4.3.3.2 From Transmit Mode

Switching to Receive from Transmit requires loading the RF Divider Word into the control register. Care must be taken, however, to set the TX/$\overline{RX}$ line low before setting the new frequency. Otherwise, the radio transmitter will "splatter" a number of frequencies before switching into Receive mode. The procedure for switching the radio from Transmit to Receive is summarized below.

- Set the TX/$\overline{RX}$ line low to disable the transmitter.
- Shift the new RF Divider Word into the synthesizer (see section 4.3.1).
- Ensure the transmitter is totally off (T1).
- Load the new RF Divider Word into the synthesizer, i.e. set SYNLD line high (see section 4.3.1).
- Wait for the synthesizer to stabilize (T8).
- Begin receiving data (see section 4.4).

Note that the RF Divider Word word may be shifted into the synthesizer at any time. It will not take effect until the SYNLD line is set high. By shifting in the RF Divider Word early, the time necessary to switch channels may be reduced.

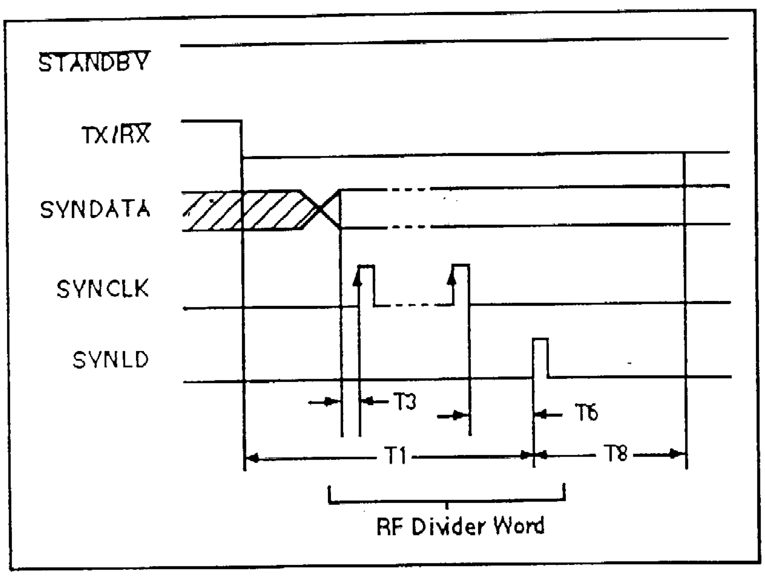

Figure 13 - Transmit to Receive Timing Diagram

For a complete listing of all these timings please see Table 3 in section 4.3.5.

4.3.3.3 From Receive Mode

Going to Receive from Receive in order to change channels requires that the RF Divider Word be reloaded into the control register. The procedure for changing the receive channel is summarized below.

- Load the new RF Divider Word into the synthesizer (see section 4.3.1.).
- Wait for the synthesizer to stabilize (T8).
- Begin receiving data (see section 4.4).

Note that the RF Divider Word word may be shifted into the synthesizer at any time. It will not take effect until the SYNLD line is set high. By shifting in the RF Divider Word early, the time necessary to switch channels may be reduced.

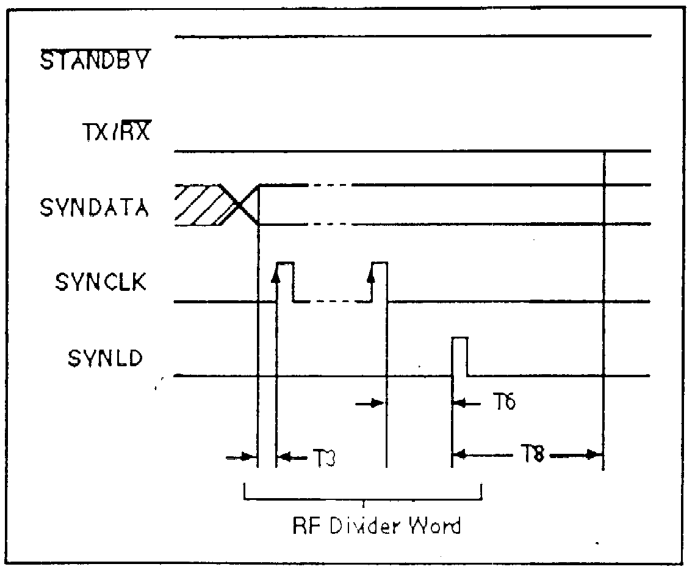

Figure 14 - Receive Channel Change Timing Diagram

For a complete listing of all these timings please see Table 3 in section 4.3.5.

4.3.4 Standby Mode

The following two sections detail the necessary steps to put the radio into Standby mode from either Transmit or Receive mode.

4.3.4.1 From Transmit Mode

When switching the radio into Standby mode, the transmitter must be turned off before enabling the $\overline{STANDBY}$ line. Otherwise, the radio will "splatter" a number of frequencies before powering down. The procedure for entering Standby mode from Transmit mode is summarized below.

- Set the TX/$\overline{RX}$ line low.
- Wait for the transmitter to turn-off (T1).
- Set the $\overline{STANDBY}$ line low.

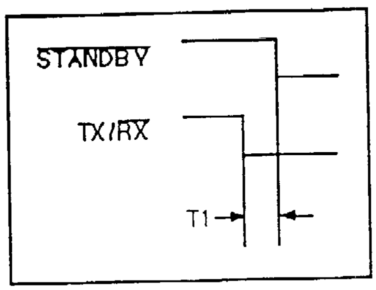

Figure 15 - Transmit to Standby Timing Diagram

For a complete listing of all these timings please see Table 3 in section 4.3.5.

4.3.4.2 From Receive Mode

When switching the radio into Standby mode, the transmitter must be off before enabling the $\overline{STANDBY}$ line. Because the TX/$\overline{RX}$ line is already low in Receive mode, all that is necessary to switch the radio into Standby is to set the $\overline{STANDBY}$ line low.

4.3.5 Radio Timing Chart

The following chart (Table 3) gives the timing values for the timing diagrams presented in sections 4.3.1-4.3.4.

Symbol	Min. Time	Description
T1	50 µs	Transmitter Turn-off
T2	150 µs	Synthesizer Power-up
T3	1 µs	Synthesizer Data Set-up
T4	1 µs	Synthesizer Clock Pulse Width
T5	1 µs	Synthesizer Load Pulse Width
T6	1 µs	Synthesizer Load Set-up
T7	2.5 ms	Synthesizer Settling from Standby (RDA-100/2)
	4.5 ms	Synthesizer Settling from Standby (RDA-100)
T8	800 µs	Synthesizer Settling
T9	1 µs	Synthesizer Data Hold
T10	1 µs	Synthesizer Load Hold

Table 3 - Radio Timing Chart

4.4 Data Interface Timing

This section describes the procedures to be followed to transmit and receive data. The timing diagram in Figure 16 depicts the relationship between the transmitter and receiver during the course of a transmission. The times denoted in the diagram and the relationships suggested will be referred to throughout this section. The timing diagrams and discussion that follows refer to measurements made with two radios communicating between each other.

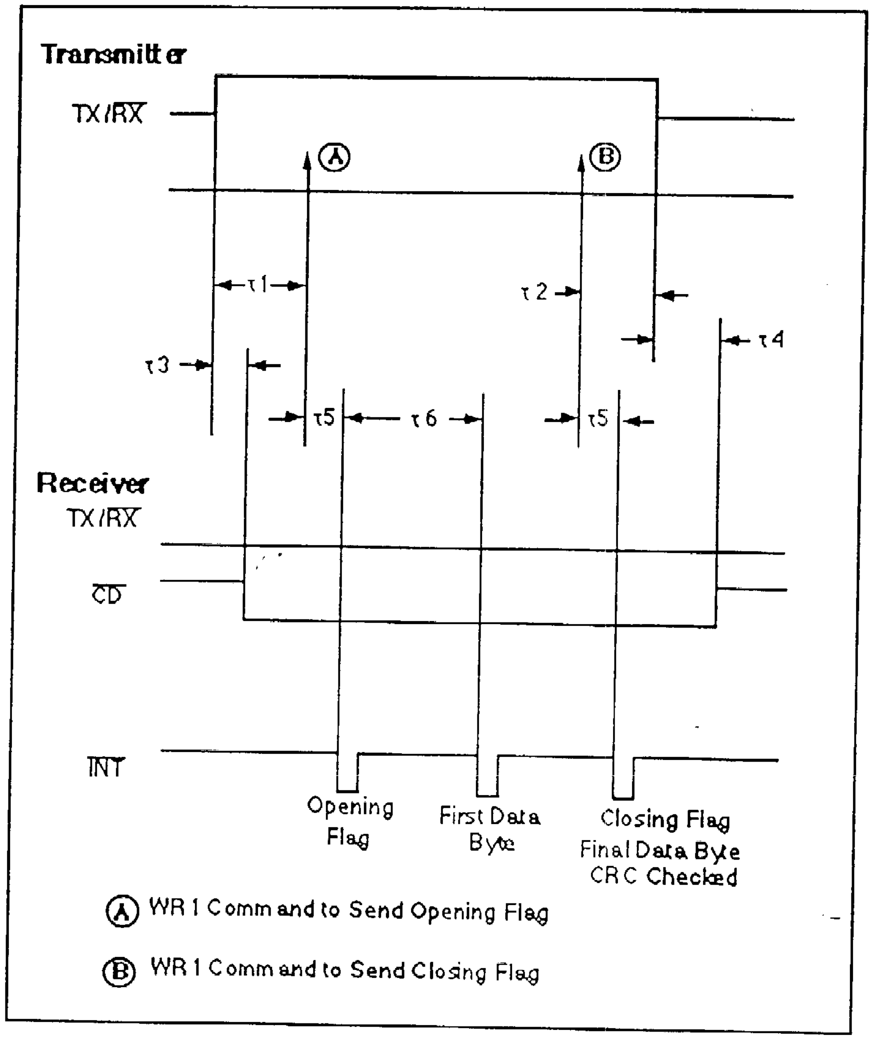

Figure 16 - Data Interface Timing Diagram

The list below enumerates each step the transmitter follows during a data transfer:

- Program the Synthesizer
  Before turning on the transmitter the synthesizer must be programmed to the appropriate frequency (see section 4.3.1). If the synthesizer is not set prior to supplying power to the transmitter, the radio may transmit at the wrong frequency.
- Set TX/$\overline{RX}$ High
  After the synthesizer has settled (see Table 3 in section 4.3.5), the transmit line may be set high. This will turn on the transmitter and start the transmission of the ABORT control character.
- Wait for the Receiver to Detect Carrier
  The transmitter must wait a time $\tau 1$ before beginning to send an HDLC packet. This allows the receiver to lock-up to the transmitter.
- Transmit Actual Data
  Transmit a data packet or packets using the parallel interface described in section 4.2.
- Hold Transmitter High
  After the last byte of data or special character has been written, the transmitter must be left on for a time $\tau 2$ to allow the data to propagate through the transmitter circuitry.
- Set TX/$\overline{RX}$ Low
  Once the data packet has been transmitted, the transmitter may be turned off. It is important to note that data is still transmitted while the TX/$\overline{RX}$ line is making its transition, and it is advisable to send an ABORT or FLAG character. This will be discussed further from the receiver's perspective.

The list below enumerates each step the receiver follows during a data transfer:

- Program the Synthesizer
  Before receiving data, the receiver must be programmed to the same channel as the transmitter (see section 4.4).
- Wait for Carrier Detect
  $\tau 3$ seconds after the transmitter is turned on, the receiver will recognize the RF signal. In order to recognize a signal, it must be on the programmed channel and must maintain the correct spread spectrum signature over a period of time $\tau 1$. Once the signature has been established the $\overline{CD}$ line goes low. Because $\overline{CD}$ gates the data, the first several bits of data will be lost while the receiver locks-up. For this reason, the transmitter is required to wait time $\tau 1$ before sending actual data.
- Receive Data Packet
  Receive a data packet or packets using the parallel interface described in section 4.2. A data packet consists of an opening FLAG, a series of data bytes, a two-byte CRC and a closing FLAG.

The following table gives the interface clock timings discussed throughout section 4.4.

Symbol	Minimum	Maximum	Description
$\tau 1$	330 µs		Transmitter setup time Scrambler flush time
$\tau 2$	170 µs		Transmitter hold time
$\tau 3$	300 µs		$\overline{CD}$ lock-up time
$\tau 4$	70 µs	120 µs	$\overline{CD}$ release time
$\tau 5$	165 µs	248 µs	Data propagation delay
$\tau 6$	247 µs	322 µs	Delay for first data byte

Table 4 - Data Interface Clock Timings for the RDA

Symbol	Minimum	Maximum	Description
$\tau 1$	250 µs		Transmitter setup time Scrambler flush time
$\tau 2$	85 µs		Transmitter hold time
$\tau 3$		235 µs	CD lock-up time
$\tau 4$	35 µs	60 µs	CD release time
$\tau 5$	82 µs	124 µs	Data propagation delay
$\tau 6$	124 µs	161 µs	Delay for first data byte

Table 5 - Data Interface Clock Timings for the RDA2

5 Performance Verification Testing

This section contains information needed to verify the radio's performance. Included are the test equipment requirements, a test setup diagram, and a step by step procedure for all the pertinent performance tests. Refer to Figure 17 throughout this section for test setup criteria. The configuration of the measurement instruments will be described when appropriate; familiarity with the equipment is assumed.

To perform these tests, it is necessary to use the radio in serial mode. Note that the channels for the RDA and the RDA2 are programmed differently, so a different test set-up must be used with each of these data rate configurations.

5.1 Equipment List

Table 6 details the test equipment recommended for the Performance Verification Tests. This list identifies the type of equipment required and a possible model. Other vendors and models may be used.

Description	Vendor	Model #
Digital Volt Meter	Fluke	87
Digital Volt Meter	Fluke	75
Power Meter	Hewlett-Packard	437B
Power Splitter	Mini-Circuits	ZFSCJ-2-4
Power Sensor	Hewlett-Packard	8481H
Synthesized Signal Generator	Hewlett-Packard	8660C
Modulator Section	Hewlett-Packard	86632B
RF Section (1-2600MHz)	Hewlett-Packard	86603A
Pulse Generator	Hewlett-Packard	8012B
Pattern Generator / Error Detector	Hewlett-Packard	3780A
Attenuator (110 dB)	JFW Industries Inc.	50BR-009
Coax fixed attenuator 10dB	Solitron Microwave	929-6200-10
Power Supply (1.0 Amps)	Leader	LPS-152
Oscilloscope (100MHz)	Tektronix	2245A
Spectrum Analyzer	Tektronix	494P

Table 6 - Test Equipment Requirements

5.2 Equipment Setup

The Bit Error Rate Tester (BERT) model HP3780A is used as the data source as well as the data receiver. When testing receiver functions, the data source is clocked by the REF Radio's TXCLK line and drives the REF Radio's TXDATA line. The DUT's RXDATA and RXCLK lines connect to the BERT's received data and clock inputs. It should be noted that since the BERT's input impedance is 75 ohms, the radio's HCMOS outputs cannot directly drive the BERT's input lines. A series 500Ω resistor should be added to each the radio's TXCLK, RXCLK and RXDATA lines before going into the BERT.

The DUT output can be connected to a power meter for output power measurements or to a power splitter. The splitter serves two purposes. First, it allows the spectrum analyzer to monitor the DUT output when transmitter measurements such as modulation BW are made. The splitter also monitors the DUT input when testing its receiver functions. In this mode, the spectrum analyzer serves as a reference as it sees exactly the same signal the receiver sees.

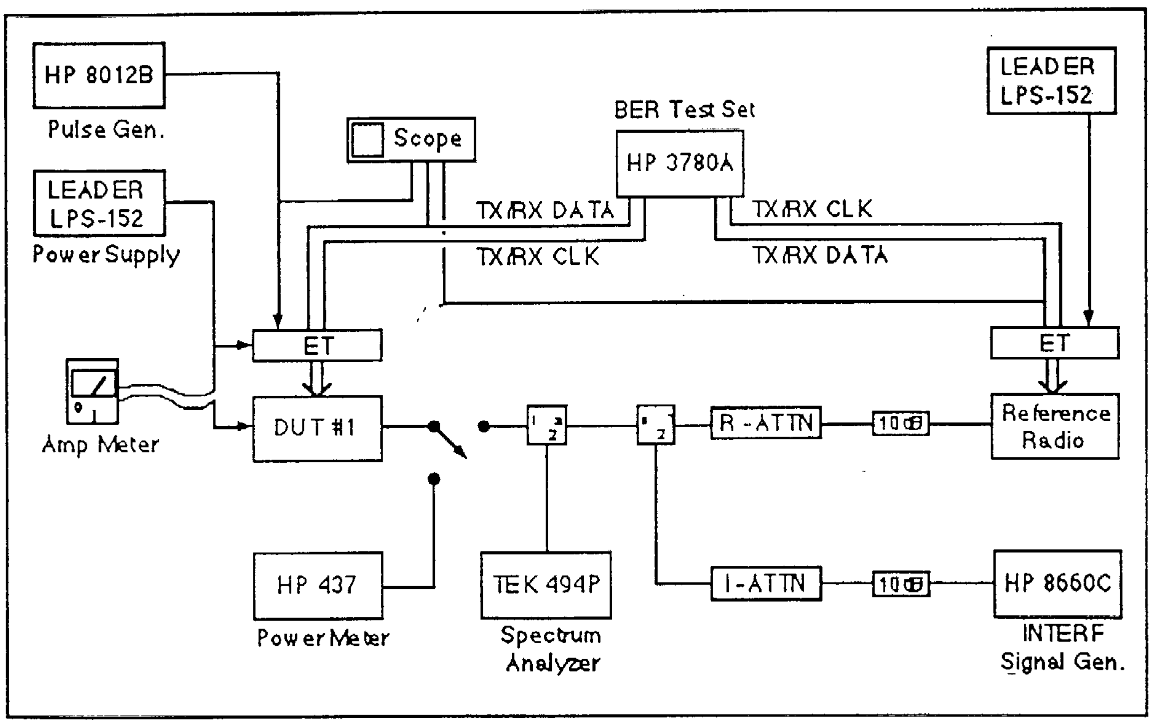

Figure 17 - Test System Setup

NOTE: It is recommended that a fixed 10dB attenuator always be used in series with the INTERF Radio and the REF Radio to keep from accidentally over-driving the DUT's input.

A second power splitter allows the injection of an interfering signal from the Interference Signal Generator. This is used when testing some of the DUT's receiver characteristics such as adjacent channel rejection, interference rejection and image rejection. The step attenuator in series with the Interference Signal Generator (ISG) is used to set the relative level of the interfering signal. In order to make the ISG simulate another RDA family radio, its internal FM modulation (1 KHz) is enabled. Setting the deviation to 1.3 MHz peak-to-peak produces an interfering signal with characteristics very similar to an RDA series radio, occupying approximately the same channel bandwidth.

Finally, an oscilloscope monitors the RX/TX Data lines of both radios, as well as the TX/$\overline{RX}$ line of the DUT to derive timing relationships. Power supply currents are measured with an Amp Meter in series with the 5v supply line. A Digital Volt Meter is also used to monitor DC voltages at several test points within the radio.

5.3 Main Performance Tests

5.3.1 Power Output

After correctly zeroing and calibrating the power meter, connect it directly to the output of the DUT. Place the radio in transmit mode, select the desired frequency and measure the power. Power should be measured within 1 sec of placing radio in transmit mode.

5.3.2 Bit Error Rate (BER)

After selecting the desired operating frequency place the REF Radio in transmit mode. Connect the REF Radio TXDATA and TXCLK lines to the BERT's transmit data output and transmit clock input respectively. Place the DUT in receive mode and connect its receive lines to the BERT. Connect the input of the DUT to the power splitter. Set up the BERT as follows: PRBS n=9, Frequency=Ext, BER=10^6, Measurement= Binary, CK=Ext and Data Threshold=200 mv.

This basic setup will be used throughout the remaining performance tests. The radio is defined to be functioning properly if its BER is less than 1E-5 under the conditions being tested. These conditions are defined in the following sections.

5.3.3 Sensitivity

Setup for a BER measurement. Set I-attenuator to maximum (make sure the Interference Signal Generator is off). Set R-attenuator so that the received signal level as measured with the spectrum analyzer is -40 dBm (1 MHz resolution BW should be used whenever making power measurements with the spectrum analyzer). Increase attenuation by 40 dB. The signal into the DUT should be -80 dBm. Make a BER measurement. Increase attenuation by 1 dB and repeat the measurement until the BER is above 1E-5.

NOTE: Whenever making a sensitivity measurement, the REF Radio and associated ET Board should be isolated from the DUT to keep radiation from the REF Radio from skewing the sensitivity measurement. This may happen when radiated emissions arrive at the DUT at higher levels than the cabled transmission. Isolation can be accomplished by enclosing the REF Radio in a shielded box (metal). Ferrite beads should be used on all lines coming into or out of the box. Equivalent isolation can be achieved by separating the REF Radio from the DUT by a distance of 30 feet or more. Again, ferrite beads should be used on all lines coming from the REF Radio.