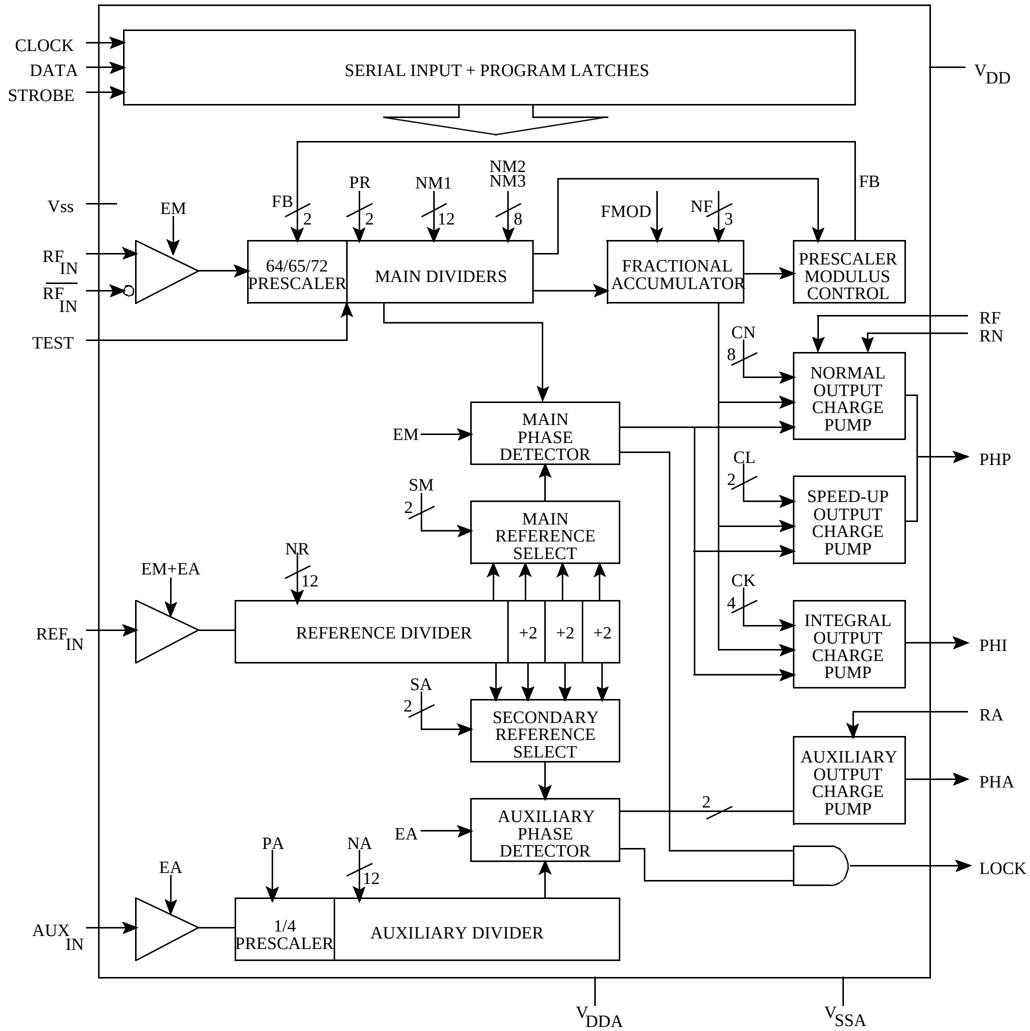

Figure 4-2 U801 SYNTHESIZER BLOCK DIAGRAM

4.2.1 VOLTAGE-CONTROLLED OSCILLATOR

Oscillator (Q850)

The VCO is formed by Q850, several capacitors and varactor diodes, and ceramic resonator Z850. It oscillates at the transmit frequency in transmit mode and first injection frequency in the receive mode (380-512 MHz in transmit and 432.950-564.950 MHz in receive).

Biasing of Q850 is provided by R862, R867, RC=867 and R868. An AC voltage divider formed by C859, C861 and C862 initiates and maintains oscillation and also matches Q850 to the tank circuit. Ceramic resonator Z850 is grounded at one end to provide shunt inductance to the tank circuit.

Frequency Control and Modulation

The VCO frequency is controlled in part by DC voltage across varactor diodes CR854, CR855, CR856 and CR851. As voltage across a reverse-biased varactor diode increases, its capacitance decreases. Therefore, VCO frequency increases as the control voltage increases. CR854/CR855 and CR856/CR851 are paralleled varactors to divide the capacitance and improve linearity. The varactors are biased at -2.0V so the control line can operate closer to ground. The control line is isolated from tank circuit RF by choke L851/L854 and decoupling capacitor C854. The amount of frequency change produced by CR854/CR855/CR856/CR851 is controlled by series capacitor C853.

The -2.0V applied to the VCO is derived from the 17.5 MHz TCXO frequency that is amplified by Q701, rectified by CR701 and filtered by C706, C707, C708 and C709 on the RF board.

The VCO frequency is modulated using a similar method. The transmit audio/data signal from J201, pin 6 is applied across varactor diode CR852 which varies the VCO frequency at an audio rate. Series capacitors C856/C870 couple the VCO to CR852. R854 provides a DC ground on the anodes of CR852/CR853, and isolation is provided by R852 and C855. C858 is an RF bypass. C853 provides isolation.

The DC voltage across CR853 provides compensation to keep modulation relatively flat over the entire bandwidth of the VCO. This compensation is required because modulation tends to increase as the VCO frequency gets higher (capacitance of CR854/CR855/CR856/CR851 gets lower). CR853 also balances the modulation signals applied to the VCO and TCXO. The DIAG on J201, pin 14 can also adjust the modulation.

The DC voltage applied across CR853 comes from the modulation adjust control R827 on the RF board. R826 applies a DC biasing voltage to CR852; C821 provides DC blocking. RF isolation is provided by C858, R853 and R847.

4.2.2 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 were modulated, the phase detector in U811 would sense the frequency change and increase or decrease the VCO control voltage to counteract the change (especially at the lower audio frequencies).

If only the reference oscillator frequency is modulated, the VCO frequency would not change fast enough (especially at the higher audio frequencies). Modulating both VCO and reference oscillators produces a flat audio response. Potentiometers R825, R826 and R827 set the VCO modulation sensitivity so that it is equal to the reference oscillator modulation sensitivity.

4.2.3 CASCODE AMPLIFIERS/VCO (Q851/Q852)

Q851/Q852 form a cascode amplifier to provide reverse isolation for the VCO. Q851 is configured as a common emitter and Q852 as a common base. The output signal is taken from the collector of Q851 and coupled to the base of amplifier Q853 through coupling capacitors C868, C871 and a PI-attenuator made up of R859 and R875.

4.2.4 AMPLIFIER (Q853)

Amplifier Q853 provides final amplification of the VCO signal. Bias for Q853 is provided by R871, R872 and R874. L856/C874 provide a match to the transmitter and first injection frequency. The T-pad attenuator made up of R892, R893 and R894 provides 6 dB of isolation between the transmitter and first injection frequency.

4.2.5 VOLTAGE FILTER (Q901)

Q901 on the RF board is a capacitance multiplier to provide filtering of the 4.6V supply to the VCO. R901 provides transistor bias and C901 provides the capacitance that is multiplied. If a noise pulse or other voltage change appears on the collector, the base voltage does not change significantly because of C901. Therefore, base current does not change and transistor current remains constant. CR901 decreases the charge time of C901 when power is turned on. This shortens the start-up time of the VCO. C902 and C903 are RF decoupling capacitors.

4.2.6 VCO FREQUENCY SHIFT (Q841)

The VCO must be capable of producing frequencies from 403-564.95 MHz to produce the required receive injection and transmit frequencies. If this large of a shift was achieved by varying the VCO control voltage, the VCO gain would be undesirably high. Therefore, capacitance is switched in and out of the tank circuit to provide a coarse shift in frequency.

This switching is controlled by the T/R pin shift (RX_EN) on J201, pin 4, Q841/Q842 and pin diode CR850. When a pin diode is forward biased, it presents a vary low impedance to RF; and when it is reverse biased, it presents a very high impedance. The capacitive leg is switched in when in transmit and out when in receive.

When J201, pin 4 is high in receive (+3-16V), Q173 is turned on and the collector voltage goes low. A low on the base of Q172 turns the transistor on and the regulated +9.6V on the emitter is on the collector for the receive circuitry. Q171 applies a low on the base of Q841, the transistor is off and the collector is high. With a high on the base of Q842 and a low on the emitter, this reverse biases CR850 for a high impedance.

The capacitive leg on the VCO board is formed by C851, CR850, C852 and C876. When J201, pin 4 is low in transmit, Q842 is turned on and a high is on the emitter, Q171 is turned off and the collector voltage goes high. A low on the base of Q173 turns the transistor off and the regulated +9.6V is removed from the receive circuitry. With a high on the base of Q841 the transistor is on and the collector is low. With a low on the collector of Q842 and a high on the emitter, this forward biases CR850 and provides an RF ground through C851 and C852/C876 are effectively connected to the tank circuit. This decreases the resonant frequency of the tank circuit.

4.2.7 SYNTHESIZER IC (U811)

<u>Introduction</u>

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

<u>Channel Programming</u>

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

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

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

4.2.8 LOCK DETECT

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

4.3 RECEIVER CIRCUIT DESCRIPTION

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

Capacitor C205 couples the receive signal from the antenna switch to helical filter Z201. (The antenna switch is described in Section 4.4.4.) 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 factory set and should not be tuned.

Impedance matching between the helical filter and RF amplifier Q202 is provided by C206, C207 and L201. CR231 protects the base-emitter junction of Q202 from excessive negative voltages that may occur during high signal conditions. Q201 is a switched constant current source which provides a base bias for Q202. Q201 base bias is provided by R202/R203. Current flows through R201 so that the voltage across it equals the voltage across R202 (minus the base/emitter drop of Q201). In the transmit mode the receive +9.6V is removed and Q201 is off. This removes the bias from Q202 and disables the RF amplifier in transmit mode. This prevents noise and RF from being amplified by Q202 and fed back on the first injection line.

Additional filtering of the receive signal is provided by Z202. L202, C208 and C209 provide impedance matching between Q202 and Z202. Resistor R205 is used to lower the Q of L202 to make it less frequency selective.

4.3.2 MIXER (U211)

First mixer U211 mixes the receive frequency with the first injection frequency to produce the 52.95 MHz first IF. Since high-side injection is used, the injection frequency is 52.95 MHz above the receive frequency. The RF signal is coupled to the mixer through C215

4.3.3 FIRST LO AMPLIFIER (Q301)

The first injection frequency from the VCO is coupled to the first local oscillator amplifier Q301 through C301. L301/C302 match Q301 to the VCO. Bias for Q301 is provided by R301, R302 and R303, R306 and C307. Impedance matching to the mixer is provided by L302, R305 and C306 decouples RF signals.

4.3.4 BUFFER (Q211), CRYSTAL FILTER (Z221/Z222), IF AMP (Q231)

The output of U221 is coupled to buffer Q211. C213, R213 and Q211 match the 50 ohm output of U221. Bias for Q211 is provided by R211 and R213. The output of Q211 is matched to crystal filter Z221 via L211, C214 and R212.

Z221 and Z222 form a 2-section, 4-pole crystal filter with a center frequency of 52.95 MHz and a -3 dB passband of 8 kHz (12.5 kHz BW) or 15 kHz (25 kHz BW). This filter establishes the receiver selectivity by attenuating the adjacent channel and other signals close to the receive frequency. C221, C222, and L221 adjust the coupling of the filter. L222, C223 and C233 provide impedance matching between the filter and Q231.

IF amplifier Q231 amplifies the 52.95 MHz IF signal to recover filter losses and improves receiver sensitivity. Biasing for Q231 is provided by R231, R232, R233, R234 and R235 and C232, C235 decouple RF signals. The output of Q231 is coupled to the detector by C234.

4.3.5 SECOND LO AMP/TRIPLER (Q401)

The input frequency to Q401 is 17.5 MHz from TCXO Y801 coupled through C402. Bias for Q401 is provided by R401, R402, R403 and R404. C403, C404 decouple RF from the amplifier. L401, L402, C405, C406 and C407 pass the third harmonic (52.5 MHz) to the input of U241, pin 4. The output of the amplifier is coupled to U241, pin 4 by C408, C409 and L403 form a 450 kHz notch.

4.3.6 SECOND MIXER/DETECTOR (U241)

Oscillator and Mixer

As shown in Figure 4-3, U241 contains the second oscillator, second mixer, limiter, detector, and squelch circuitry. The 52.95 MHz IF signal is mixed with a 52.5 MHz signal produced by second LO amplifier/tripler Q401 from TCXO Y801.

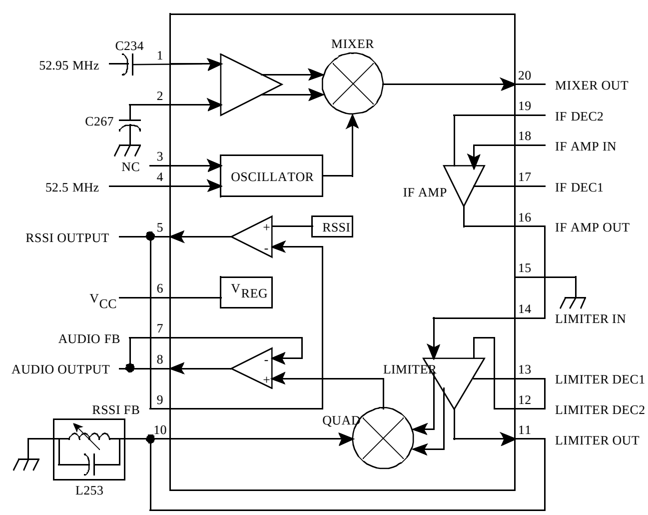

Figure 4-3 U241 BLOCK DIAGRAM

Second IF Filter

The output of the internal double-balanced mixer is the difference between 52.95 MHz and 52.5 MHz which is 450 kHz. This 450 kHz signal is fed out on pin 20 and filtered by IF filter Z251. The filtered signal is fed back into U241 on pin 18 to an internal IF amplifier. After amplification the signal is fed out on pin 16 where it is filtered by Z252 and then fed back into U241, pin 14 to the limiter.

Limiter-Amplifier

The output of Z252 is applied to a limiter-amplifier circuit in U241. This circuit amplifies the 450 kHz signal and any noise present; then limits this signal to a specific value. When the 450 kHz signal level is high, noise pulses tend to get clipped off by the limiter; however, when the 450 kHz signal level is low, the noise passes through the limiter. C275/C276 decouple the 450 kHz signal.

Quadrature Detector

From the limiter stage the signal is fed to the quadrature detector. An external phase-shift network connected to pin 8 shifts the phase of one of the detector inputs 90° at 450 kHz (all other inputs are unshifted in phase). When modulation occurs, the frequency of the IF signal changes at an audio rate as does the phase of the shifted input. The detector, which has no output with a 90° phase shift, converts this phase shift into an audio signal. L253 is tuned to provide maximum undistorted output from the detector. R255 is used to lower the Q of L253. From the detector the audio and data signal is fed out on pin 8.

Audio/Data Amplifier

The audio/data output of U241, pin 8 is fed to the audio amplifier U261. U261 amplifies and inverts the detected audio/data signal and shifts the DC bias level to +2.5V DC at the output on pin 13. The gain is set at approximately 2.5 by R262/R263. R264/R265 provide a 1.3V DC reference bias voltage for U241. The audio output of U261 is applied to J201, pin 13.

Receive Signal Strength Indicator (RSSI)

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

4.4 TRANSMITTER CIRCUIT DESCRIPTION

4.4.1 BUFFER (Q501)

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

4.4.2 PRE-DRIVER (Q511)

Pre-driver Q511 is biased Class A by R511, R512, R513 and R515. L513, C517 and C518 match Q511 to U521. R514 provides a resistive feedback path to stabilize Q511 and C515 provides DC blocking. C516 bypasses RF from the DC line, and R513 provides supply voltage isolation and ties the +9V transmit supply to the circuit.

4.4.3 FINAL (U521), COMPARATOR (U111C)

RF module U521 has an RF output of 1 to 5W and operates on an input voltage from 10-16V.

Power control is provided by U581, U111, Q531 and a stripline directional coupler. The power is adjusted by Power Set Control of U911 by R535 that provides a reference voltage to U111C. U111C drives Q531 and PA module U521.

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

If the power output of U521 decreases due to temperature variations, etc., the forward peak detector voltage drops. This detector voltage drop is buffered by U581A and applied to inverting amplifier U111C which increases the forward bias on Q531. The increase on Q531 increases the power output level of U521. If the power output of U521 increases, the forward peak detector voltage increases and U111C decreases the forward bias on Q531. The decrease on Q531 decreases the output power of U521.

The output of CR591 and CR592 are fed to U581A/B respectively. If the output of either buffer increases, the increase is applied to the inverting input of U111C. The output of U111C then decreases and

Q531 decreases the input voltage to U521 to lower the power. The control voltage is isolated from RF by ferrite bead EP532 and C531 decouples RF.

The forward/reverse power voltages from U581A/B are also applied to U913 for Diagnostic outputs on J201, pin 14.

The low-pass filter consists of C552, L551, C553, L552, C554, L553, C555, L554 and C556. 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.

4.4.4 ANTENNA SWITCH (CR561, CR562)

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

C583, L561, and C564 form a discrete quarter-wave line. When CR561 is forward biased, this quarter-wave line is effectively AC grounded on one end by C564. When a quarter-wave line is grounded on one end, the other end presents a high impedance to the quarter-wave frequency. This blocks the transmit signal from the receiver. C561/C562 matches the antenna to 50 ohms in transmit and receive.

4.4.5 TRANSMIT KEY-UP CONTROL

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

U111A/B provide the key-up and key-down conditioning circuit. C116 and R117 provide a ramp-up and ramp-down of the 9V transmit supply during key-up and key-down which reduces load pull of the VCO during key-up. The conditioning provides a stable 5.5V output by balancing the 5.5V reference with the 5.5V regulated supply.

The output on U111B, pin 7 is applied to the non-inverting input of comparator U111D, pin 12. The output of U111D, pin 14 is applied to the base of current source Q124. The output of Q124 is on the emitter and is applied back to the inverting input of comparator U111D, pin 13. A decrease or increase at U111D, pin 13 causes a correction by U111D to stabilize the 9V transmit output. R125/R126 establishes the reference voltage on U111D, pin 13. C123 provides RF bypass, C124 provides RF decoupling and C125 stabilizes the output. The 9V transmit voltage is then distributed to the circuits.

4.5 VOLTAGE REGULATORS

4.5.1 +9.6 AND +5.5V REGULATED

The +5-16V applied on J201, pin 5 is applied to the base of Q131 turning the transistor on. This causes the collector to go low and applies a low to the control line of U131, pin 2 and R132 provides supply voltage isolation. The 13.3V from J201, pin 2 is on U131, pin 6 to produce a +5.5V reference output on U131, pin 4. C132 stabilizes the voltage and C131/C133 provide RF decoupling. C134 provides RF bypass and C136 provides RF decoupling. C135 helps to stabilize the voltage when the +5.5V supply first turned on.

The low from the collector of Q131 is also applied to the control line of U141, pin 2. The 13.3V from J201, pin 2 is on U141, pin 6 to produce a +9.6V output on U141, pin 4. C144 provides RF bypass and C146 provides RF decoupling. C145 helps to stabilize the voltage when the +9.6V supply first turned on.

SECTION 5 SERVICING

5.1 GENERAL

5.1.1 PERIODIC CHECKS

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

5.1.2 SURFACE-MOUNTED COMPONENTS

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

5.1.3 SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

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

5.1.4 REPLACEMENT PARTS LIST

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

5.1.5 TCXO MODULE NOT SERVICEABLE

The ±1.5 PPM TCXO module is not field serviceable. Part changes require a factory recalibration to ensure that the oscillator stays within its ±1.5 PPM tolerance.

5.2 SYNTHESIZER SERVICING

5.2.1 INTRODUCTION

When there is a synthesizer malfunction, the VCO is not locked on frequency. When an unlocked VCO is detected by the lock detector circuit, U801, pin 18 goes low (0V).

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

When the VCO is unlocked, the f_R and f_V inputs to the phase detector are 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 Q850, amplifier Q851/Q852, and the RF IN of 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 U811, pin 8. It should be 17.5 MHz at a level of approximately 1V P-P. If the TCXO module is defective, it is not serviceable and must be replaced with a new module as described in Section 5.1.5.

5.2.3 VCO

Output Level

The output level of Q853 can be measured with an RF voltmeter or some other type of high impedance meter. The minimum level after a power splitter at R893 should be -10 dBm.

Control Voltage

Check the DC voltage at TP831 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 5.5V).

Output Frequency

Check the VCO frequency at R893. 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 5.5V.

5.2.4 SYNTHESIZER (U801)

Lock Detector

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

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 J201:

Pin 2 - 13.3V DC nominal
Pin 3 - 0.0V DC while in Receive
Pin 4 - 3-16V DC in Receive Mode
Pin 5 - 3-16V DC
Pin 6 - 2.5V DC ±1%

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

Pin 4 - 150 µA

5.3.2 MIXER/DETECTOR (U241)

Data Output

Using a .01 µF coupling capacitor, inject a 52.95 MHz, 1 mV signal, modulated with 1 kHz at ± 3 kHz deviation at U241, pin 1. The signal output at U241, pin 8 should be approximately 150 mV P-P.

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

RSSI Output

The RSSI output on J201, pin 12 should be <900 mV DC with no signal applied, and >2.3V DC with a 1 mV input signal.

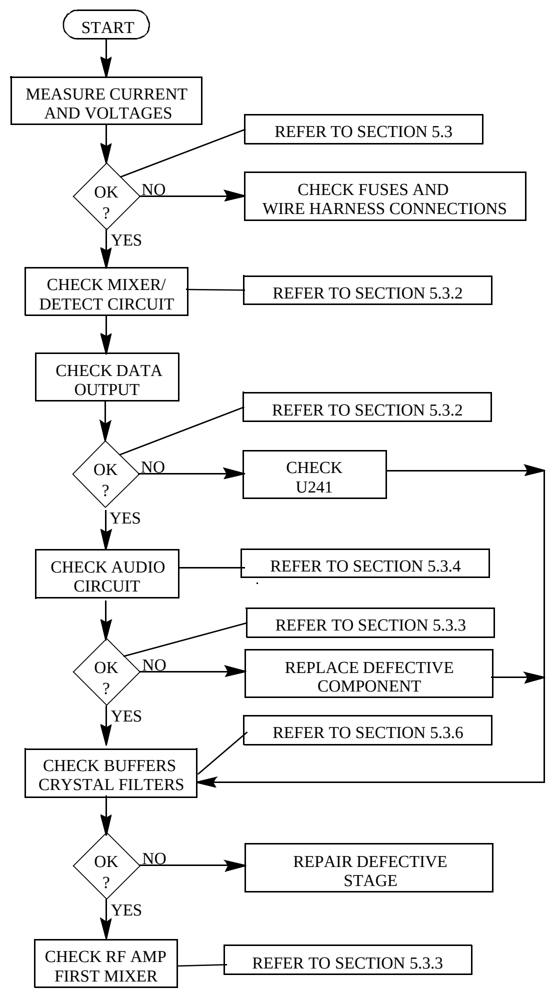

Figure 5-1 RECEIVER SERVICING

5.3.3 SECOND LO (Q401)

Verify the Second LO signal is present at U241, pin 4. The Second LO should be at 52.50 MHz and not less than 500 mV P-P.

5.3.4 AUDIO BUFFER AMP (U261)

The Data output on J201, pin 13 should be 280-700 mV P-P, with the preceding injection signal. If these levels are not correct, verify proper adjustment of L253 (see Section 6.3). The gain of U261 is 2.5 for 25 kHz radios and 5 for 12.5 kHz radios.

5.3.5 IF AMP (U231)

The IF Amp input signal is 52.95 MHz. This amp provides approximately 15 dB of gain to U241.

5.3.6 BUFFER AMP (Q211), CRYSTAL FILTERS

Q211 buffers the 52.95 MHz IF signal and provides matching to the crystal filters Z221/Z222.

5.3.7 MIXER (U211)

The mixer converts the RF signal (380-512 MHz) to 52.95 MHz. The Local Oscillator is provided by the VCO and Q301. The level of the LO should be approximately +3 dBm.

5.3.8 LNA (Q202), HELICAL FILTERS

The LNA provides approximately 15 dB of gain at 380-512 MHz. The helical filters Z201/Z202 have approximately 2.5 dB of loss each. Q201 provides active bias to Q201.

5.3.9 ANTENNA SWITCH

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

5.4 TRANSMITTER SERVICING

5.4.1 SUPPLY VOLTAGES AND CURRENT

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

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

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

Pin 2 - 2.5A maximum
Pin 3 - 150 µA
Pin 5 - 150 µA

5.4.2 VCO (A801)

1. Check VCO A801 for power output. (Power output should be at least -10 dBm.)

2. Check 9V Transmit (Q141, emitter).

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

4. Check voltages on Buffer Q501.

   Input = 1.5V DC
   Output = 3.5V DC

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

5.4.3 PRE-DRIVER (Q511)

1. Check voltages on Q511.

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

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

5.4.4 FINAL AMPLIFIER (U521)

1. Check the voltages on U521.

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

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

5.4.5 ANTENNA SWITCH (CR561/CR562)

1. Check the antenna switch voltages.

   CR561 = 8.6V DC
   CR562 = 8.0V DC

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

5.4.6 MODULATION INPUT (J201, PIN 6)

1. Check for audio/data signals at J201, pin 6, Y801, pin 1 and A801, pin 3.

5.4.7 TCXO (Y801)

1. Check Y801, pin 1 for 2.5V DC ±1%.

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

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

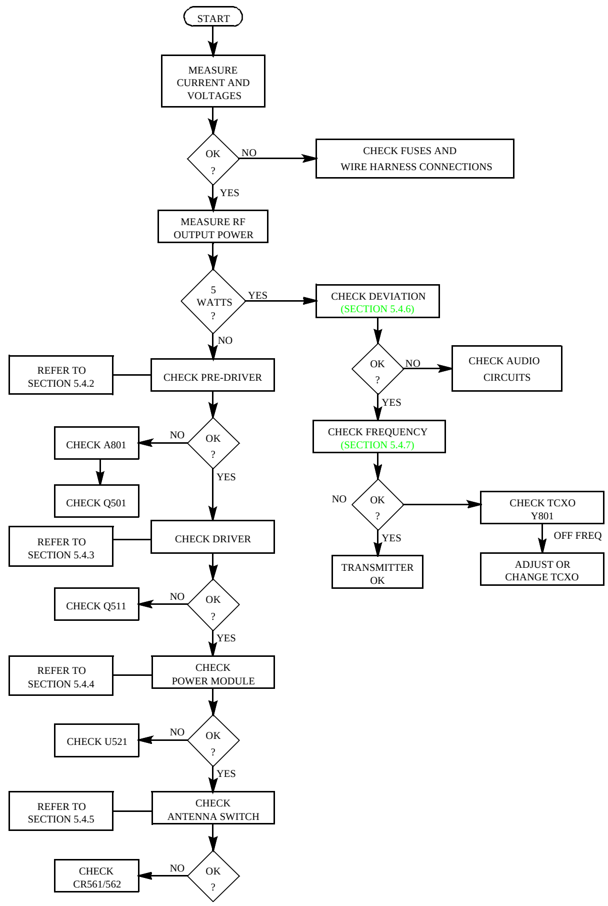

Figure 5-2 TRANSMITTER SERVICING

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 6-4 or component layouts are located in Section 8.

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

6.2 TEST EQUIPMENT

- Modulation Analyzer, HP8901 or equivalent
- RF Signal Generator, HP8656 or equivalent
- Power Meter
- Oscilloscope
- Digital Multimeter
- Power Supply, HP8264A or equivalent
- Audio Analyzer, HP8903A or equivalent
- Loader Board (PN 023-3240-330) or equivalent

6.3 DL3412 TRANSCEIVER ONLY

6.3.1 VCO CONTROL VOLTAGE

1. Connect the test setup shown in Figure 6-1. Set the power supply for +13.3V DC. See Figure 2-1 for interface cable.

2. Load the synthesizer with the channel frequency (see Section 3.2).

3. Connect a DC voltmeter at the junction of R833/ C836 (VCO pin 16) to measure the VCO control line voltage for a meter reading of ≥ 0.50 and ≤ 4.90V DC (see Figure 6-4).

NOTE: These voltages will be approximately 0.50V DC higher with the VCO cover off.

4. Adjust R535 fully counterclockwise and key the transmitter.

5. Connect a DC voltmeter at the junction of R833/ C836 (VCO pin 16) to measure the VCO control line voltage for a meter reading of ≥ 0.75 and ≤ 5.00V DC (see Figure 6-4).

NOTE: These voltages will be approximately 0.50V DC higher with the VCO cover off.

6. Unkey the transmitter.

6.3.2 TRANSMITTER AND FREQUENCY ALIGNMENT (OEM Not Using Diagnostics)

1. Connect the test setup shown in Figure 6-1. A DC ammeter capable of measuring up to 3A should be installed in the supply line. Set the input voltage for +13.3V DC.

2. Load the synthesizer with the channel frequency.

(Do not transmit for extended periods.)

3. Adjust R535 clockwise for 5.0W +0.5/-0.2W. Power output should be between 4.0-6.0W with current less than 2.5A (subtract 30 mA if Loader Board is used).

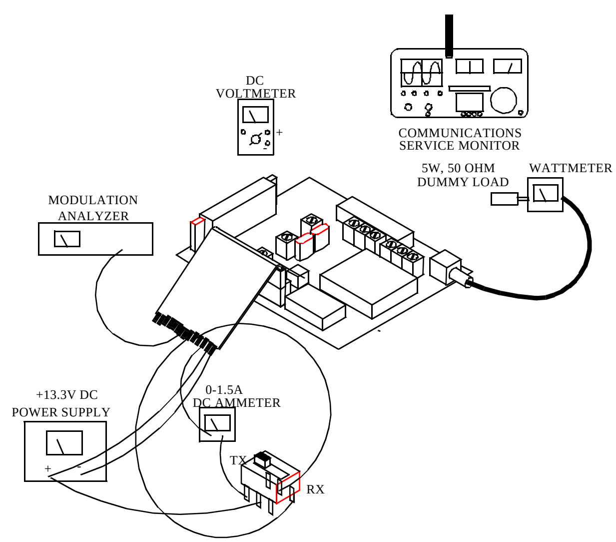

Figure 6-1 TRANSMITTER TEST SETUP

6.3.3 MODULATION ALIGNMENT

1. Connect a DC voltmeter to the junction of R822/ R823 and adjust R823 for 2.10V DC ±0.05V DC (see Figure 6-4).

2. Inject a 100 Hz square-wave tone at approximately 0.35V P-P, biased at +2.5V DC on J201, pin 6.

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

4. Adjust R827 for a flat square-wave on the oscilloscope. (The voltage at the wiper of R827 should be between 1-3V DC. If the voltage is less than 1V DC, replace R825 with a larger value.)

5. Inject a 100 Hz sine-wave on J201, pin 6, biased at +2.5V DC, the modulation analyzer should still have the 15 kHz lowpass filter selected.

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

   1.5 kHz for 12.5 kHz BW (-X10 Radios)
   3.0 kHz for 25.0 kHz BW (-X30 Radios)

7. Set a 0 dB reference of FM peak deviation on the Audio Analyzer.

8. Input a 1kHz sine-wave. The level should be within ±1.5 dB of the reference at 100 Hz.
   0.2V RMS for 12.5 kHz BW (-X10 Radios)
   0.4V RMS for 25.0 kHz BW (-X30 Radios)

9. Remove transmit modulation and unkey the transmitter.

6.3.4 TRANSMITTER AND FREQUENCY ALIGNMENT (Johnson Loader Using Diagnostics)

NOTE: Subtract the current drawn by the test loader or any interface units from all measurements.

NOTE: Refer to DL-3240 Universal Loader Board Service Manual for software description and programming information. The PRODUCTION TEST : TEST SELECT menu is required for alignment.

1. Check that R571 is installed and R572 is removed on Revision 2 or earlier boards (see Figure 6-4).

2. Make sure input supply voltage equals +13.3V.

3. Arrow to the "mid" channel.

4. Press F5 to key the transmitter (see Figure 6-2).

5. Adjust R535 fully clockwise for maximum power output.

6. Adjust the DAC value using PgUp/PgDn to set the power out to 5.0W ±0.3W. Re-check supply voltage for +13.3V. Adjust voltage and power if necessary (see Figure 6-2).

7. Repeat Step 6 at the "low" and "high" channels.

8. Power output should be 4.7-5.3W (50% Duty Cycle) and current less than 2.5A for 380-512 MHz Transmitters.

9. Arrow to the "mid" channel. Adjust the frequency displayed on the Frequency Counter to read according to the frequency shown on the monitor by adjusting the TCXO (Y801).

10. Observe the Forward Power voltage on the monitor. The voltage should be greater than 3.0V DC.

11. Observe the Reverse Power voltage on the monitor. The voltage should be less than 1.0V DC.

6.3.5 MODULATION ADJUSTMENT

1. Arrow down to Square Wave and arrow over to toggle the 100 Hz square-wave tone on.

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

3. Check to be sure the DAC values are at there initial settings. Press F3 to initialize the Power Adjust, Mod Adjust, and Front-End Adjust if they are not initialized (see Figure 6-2).

4. Arrow to the "mid" channel the DAC value should be "125" (the voltage at the wiper of R827 should be set to 1.5V DC). If the square wave is rolled off on the edges, adjust R825 up in value to achieve as flat a square wave as possible. If the square wave is peaked on the edges, adjust R825 down in value to achieve as flat a square wave as possible.

5. Adjust the DAC value using CTRL Page Up/Page Down to fine tune the DAC value for the latest square wave (see Figure 6-2).

6. If the radio/loader combination is to stay together as one unit, press F10 to save the values to the loader EEPROM.

7. Repeat the previous two steps at the Low and High channels.

8. Arrow down to Square Wave and arrow over to shut the square wave off.

9. Arrow up to Tx Audio Mode and arrow over to Wide AC.

10. Input a 100 Hz sine wave. With the modulation analyzer 15 kHz low pass filter selected. Adjust the audio analyzer output level to achieve a transmit deviation of:

    fd= 1.5 kHz for 12.5 kHz radios
    fd= 3.0 kHz for 25 kHz radios

11. Arrow to the Low channel, input a 100 Hz sine wave and set a 0 dB reference on the MOdulation Analyzer. Input a 1 kHz sine wave, the level should be within ±0.5 dB of the reference at 100 Hz.

12. Arrow to the "mid" channel, input a 100 Hz sine wave and set a 0 dB reference on the MOdulation Analyzer. Input a 1 kHz sine wave, the level should be within ±0.5 dB of the reference at 100 Hz.

13. Arrow to the High channel, input a 100 Hz sine wave and set a 0 dB reference on the MOdulation Analyzer. Input a 1 kHz sine wave, the level should be within .05 dB of the reference at 100 Hz.

14. Unkey the transmitter by pressing F6.

```
File  Edit  Utilities  Program  Code  Prod Test                <F1>-Help  08:43:30

                         Frequency Select  (ESC to Exit)

        Radio            = 3412                     RSSI Voltage   = 0.70 V
        Freq Pair        = MID                      Forware Power  = 2.40 V
        Range            = 1                        Reverse Power  = 0.60 V
        Rx Frequency     = 450.000000 MHz           Voltage        = 13.3 V
        Tx Frequency     = 450.000000 MHz           Current        = 0.09 A
        Rx Audio Mode    = Audio                    Temperature    =   89 F
        Tx Audio Mode    = Audio                    VSWR           =  1.4:1
        600 Ohm Input    = OFF
        Square Wave      = OFF                      Power Adj      =   89
        Carrier Squelch  = ON                       MOd Adj        =  102
                                                    Front-End Adj  =  122
        PgUp/Dn:         Power Adj                  Diag-En Adj    =  255
        CTRL PgUp/Dn:    Mod Adj
        ALT PgUp/Dn:     Front End Adj              Synth Lock

     F2: Auto Front-End Adjust   F3: Init Tune Settings   F4: Start Heat Run
     F5: PTT On                  F6: PTT Off              F7: Direct DAC Adj
     F9: Toggle Sleep Mode      F10: Save Power/Mod/Front-End Adj for Pair

 Frequency Pair (Left/Right Arrow to Select)
```

Figure 6-2 PRODUCTION TEST:TEST SELECT

6.3.6 RECEIVER ALIGNMENT

C A U T I O N

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

1. Connect the test setup shown in Figure 6-3. Adjust the power supply for +13.3V DC.
2. Measure the receive current drain. (Typically current should be approximately 88 mA or 105 mA with Loader Board.)
3. Preset tuning slugs of L211/L222 to the full clockwise position (slug in all the way).
4. Preset C221 to center position (slot in-line with axis of part).
5. Readjust L222 counterclockwise 2 turns.

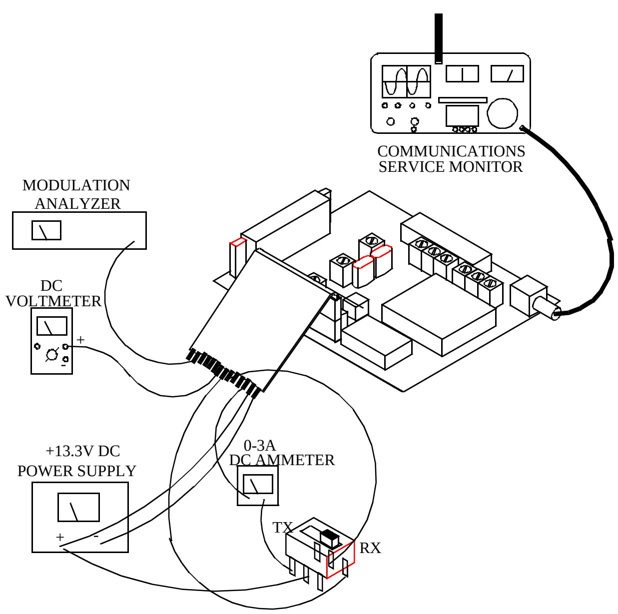

Figure 6-3 RECEIVER TEST SETUP

6.3.7 IF AND AUDIO ADJUSTMENTS

1. Load the synthesizer with the channel frequency.
2. Set the RF signal generator for this frequency with a 1 kHz tone (modulated output shown below) at a level of -47 dBm (1000 µV) and inject into J501.

   1.5 kHz deviation 12.5 kHz BW (-X10 Radio)
   3.0 kHz deviation 25.0 kHz BW (-X30 Radio)

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

3. Adjust L253 for +2.5V DC (±0.05V DC) at the receive audio output, J201, pin 13.
4. Set the RF signal generator level to -105 dBm, "unmodulated".
5. Set the generator frequency 3 kHz (-X10) or 5 kHz (-X30) below channel center.
6. Adjust C221, then L211 for peak RSSI voltage.

   NOTE: Use 2V scale on DVM.

7. Set the RF signal generator frequency back to channel center at -47 dBm with standard deviation level.
8. Adjust L222 for minimum distortion.
9. Set the RF signal generator to -105 dBm, "unmodulated".
10. Adjust L211 for peak RSSI voltage.

    NOTE: Use 2V scale on DVM.

11. Set RF generator back to standard deviation levels and re-adjust L253 for peak audio output. Verify audio output level of 150 mV RMS, ±50 mV RMS at a DC bias of 2.5V DC, ±0.3V DC.
12. Measure the percent distortion. (Typically <3%.)
13. Adjust the RF input level until 12 dB SINAD is measured. (Typically <0.35 µV/-116 dBm).
14. Adjust the generator RF level to -120 dBm and measure DC (RSSI) voltage on J201, pin 12. (Typically ≤ 0.90V DC.)
15. Adjust the generator RF level to -60 dBm and measure DC (RSSI) voltage on J201, pin 12. (Typically ≥ 2.40V DC.)

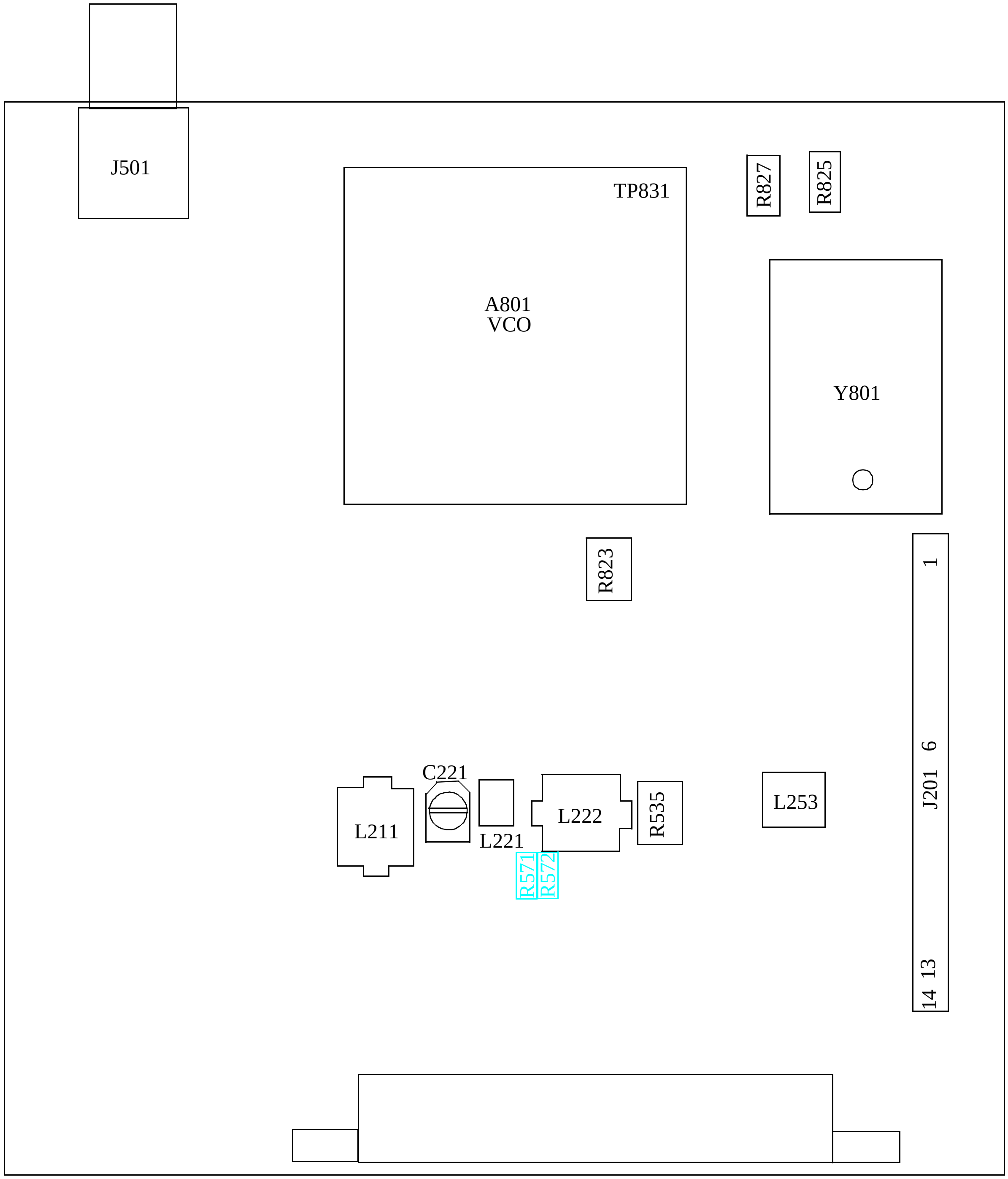

Figure 6-4 ALIGNMENT POINTS DIAGRAM

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SECTION 7 PARTS LIST

3412 TRANSCEIVER
PART NO. 242-3412-XX0

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 002	Loader board assembly	023-3240-330
A 801	VCO 403-419 MHz	023-3474-240
A 801	VCO 419-435 MHz	023-3474-340
A 801	VCO 435-451 MHz	023-3474-440
A 801	VCO 450-470 MHz	023-3412-540
A 801	VCO 464-480 MHz	023-3474-640
A 801	VCO 480-496 MHz	023-3474-740
A 801	VCO 496-512 MHz	023-3474-840
C 101	68 pF ±5% NPO 0603	510-3674-680
C 102	1 µF 16V SMD tantalum	510-2625-109
C 103	68 pF ±5% NPO 0603	510-3674-680
C 104	.01 µF ±10% X7R 0603	510-3675-103
C 105	1 µF 16V SMD tantalum	510-2625-109
C 106	68 pF ±5% NPO 0603	510-3674-680
C 111	.01 µF ±10% X7R 0603	510-3675-103
C 112	68 pF ±5% NPO 0603	510-3674-680
C 113	68 pF ±5% NPO 0603	510-3674-680
C 114	.1 µF ±5% X7R 1206	510-3609-104
C 115	.01 µF ±10% X7R 0603	510-3675-103
C 116	.0082 µF ±10% X7R 0805	510-3605-822
C 121	68 pF ±5% NPO 0603	510-3674-680
C 122	68 pF ±5% NPO 0603	510-3674-680
C 123	.01 µF ±10% X7R 0603	510-3675-103
C 124	68 pF ±5% NPO 0603	510-3674-680
C 125	1 µF 16V SMD tantalum	510-2625-109
C 131	68 pF ±5% NPO 0603	510-3674-680
C 132	1 µF 16V SMD tantalum	510-2625-109
C 133	68 pF ±5% NPO 0603	510-3674-680
C 134	.01 µF ±10% X7R 0603	510-3675-103
C 135	1 µF 16V SMD tantalum	510-2625-109
C 136	68 pF ±5% NPO 0603	510-3674-680
C 137	.01 µF ±10% X7R 0603	510-3675-103
C 141	1 µF 16V SMD tantalum	510-2625-109
C 142	68 pF ±5% NPO 0603	510-3674-680
C 143	.01 µF ±10% X7R 0603	510-3675-103
C 144	.01 µF ±10% X7R 0603	510-3675-103
C 145	1 µF 16V SMD tantalum	510-2625-109
C 146	68 pF ±5% NPO 0603	510-3674-680
C 151	68 pF ±5% NPO 0603	510-3674-680
C 152	68 pF ±5% NPO 0603	510-3674-680
C 153	68 pF ±5% NPO 0603	510-3674-680
C 154	68 pF ±5% NPO 0603	510-3674-680
C 155	68 pF ±5% NPO 0603	510-3674-680
C 156	68 pF ±5% NPO 0603	510-3674-680
C 157	68 pF ±5% NPO 0603	510-3674-680
C 158	68 pF ±5% NPO 0603	510-3674-680
C 159	68 pF ±5% NPO 0603	510-3674-680
C 160	68 pF ±5% NPO 0603	510-3674-680
C 161	68 pF ±5% NPO 0603	510-3674-680
C 162	68 pF ±5% NPO 0603	510-3674-680
C 163	68 pF ±5% NPO 0603	510-3674-680
C 171	1 µF 16V SMD tantalum	510-2625-109
C 172	68 pF ±5% NPO 0603	510-3674-680
C 201	68 pF ±5% NPO 0603	510-3674-680
C 202	.01 µF ±10% X7R 0603	510-3675-103
C 203	68 pF ±5% NPO 0603	510-3674-680
C 204	.01 µF ±10% X7R 0603	510-3675-103
C 205	68 pF ±5% NPO 0603	510-3674-680
C 206	68 pF ±5% NPO 0603	510-3674-680
C 207	3.9 pF ±0.1% NPO 0603	510-3673-399
C 208	22 pF ±5% NPO 0603	510-3674-220
C 209	5.6 pF ±0.1% NPO 0603	510-3673-569
C 210	.01 µF ±10% X7R 0603	510-3675-103
C 211	.01 µF ±10% X7R 0603	510-3675-103
C 212	.01 µF ±10% X7R 0603	510-3675-103
C 213	.01 µF ±10% X7R 0603	510-3675-103
C 214	3.9 pF ±0.1% NPO 0603	510-3673-399
C 215	68 pF ±5% NPO 0603	510-3674-680
C 221	1.5-5 pF ceramic SMD	512-1602-001
C 222	3.3 pF ±0.1% NPO 0603	510-3673-339
C 223	.01 µF ±10% X7R 0603 (12.5 kHz Bandwidth)	510-3675-103
	39 pF ±5% NPO 0805 (25 kHz Bandwidth)	510-3601-390
C 231	68 pF ±5% NPO 0603	510-3674-680
C 232	.01 µF ±10% X7R 0603	510-3675-103
C 233	8.2 pF ±0.1% NPO 0603 (12.5 kHz BW)	510-3673-829
	10 pF ±0.1% NPO 0805 (25 kHz BW)	510-3601-100
C 234	.01 µF ±10% X7R 0603	510-3675-103
C 235	.01 µF ±10% X7R 0603	510-3675-103
C 261	68 pF ±5% NPO 0603	510-3674-680

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 262	.1 µF ±5% X7R 1206	510-3609-104
C 264	47 µF 10V SMD tantalum	510-2624-470
C 265	.01 µF ±10% X7R 0603	510-3675-103
C 266	68 pF ±5% NPO 0603	510-3674-680
C 267	.01 µF ±10% X7R 0603	510-3675-103
C 268	.01 µF ±10% X7R 0603	510-3675-103
C 271	.01 µF ±10% X7R 0603	510-3675-103
C 272	.01 µF ±10% X7R 0603	510-3675-103
C 273	.01 µF ±10% X7R 0603	510-3675-103
C 275	.01 µF ±10% X7R 0603	510-3675-103
C 276	.01 µF ±10% X7R 0603	510-3675-103
C 277	10 pF ±0.1% NPO 0603	510-3673-100
C 279	.01 µF ±10% X7R 0603	510-3675-103
C 301	68 pF ±5% NPO 0603	510-3674-680
C 302	8.2 pF ±0.1% NPO 0603 (403-470 MHz)	510-3673-829
	5.6 pF ±0.1% NPO 0603 (464-512 MHz)	510-3673-569
C 303	1 µF 16V SMD tantalum	510-2625-109
C 304	68 pF ±5% NPO 0603	510-3674-680
C 305	68 pF ±5% NPO 0603	510-3674-680
C 306	5.6 pF ±0.1% NPO 0603	510-3673-569
C 307	68 pF ±5% NPO 0603	510-3674-680
C 401	.01 µF ±10% X7R 0603	510-3675-103
C 402	.01 µF ±10% X7R 0603	510-3675-103
C 403	.01 µF ±10% X7R 0603	510-3675-103
C 404	.01 µF ±10% X7R 0603	510-3675-103
C 405	82 pF ±5% NPO 0603	510-3674-820
C 406	6.8 pF ±0.1% NPO 0603	510-3673-689
C 407	82 pF ±5% NPO 0603	510-3674-820
C 408	.01 µF ±10% X7R 0603	510-3675-103
C 409	.1 µF ±5% X7R 1206	510-3609-104
C 501	68 pF ±5% NPO 0603	510-3674-680
C 502	68 pF ±5% NPO 0603	510-3674-680
C 503	68 pF ±5% NPO 0603	510-3674-680
C 504	68 pF ±5% NPO 0603	510-3674-680
C 505	22 pF ±5% NPO 0603	510-3674-220
C 506	10 pF ±0.1% NPO 0603	510-3673-100
C 507	.01 µF ±10% X7R 0603	510-3675-103
C 508	68 pF ±5% NPO 0603	510-3674-680
C 511	68 pF ±5% NPO 0603	510-3674-680
C 512	3.9 pF ±0.1% NPO 0603	510-3673-399
C 513	.01 µF ±10% X7R 0603	510-3675-103
C 514	68 pF ±5% NPO 0603	510-3674-680
C 515	470 pF ±5% NPO 0603	510-3674-471
C 516	68 pF ±5% NPO 0603	510-3674-680
C 517	68 pF ±5% NPO 0603	510-3674-680

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 518	1.8 pF ±0.1% NPO 0603	510-3673-189
C 519	68 pF ±5% NPO 0603	510-3674-680
C 521	68 pF ±5% NPO 0603	510-3674-680
C 522	1 µF 16V SMD tantalum	510-2625-109
C 523	.01 µF ±10% X7R 0603	510-3675-103
C 524	68 pF ±5% NPO 0603	510-3674-680
C 531	68 pF ±5% NPO 0603	510-3674-680
C 532	68 pF ±5% NPO 0603	510-3674-680
C 533	68 pF ±5% NPO 0603	510-3674-680
C 534	68 pF ±5% NPO 0603	510-3674-680
C 535	68 pF ±5% NPO 0603	510-3674-680
C 536	.01 µF ±10% X7R 0603	510-3675-103
C 541	22 pF ±5% NPO 0603	510-3674-220
C 542	10 pF ±0.1% NPO 0603	510-3673-100
C 543	.01 µF ±10% X7R 0603	510-3675-103
C 544	68 pF ±5% NPO 0603	510-3674-680
C 551	68 pF ±5% NPO 0603	510-3674-680
C 552	7.5 pF ±5% NPO 0805 (380-403 MHz)	510-3601-759
	6.8 pF ±5% NPO 0805 (403-435 MHz)	510-3601-689
	8.2 pF ±5% NPO 0805 (435-470 MHz)	510-3601-829
	5.6 pF ±5% NPO 0805 (464-512 MHz)	510-3601-569
C 553	15 pF ±5% NPO 0805 (380-403 MHz)	510-3601-150
	12 pF ±5% NPO 0805 (403-435 MHz)	510-3601-120
	10 pF ±5% NPO 0805 (435-470 MHz)	510-3601-100
	7.5 pF ±5% NPO 0805 (464-512 MHz)	510-3601-759
C 554	8.2 pF ±5% NPO 0805 (380-435 MHz)	510-3601-829
	7.5 pF ±5% NPO 0805 (435-470 MHz)	510-3601-759
	6.8 pF ±5% NPO 0805 (464-512 MHz)	510-3601-689
C 555	15 pF ±5% NPO 0805 (380-403 MHz)	510-3601-150
	13 pF ±5% NPO 0805 (403-435 MHz)	510-3601-130
	11 pF ±5% NPO 0805 (435-470 MHz)	510-3601-110
	9.1 pF ±5% NPO 0805 (464-512 MHz)	510-3601-919

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 556	16 pF ±5% NPO 0805 (380-403 MHz)	510-3601-160
	15 pF ±5% NPO 0805 (403-435 MHz)	510-3601-150
	13 pF ±5% NPO 0805 (435-470 MHz)	510-3601-130
	10 pF ±5% NPO 0805 (464-512 MHz)	510-3601-100
C 561	1 pF ±5% NPO 0805	510-3601-109
C 562	68 pF ±5% NPO 0603	510-3674-680
C 563	1.5 pF ±5% NPO 0805	510-3601-159
C 564	33 pF ±5% NPO 0603	510-3674-330
C 581	68 pF ±5% NPO 0603	510-3674-680
C 591	27 pF ±5% NPO 0603	510-3674-270
C 592	.01 µF ±10% X7R 0603	510-3675-103
C 593	27 pF ±5% NPO 0603	510-3674-270
C 594	.01 µF ±10% X7R 0603	510-3675-103
C 701	.01 µF ±10% X7R 0603	510-3675-103
C 702	.01 µF ±10% X7R 0603	510-3675-103
C 703	.01 µF ±10% X7R 0603	510-3675-103
C 704	.01 µF ±10% X7R 0603	510-3675-103
C 706	.01 µF ±10% X7R 0603	510-3675-103
C 707	68 pF ±5% NPO 0603	510-3674-680
C 708	1 µF 16V SMD tantalum	510-2625-109
C 709	.01 µF ±10% X7R 0603	510-3675-103
C 801	.01 µF ±10% X7R 0603	510-3675-103
C 802	68 pF ±5% NPO 0603	510-3674-680
C 803	.01 µF ±10% X7R 0603	510-3675-103
C 804	.01 µF ±10% X7R 0603	510-3675-103
C 805	68 pF ±5% NPO 0603	510-3674-680
C 806	.01 µF ±10% X7R 0603	510-3675-103
C 811	.01 µF ±10% X7R 0603	510-3675-103
C 812	.01 µF ±10% X7R 0603	510-3675-103
C 813	68 pF ±5% NPO 0603	510-3674-680
C 815	4.7 pF ±0.1% NPO 0603 (380-403 MHz)	510-3673-479
	3.3 pF ±0.1% NPO 0603 (403-435 MHz)	510-3673-339
C 816	3.9 pF ±0.1% NPO 0603	510-3673-399
C 821	1 µF 16V SMD tantalum	510-2625-109
C 822	68 pF ±5% NPO 0603	510-3674-680
C 825	.001 µF ±10% X7R 0603	510-3675-102
C 831	100 pF ±5% NPO 0805	510-3601-101
C 832	.1 µF ±5% X7R 1206	510-3609-104
C 833	.0047 µF ±10% X7R 0805	510-3605-472
C 836	.0047 µF ±10% X7R 0805	510-3605-472
C 841	.01 µF ±10% X7R 0603	510-3675-103
C 842	68 pF ±5% NPO 0603	510-3674-680

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 843	.01 µF ±10% X7R 0603	510-3675-103
C 844	68 pF ±5% NPO 0603	510-3674-680
C 845	.01 µF ±10% X7R 0603	510-3675-103
C 846	68 pF ±5% NPO 0603	510-3674-680
C 847	.01 µF ±10% X7R 0603	510-3675-103
C 848	68 pF ±5% NPO 0603	510-3674-680
C 849	.01 µF ±10% X7R 0603	510-3675-103
C 850	68 pF ±5% NPO 0603	510-3674-680
C 901	4.7 µF 10V SMD tantalum	510-2624-479
C 902	.01 µF ±10% X7R 0603	510-3675-103
C 903	68 pF ±5% NPO 0603	510-3674-680
C 911	.01 µF ±10% X7R 0603	510-3675-103
C 912	.01 µF ±10% X7R 0603	510-3675-103
CR231	Switching diode SOT-23	523-1504-002
CR561	Pin switch diode SOT-23	523-1504-001
CR562	Pin switch diode SOT-23	523-1504-001
CR591	Hot carrier diode SOT-23	523-1504-016
CR592	Hot carrier diode SOT-23	523-1504-016
CR701	Dual switch diode SOT-23	523-1504-023
CR901	Varactor diode SOD-323	523-5005-022
EP111	Ferrite bead SMD	517-2503-001
EP200	Mini cer xtal pin insulator	010-0345-280
EP501	Ferrite bead SMD	517-2503-001
EP531	Ferrite bead SMD	517-2503-001
EP532	Ferrite bead SMD	517-2503-001
EP533	Ferrite bead SMD 123	517-2503-010
EP534	Ferrite bead SMD	517-2503-001
HW102	Grafoil M577xx	018-1007-102
HW104	4-40 machine panhead ZPS	575-1604-010
J 201	14-pin single row receptacle	515-7110-214
J 501	Right angle PC bd mt	142-0701-501
L 201	12 nH inductor LL2012 F12N	542-9003-127
L 202	10 nH inductor 0805 SMD	542-9003-107
L 211	1 µH ±6% 5mm variable	542-1012-015
L 221	.82 µH SMD inductor	542-9001-828
L 222	1 µH ±6% 5mm variable	542-1012-015
L 253	680 µH quad coil	542-5102-001
L 301	15 nH inductor LL2012 F15N (403-470 MHz)	542-9003-157
	12 nH inductor LL2012 F12N (464-512 MHz)	542-9003-127

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
L 302	18 nH inductor LL2012 F15N (403-470 MHz)	542-9003-187
	15 nH inductor LL2012 F15N (464-512 MHz)	542-9003-157
L 401	.1 µH SMD inductor	542-9001-108
L 402	.1 µH SMD inductor	542-9001-108
L 403	1 µH SMD inductor	542-9001-109
L 501	1 µH SMD inductor	542-9001-109
L 511	18 nH inductor LL2012 F18N	542-9003-187
L 512	1 µH SMD inductor	542-9001-109
L 513	18 nH inductor LL2012 F15N	542-9003-187
L 551	18.5 nH 5-turn SMD air core	542-0030-005
L 552	35.5 nH 9-turn SMD air core	542-0030-009
L 553	35.5 nH 9-turn SMD air core	542-0030-009
L 554	18.5 nH 5-turn SMD air core	542-0030-005
L 555	1 µH SMD inductor	542-9001-109
L 561	8 nH SMD air core	542-0030-003
L 811	39 µH ±10% SMD NHY0805	542-9003-397
MP101	Heat sink	014-0778-047
MP102	VHF/UHF module shield	017-2225-756
MP107	Low-pass filter top shield	017-2225-771
MP108	Synthesizer bottom shield	017-2225-772
MP109	Driver bottom shield	017-2225-773
MP110	Low-pass filter bottom shield	017-2225-774
MP801	VCO can	017-2225-751
MP806	Crystal filter shield	017-2225-699
PC001	PC board	035-3412-030
Q 101	NPN digital transistor	576-0013-046
Q 102	PNP digital transistor	576-0013-032
Q 121	NPN digital transistor	576-0013-046
Q 122	NPN digital transistor	576-0013-046
Q 123	PNP digital transistor	576-0013-032
Q 124	NPN high current SOT-23	576-0006-027
Q 131	NPN digital transistor	576-0013-046
Q 171	NPN digital transistor	576-0013-046
Q 172	PNP digital transistor	576-0013-032
Q 173	NPN digital transistor	576-0013-046
Q 201	PNP gen purp SC-70	576-0013-700
Q 202	NPN low noise SOT-23	576-0003-636
Q 211	Si N-chnl JFET SOT	576-0006-019
Q 231	VHF/UHF amp SOT-23	576-0003-634
Q 301	NPN low noise SOT-23	576-0003-636
Q 401	VHF/UHF amp SOT-23	576-0003-634
Q 501	Bi-polar MMIC SOT-143	576-0003-640

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
Q 511	NPN low noise SOT-23	576-0003-636
Q 531	NPN high current SOT-23	576-0006-027
Q 701	VHF/UHF amp SOT-23	576-0003-634
Q 801	NPN gen purp SC-70	576-0013-701
Q 841	NPN digital transistor	576-0013-046
Q 842	PNP digital transistor	576-0013-032
Q 901	NPN gen purp SC70	576-0013-701
Q 902	NPN gen purp SC70	576-0013-701
Q 911	Si NPN gen purp SOT-23	576-0003-658
R 102	1k ohm ±5% .063W 0603	569-0155-102
R 111	22k ohm ±5% .063W 0603	569-0155-223
R 112	43k ohm ±5% .063W 0603	569-0155-433
R 113	10k ohm ±5% .063W 0603	569-0155-103
R 114	10k ohm ±5% .063W 0603	569-0155-103
R 115	10k ohm ±5% .063W 0603	569-0155-103
R 116	150k ohm ±5% .063W 0603	569-0155-154
R 117	150k ohm ±5% .063W 0603	569-0155-154
R 121	120 ohm ±5% 1206 SMD	569-0115-121
R 122	120 ohm ±5% 1206 SMD	569-0115-121
R 123	10k ohm ±5% .063W 0603	569-0155-103
R 124	470 ohm ±5% .063W 0603	569-0155-471
R 125	3.6k ohm ±5% .063W 0603	569-0155-362
R 126	5.6k ohm ±5% .063W 0603	569-0155-562
R 127	100k ohm ±5% .063W 0603	569-0155-104
R 131	100k ohm ±5% .063W 0603	569-0155-104
R 132	51 ohm ±5% 1206 SMD	569-0115-510
R 133	51k ohm ±5% .063W 0603	569-0155-513
R 134	15k ohm ±5% .063W 0603	569-0155-153
R 141	100k ohm ±5% .063W 0603	569-0155-104
R 142	15k ohm ±5% .063W 0603	569-0155-153
R 171	10k ohm ±5% .063W 0603	569-0155-103
R 201	100 ohm ±5% .063W 0603	569-0155-101
R 202	3k ohm ±5% .063W 0603	569-0155-302
R 203	10k ohm ±5% .063W 0603	569-0155-103
R 204	8.2k ohm ±5% .063W 0603	569-0155-822
R 205	180 ohm ±5% .063W 0603	569-0155-181
R 211	10 ohm ±5% .063W 0603	569-0155-100
R 212	2.7k ohm ±5% .063W 0603 (12.5 kHz Bandwidth)	569-0155-272
	1.8k ohm ±5% .063W 0603 (25 kHz Bandwidth)	569-0155-182
R 213	330 ohm ±5% .063W 0603	569-0155-331
R 231	330 ohm ±5% .063W 0603	569-0155-331
R 232	1k ohm ±5% .063W 0603	569-0155-102
R 233	30k ohm ±5% .063W 0603	569-0155-303
R 234	10k ohm ±5% .063W 0603	569-0155-103

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 235	680 ohm ±5% .063W 0603	569-0155-681
R 255	39k ohm ±5% .063W 0603	569-0155-393
R 261	100 ohm ±5% .063W 0603	569-0155-101
R 262	12k ohm ±5% .063W 0603	569-0155-123
	(12.5 kHz Bandwidth)	
	27k ohm ±5% .063W 0603	569-0155-273
	(25 kHz Bandwidth)	
R 263	68k ohm ±5% .063W 0603	569-0155-683
R 264	43k ohm ±5% .063W 0603	569-0155-433
	(12.5 kHz Bandwidth)	
	33k ohm ±5% .063W 0603	569-0155-333
	(25 kHz Bandwidth)	
R 265	10k ohm ±5% .063W 0603	569-0155-103
R 266	10 ohm ±5% .063W 0603	569-0155-100
R 271	3.3k ohm ±5% .063W 0603	569-0155-332
R 272	2.4k ohm ±5% .063W 0603	569-0155-242
R 275	330 ohm ±5% .063W 0603	569-0155-331
R 301	330 ohm ±5% .063W 0603	569-0155-331
R 302	10k ohm ±5% .063W 0603	569-0155-103
R 303	3.6k ohm ±5% .063W 0603	569-0155-362
R 304	1k ohm ±5% .063W 0603	569-0155-102
R 305	2.2k ohm ±5% .063W 0603	569-0155-222
R 306	270 ohm ±5% .063W 0603	569-0155-271
R 401	10 ohm ±5% .063W 0603	569-0155-100
R 402	39k ohm ±5% .063W 0603	569-0155-393
R 403	10k ohm ±5% .063W 0603	569-0155-103
R 404	1.2k ohm ±5% .063W 0603	569-0155-122
R 501	150 ohm ±5% .063W 0603	569-0155-151
R 502	39 ohm ±5% .063W 0603	569-0155-390
R 503	150 ohm ±5% .063W 0603	569-0155-151
R 504	470 ohm ±5% .063W 0603	569-0155-471
R 505	470 ohm ±5% .063W 0603	569-0155-471
R 511	4.7k ohm ±5% .063W 0603	569-0155-472
R 512	1.8k ohm ±5% .063W 0603	569-0155-182
R 513	10 ohm ±5% .063W 0603	569-0155-100
R 514	560 ohm ±5% .063W 0603	569-0155-561
R 515	100 ohm ±5% .063W 0603	569-0155-101
R 533	470 ohm ±5% .063W 0603	569-0155-471
R 534	100k ohm ±5% .063W 0603	569-0155-104
R 535	100k ohm SMD trimmer	562-0130-104
R 536	20k ohm ±5% .063W 0603	569-0155-203
R 561	100 ohm ±5% .063W 0603	569-0155-101
R 565	47k ohm ±5% .063W 0603	569-0155-473
R 573	10k ohm ±5% .063W 0603	569-0155-103
R 574	10k ohm ±5% .063W 0603	569-0155-103
R 581	10 ohm ±5% .063W 0603	569-0155-100
R 583	10k ohm ±5% .063W 0603	569-0155-103
R 584	10 ohm ±5% .063W 0603	569-0155-100
R 586	10k ohm ±5% .063W 0603	569-0155-103
R 591	51 ohm ±5% .063W 0603	569-0155-510
R 592	1k ohm ±5% .063W 0603	569-0155-102
R 593	51 ohm ±5% .063W 0603	569-0155-510
R 594	1k ohm ±5% .063W 0603	569-0155-102
R 701	100 ohm ±5% .063W 0603	569-0155-101
R 702	1k ohm ±5% .063W 0603	569-0155-102
R 703	22k ohm ±5% .063W 0603	569-0155-223
R 704	15k ohm ±5% .063W 0603	569-0155-153
R 705	1k ohm ±5% .063W 0603	569-0155-102
R 706	1M ohm ±5% .063W 0603	569-0155-105
R 801	10k ohm ±5% .063W 0603	569-0155-103
R 802	20 ohm ±5% .063W 0603	569-0155-200
R 803	4.7k ohm ±5% .063W 0603	569-0155-472
R 804	10k ohm ±5% .063W 0603	569-0155-103
R 811	4.7k ohm ±5% .063W 0603	569-0155-472
R 812	4.7k ohm ±5% .063W 0603	569-0155-472
R 813	4.7k ohm ±5% .063W 0603	569-0155-472
R 814	4.7k ohm ±5% .063W 0603	569-0155-472
R 815	4.7k ohm ±5% .063W 0603	569-0155-472
R 816	4.7k ohm ±5% .063W 0603	569-0155-472
R 817	4.7k ohm ±5% .063W 0603	569-0155-472
R 821	100k ohm ±5% .063W 0603	569-0155-104
R 822	4.7k ohm ±5% .063W 0603	569-0155-472
R 823	100k ohm SMD trimmer	562-0130-104
R 825	100k ohm SMD trimmer	562-0130-104
R 826	10k ohm ±5% .063W 0603	569-0155-103
R 827	220k ohm SMD trimmer	562-0130-224
R 829	27k ohm ±5% .063W 0603	569-0155-273
R 831	10 ohm ±5% .063W 0603	569-0155-100
R 832	12k ohm ±5% .063W 0603	569-0155-123
R 833	18k ohm ±5% .063W 0603	569-0155-183
R 841	10k ohm ±5% .063W 0603	569-0155-103
R 842	100 ohm ±5% .063W 0603	569-0155-101
R 843	1.5k ohm ±5% .063W 0603	569-0155-152
R 847	10k ohm ±5% .063W 0603	569-0155-103
R 892	18 ohm ±5% .063W 0603	569-0155-180
R 893	18 ohm ±5% .063W 0603	569-0155-180
R 894	18 ohm ±5% .063W 0603	569-0155-180
R 901	4.7k ohm ±5% .063W 0603	569-0155-472
R 902	2.2k ohm ±5% .063W 0603	569-0155-222
R 903	10k ohm ±5% .063W 0603	569-0155-103
R 911	10k ohm ±5% .063W 0603	569-0155-103
R 912	10k ohm ±5% .063W 0603	569-0155-103
R 914	10k ohm ±5% .063W 0603	569-0155-103
R 915	47k ohm ±5% .063W 0603	569-0155-473
R 916	47k ohm ±5% .063W 0603	569-0155-473
R 917	1k ohm ±5% .063W 0603	569-0155-102

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 111	Quad op amp SO-14 331	544-2020-017
U 131	Voltage regulator SO-6	544-2603-093
U 141	Voltage regulator SO-6	544-2603-093
U 211	Double balanced mixer	544-0007-014
U 241	LV FM IF SA676DK	544-2002-037
U 261	Single op amp SOT-23-5	544-2016-001
U 521	5W RF power module	544-4001-064
U 581	Op amp SO-8 MC33172D	544-2019-017
U 811	Fractional-N synthesizer	544-3954-027
U 911	Quad 8-bit TLC5620ID	544-2031-014
U 912	8-stage shift register SOIC	544-3016-094
U 913	3 - 2-chnl analog mux/demux	544-3016-053
Y 801	17.5 MHz TCXO ±1.5 PPM	518-7009-521
Z 201	411 MHz helical filter SMD (403-419 MHz)	532-1005-040
	427 MHz helical filter SMD (419-435 MHz)	532-1005-041
	443 MHz helical filter SMD (435-451 MHz)	532-1005-042
	459 MHz helical filter SMD (450-470 MHz)	532-1005-044
	472 MHz helical filter SMD (464-480 MHz)	532-1005-045
	488 MHz helical filter SMD (480-496 MHz)	532-1005-046
	504 MHz helical filter SMD (496-512 MHz)	532-1005-047
Z 202	411 MHz helical filter SMD (403-419 MHz)	532-1005-040
	427 MHz helical filter SMD (419-435 MHz)	532-1005-041
	443 MHz helical filter SMD (435-451 MHz)	532-1005-042
	459 MHz helical filter SMD (450-470 MHz)	532-1005-044
	472 MHz helical filter SMD (464-480 MHz)	532-1005-045
	488 MHz helical filter SMD (480-496 MHz)	532-1005-046
	504 MHz helical filter SMD (496-512 MHz)	532-1005-047
Z 221	52.95 MHz 4-pole 8 kHz BW (12.5 kHz bandwidth)	532-0009-011
	52.95 MHz 4-pole 15 kHz BW (25 kHz bandwidth)	532-0009-009
Z 251	450 kHz, 9 kHz BW (12.5 kHz bandwidth)	532-2004-015
	450 kHz, 20 kHz BW (25 kHz bandwidth)	532-2004-013
Z 252	450 kHz, 9 kHz BW (12.5 kHz bandwidth)	532-2004-015
	450 kHz, 20 kHz BW (25 kHz bandwidth)	532-2004-013

VCO (450-470 MHz)
PART NO. 023-3412-540

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 850	68 pF ±5% NPO 0603	510-3674-680
C 851	68 pF ±5% NPO 0603	510-3674-680
C 852	8.2 pF ±0.1% NPO 0603	510-3674-829
C 853	12 pF ±5% NPO 0603	510-3674-120
C 854	68 pF ±5% NPO 0603	510-3674-680
C 855	68 pF ±5% NPO 0603	510-3674-680
C 856	2.7 pF ±0.1% NPO 0603	510-3673-279
C 858	68 pF ±5% NPO 0603	510-3674-680
C 859	5.6 pF ±0.1% NPO 0603	510-3673-569
C 861	6.8 pF ±0.1% NPO 0603	510-3673-689
C 862	6.8 pF ±0.1% NPO 0603	510-3673-689
C 863	68 pF ±5% NPO 0603	510-3674-680
C 864	10 pF ±0.1% NPO 0603	510-3673-100
C 865	68 pF ±5% NPO 0603	510-3674-680
C 866	68 pF ±5% NPO 0603	510-3674-680
C 867	68 pF ±5% NPO 0603	510-3674-680
C 868	1.8 pF ±0.1% NPO 0603	510-3673-189
C 869	1 pF ±0.1% NPO 0603	510-3673-109
C 870	1 pF ±0.1% NPO 0603	510-3673-109
C 871	100 pF ±5% NPO 0603	510-3674-101
C 873	100 pF ±5% NPO 0603	510-3674-101
C 874	3.3 pF ±0.1% NPO 0603	510-3673-339
C 876	8.2 pF ±0.1% NPO 0603	510-3673-829
C 877	1 pF ±0.1% NPO 0603	510-3673-109
C 878	10 pF ±0.1% NPO 0603	510-3673-100
CR850	Pin switch diode SOT-23	523-1504-001
CR851	Varactor SOD-323 BB535	523-5005-022
CR852	Varactor diode SOD-123	523-5005-020
CR853	Varactor diode SOD-123	523-5005-020
CR854	Varactor SOD-323 BB535	523-5005-022
CR855	Varactor SOD-323 BB535	523-5005-022
CR856	Varactor SOD-323 BB535	523-5005-022

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
L 851	150 nH ±10% SMD 0805	542-9003-158
L 852	150 nH ±10% SMD 0805	542-9003-158
L 853	22 nH inductor LL2012 F18N	542-9003-227
L 854	150 nH ±10% SMD 0805	542-9003-158
L 855	56 nH inductor LL2012 F56N	542-9003-567
L 856	22 nH ±10% SMD 0805	542-9003-227
Q 850	NPN transistor NE85619	576-0003-651
Q 851	NPN transistor NE85619	576-0003-651
Q 852	NPN transistor NE85619	576-0003-651
Q 853	NPN transistor NE85619	576-0003-651
R 851	10k ohm ±5% .063W 0603	569-0155-103
R 852	47k ohm ±5% .063W 0603	569-0155-473
R 853	47k ohm ±5% .063W 0603	569-0155-473
R 854	10 ohm ±5% .063W 0603	569-0155-100
R 856	10 ohm ±5% .063W 0603	569-0155-100
R 857	6.8k ohm ±5% .063W 0603	569-0155-682
R 858	1k ohm ±5% .063W 0603	569-0155-102
R 862	10k ohm ±5% .063W 0603	569-0155-103
R 863	10 ohm ±5% .063W 0603	569-0155-100
R 864	10k ohm ±5% .063W 0603	569-0155-103
R 865	10k ohm ±5% .063W 0603	569-0155-103
R 866	390 ohm ±5% .063W 0603	569-0155-391
R 867	12k ohm ±5% .063W 0603	569-0155-123
R 868	330 ohm ±5% .063W 0603	569-0155-331
R 869	270 ohm ±5% .063W 0603	569-0155-271
R 870	18 ohm ±5% .063W 0603	569-0155-180
R 871	3.9k ohm ±5% .063W 0603	569-0155-392
R 872	1.2k ohm ±5% .063W 0603	569-0155-122
R 874	330 ohm ±5% .063W 0603	569-0155-331
R 875	270 ohm ±5% .063W 0603	569-0155-271
Z 850	SMD resonator	542-9004-006

VCO
PART NO. 023-3474-X40

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 850	68 pF ±5% NPO 0603	510-3674-680
C 851	68 pF ±5% NPO 0603 (403-496 MHz)	510-3674-680
	47 pF ±5% NPO 0603 (496-512 MHz)	510-3674-470
C 852	9.1 pF ±5% NPO 0603 (403-419 MHz)	510-3673-919
	8.2 pF ±0.1% NPO 0603 (419-451 MHz)	510-3674-829
	7.5 pF ±0.1% NPO 0603 (464-496 MHz)	510-3674-759
	6.8 pF ±5% NPO 0603 (496-512 MHz)	510-3674-689
C 853	12 pF ±5% NPO 0603 (403-419 MHz)	510-3674-120
	10 pF ±5% NPO 0603 (419-451 MHz)	510-3674-100
	9.1 pF ±5% NPO 0603 (464-480 MHz)	510-3674-919
	8.2 pF ±5% NPO 0603 (480-512 MHz)	510-3674-829
C 854	100 pF ±5% NPO 0603 (403-451/464-480 MHz)	510-3674-101
	68 pF ±5% NPO 0603 (480-496 MHz)	510-3674-680
	47 pF ±5% NPO 0603 (480-496 MHz)	510-3674-470
C 855	68 pF ±5% NPO 0603	510-3674-680
C 856	2.7 pF ±0.1% NPO 0603	510-3673-279
C 858	68 pF ±5% NPO 0603	510-3674-680
C 859	8.2 pF ±0.1% NPO 0603 (403-419 MHz)	510-3673-829
	7.5 pF ±0.1% NPO 0603 (419-451 MHz)	510-3673-759
	6.8 pF ±0.1% NPO 0603 (464-512 MHz)	510-3673-689
C 860	1 pF ±0.1% NPO 0603 (403-419/435-451 MHz Only)	510-3673-109
C 861	8.2 pF ±0.1% NPO 0603 (403-419 MHz)	510-3673-829
	6.8 pF ±0.1% NPO 0603 (419-451 MHz)	510-3673-689
	5.6 pF ±0.1% NPO 0603 (464-480 MHz)	510-3673-569
	6.8 pF ±0.1% NPO 0603 (480-512 MHz)	510-3673-689

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 862	6.8 pF ±0.1% NPO 0603	510-3673-689
C 863	100 pF ±0.1% NPO 0603 (403-419 MHz)	510-3673-101
	68 pF ±5% NPO 0603 (419-451/464-512 MHz)	510-3674-680
C 864	10 pF ±0.1% NPO 0603	510-3673-100
C 865	100 pF ±0.1% NPO 0603 (403-419 MHz)	510-3673-101
	68 pF ±5% NPO 0603 (419451/464-512 MHz)	510-3674-680
C 866	100 pF ±0.1% NPO 0603 (403-419 MHz)	510-3673-101
	68 pF ±5% NPO 0603 (419-451/464-512 MHz)	510-3674-680
C 867	100 pF ±0.1% NPO 0603 (403-419 MHz)	510-3673-101
	68 pF ±5% NPO 0603 (419-451/464-512 MHz)	510-3674-680
C 868	2.4 pF ±0.1% NPO 0603 (403-419 MHz)	510-3673-249
	2.2 pF ±0.1% NPO 0603 (419-435 MHz)	510-3673-229
	1.8 pF ±0.1% NPO 0603 (435-451 MHz)	510-3673-189
	1.2 pF ±0.1% NPO 0603 (464-480 MHz)	510-3673-129
	1.8 pF ±0.1% NPO 0603 (480-496 MHz)	510-3673-189
	1.5 pF ±0.1% NPO 0603 (496-512 MHz)	510-3673-159
C 869	1 pF ±0.1% NPO 0603 (464-496 MHz)	510-3673-109
C 870	1 pF ±0.1% NPO 0603	510-3673-109
C 871	100 pF ±5% NPO 0603	510-3674-101
C 873	100 pF ±5% NPO 0603	510-3674-101
C 874	3.3 pF ±0.1% NPO 0603 (403-419 MHz)	510-3673-339
	2.7 pF ±0.1% NPO 0603 (419-435 MHz)	510-3673-279
	3.3 pF ±0.1% NPO 0603 (435-451/464-496 MHz)	510-3673-339
	3.9 pF ±0.1% NPO 0603 (496-512 MHz)	510-3673-399
C 876	10 pF ±0.1% NPO 0603 (403-419 MHz)	510-3673-100
	9.1 pF ±0.1% NPO 0603 (419-435 MHz)	510-3673-919
	8.2 pF ±0.1% NPO 0603 (435-451/464-512 MHz)	510-3673-829
C 877	1.2 pF ±0.1% NPO 0603 (403-435 MHz)	510-3673-129
	1 pF ±0.1% NPO 0603 (435-451/464-512 MHz)	510-3673-109
C 878	10 pF ±0.1% NPO 0603	510-3673-100
CR850	Pin switch diode SOT-23	523-1504-001
CR851	Varactor SOD-323 BB535	523-5005-022
CR852	Varactor diode SOD-123	523-5005-020
CR853	Varactor diode SOD-123	523-5005-020
CR854	Varactor SOD-323 BB535	523-5005-022
CR855	Varactor SOD-323 BB535	523-5005-022
CR856	Varactor SOD-323 BB535	523-5005-022
L 851	82 nH ±10% SMD 0805 (403-435 MHz)	542-9003-827
	150 nH ±10% SMD 0805 (435-451/464-512 MHz)	542-9003-158
L 852	150 nH ±10% SMD 0805	542-9003-158
L 853	22 nH ±10% SMD 0805 (403-451/464-480 MHz)	542-9003-227
	18 nH inductor LL2012 F18N (480-512 MHz)	542-9003-187
L 854	150 nH ±10% SMD 0805	542-9003-158
L 855	56 nH inductor LL2012 F56N	542-9003-567
L 856	27 nH ±10% SMD 0805 (403-435 MHz)	542-9003-277
	22 nH ±10% SMD 0805 (435-451/464-480 MHz)	542-9003-227
	18 nH ±10% SMD 0805 (480-512 MHz)	542-9003-187
L 861	15 nH ±10% SMD 0805 (480-496 MHz)	542-9003-157
	12 nH ±10% SMD 0805 (496-512 MHz)	542-9003-127
Q 850	NPN transistor NE85619	576-0003-651
Q 851	NPN transistor NE85619	576-0003-651
Q 852	NPN transistor NE85619	576-0003-651
Q 853	NPN transistor NE85619	576-0003-651
R 851	10k ohm ±5% .063W 0603	569-0155-103
R 852	47k ohm ±5% .063W 0603	569-0155-473
R 853	47k ohm ±5% .063W 0603	569-0155-473
R 854	10 ohm ±5% .063W 0603	569-0155-100
R 856	10 ohm ±5% .063W 0603	569-0155-100
R 857	6.8k ohm ±5% .063W 0603	569-0155-682
R 858	1k ohm ±5% .063W 0603	569-0155-102

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 862	10k ohm ±5% .063W 0603	569-0155-103
R 863	10 ohm ±5% .063W 0603	569-0155-100
R 864	10k ohm ±5% .063W 0603	569-0155-103
R 865	10k ohm ±5% .063W 0603	569-0155-103
R 866	470 ohm ±5% .063W 0603	569-0155-471
R 867	12k ohm ±5% .063W 0603	569-0155-123
R 868	390 ohm ±5% .063W 0603	569-0155-391
R 869	270 ohm ±5% .063W 0603	569-0155-271
R 870	18 ohm ±5% .063W 0603	569-0155-180
R 871	3.9k ohm ±5% .063W 0603	569-0155-392
R 872	1.8k ohm ±5% .063W 0603	569-0155-182
R 874	680 ohm ±5% .063W 0603	569-0155-681
R 875	270 ohm ±5% .063W 0603	569-0155-271
Z 850	SMD resonator (403-4135MHz)	542-9004-002
	SMD resonator (435-451 MHz)	542-9004-004
	SMD resonator (464-480 MHz)	542-9004-006
	SMD resonator (480-496 MHz)	542-9004-007
	SMD resonator (496-512 MHz)	542-9004-008

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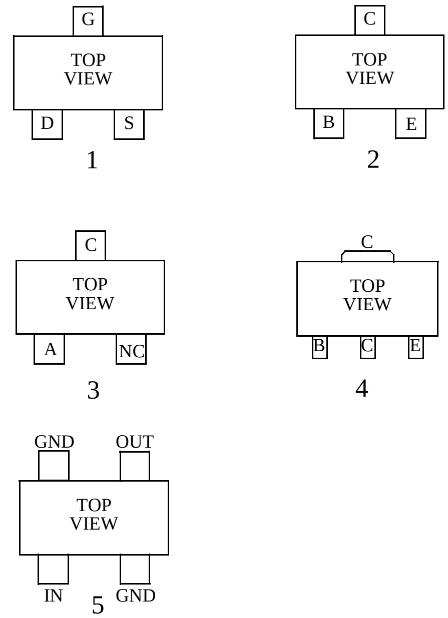
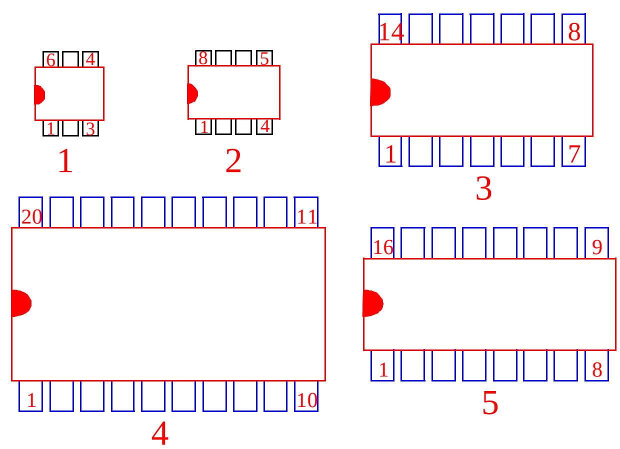
SECTION 8 SCHEMATICS AND COMPONENT LAYOUTS

TRANSISTOR AND DIODE BASING REFERENCE TABLE		
TRANSISTORS		
Part Number	Basing Diagram	Identification
576-0003-634	2	3B
576-0003-636	2	R25
576-0003-640	5	
576-0003-651	2	24
576-0003-658	2	1A
576-0006-019	1	6T
576-0006-027	4	P1F
576-0013-032	2	6D
576-0013-046	2	8C
576-0013-700	2	BR
576-0013-701	2	ZR
DIODES		
523-1504-001	3	4D
523-1504-002	3	5A
523-1504-016	3	5F
523-1504-020	3	
523-5005-022	3	5B
523-1504-023	3	A7



IC BASING REFERENCE TABLE		
Part Number	Basing Diagram	Identification
544-0007-014	1	U211
544-2002-037	4	U241
544-2016-001	1	U261
544-2019-017	2	U581
544-2020-017	3	U111
544-2031-014	3	U911
544-2603-093	1	U131/U141
544-3016-053	3	U913
544-3016-094	5	U912
544-3954-027	4	U811



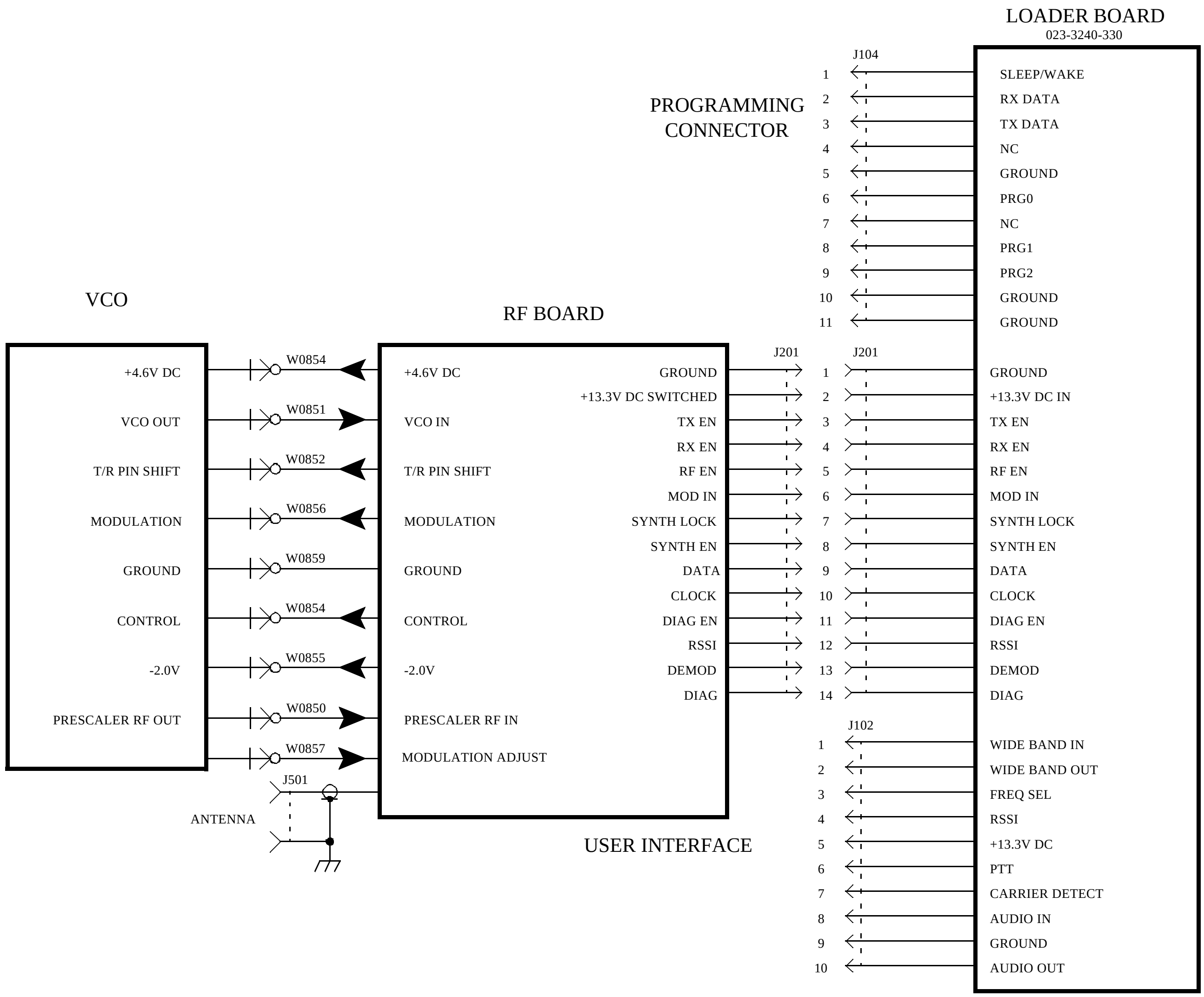


Figure 8-1   3412 INTERCONNECT

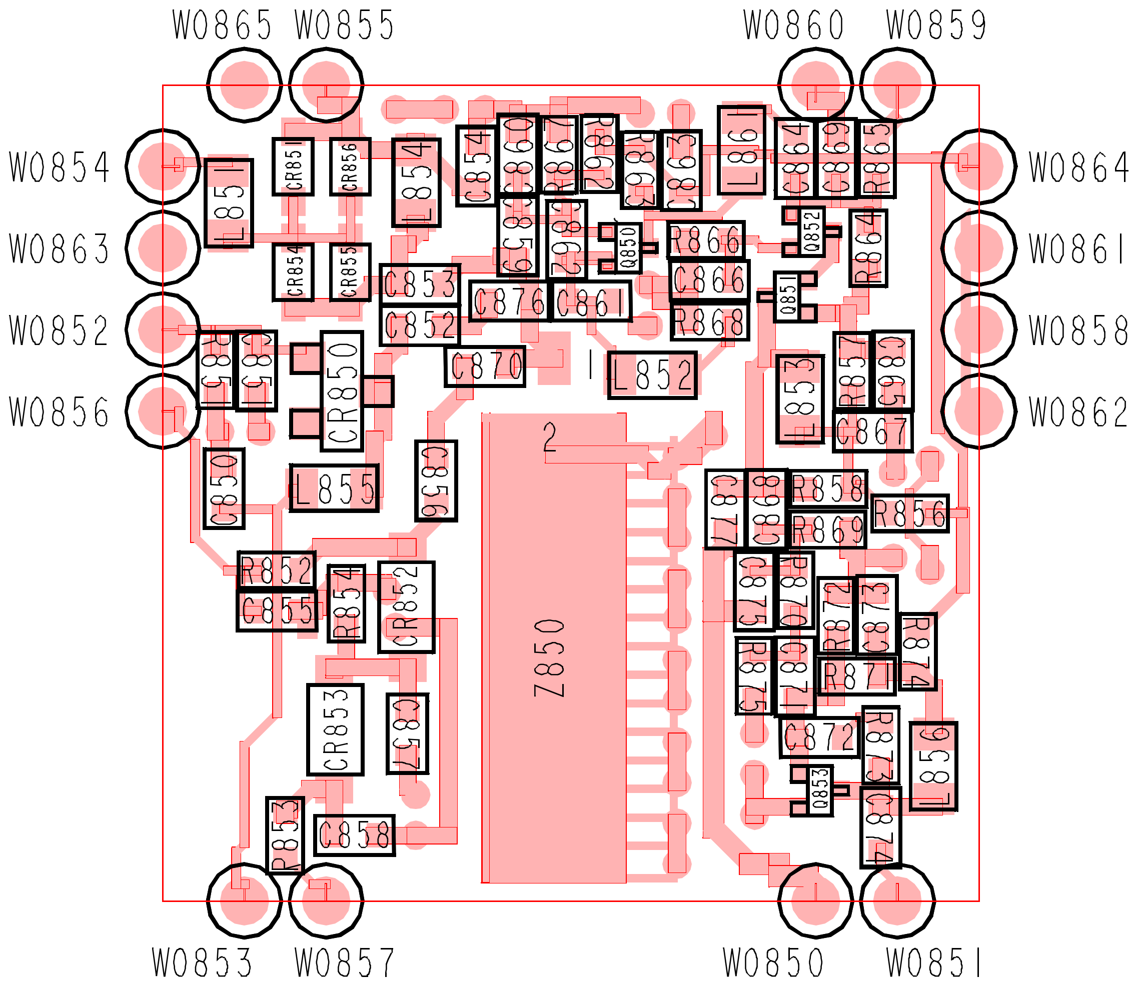


Figure 8-2   VCO COMPONENT LAYOUT (COMPONENT SIDE VIEW)

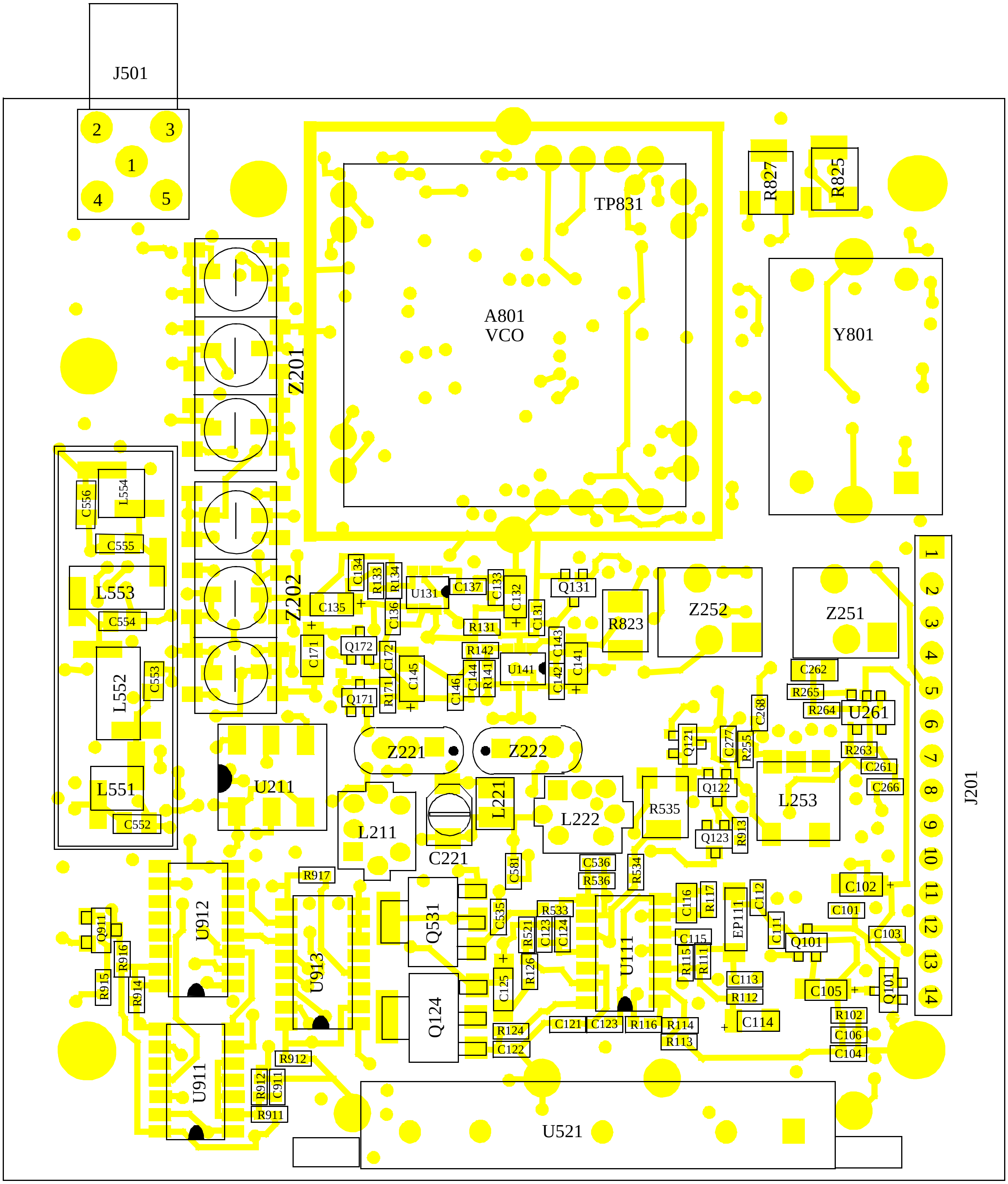


Figure 8-3 TRANSCEIVER COMPONENT LAYOUT (COMPONENT SIDE VIEW)

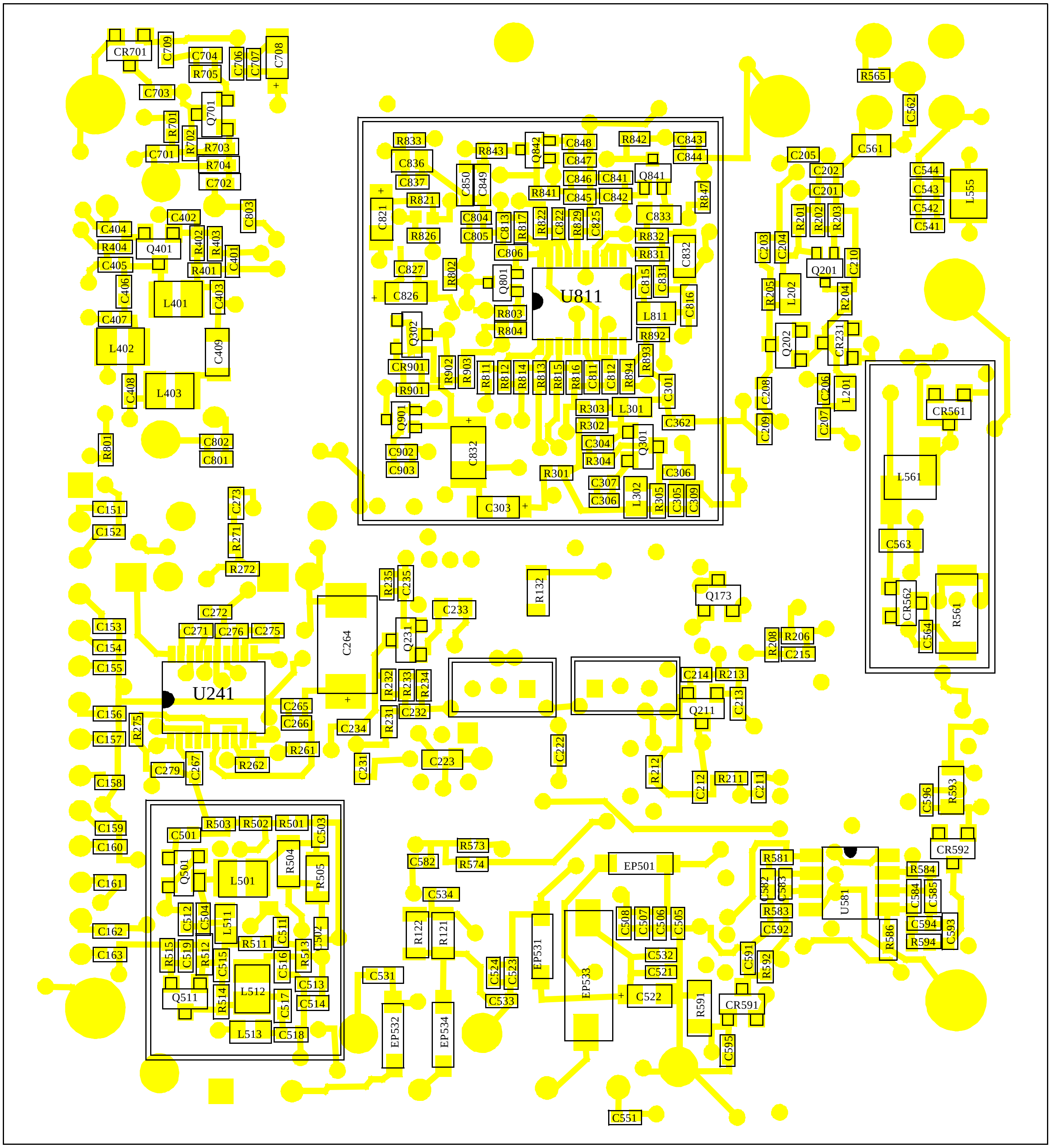


Figure 8-4 TRANSCEIVER COMPONENT LAYOUT (OPPOSITE COMPONENT SIDE VIEW)

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Figure 8-5 SCHEMATIC (1 OF 2)

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Figure 8-6 SCHEMATIC (2 OF 2)

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