QuadHopper™

MODEL 9000

E1/DS1 SPREAD SPECTRUM 5.78 GHz DIGITAL MICROWAVE RADIO SYSTEM

VOLUME 1

System Description

This practice applies to the following equipment:

Model	Equip Issue	Model	Equip Issue
007-01794-000	1	041-02110-XXX	1
007-01794-001	1	5702-1	1,2,3,4
007-02068-000	1	5702-3	2
007-02078-000	1	7509-3	1
007-02078-001	1	9020-0	1
007-02079-000	1	9021-0	1
007-02079-001	1	9021-1	1
007-02109-000	1		

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FCC Notice

FCC ID:

The Federal Communications Commission (FCC) Rules define issues concerning radio frequency emissions. The Model 9000 equipment complies with FCC Part 15.247 which specifies the license-free operation of spread spectrum radio equipment within the 5.730 to 5.845 GHz band reserved for industrial, scientific, and medical (ISM) applications. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

Professional Installation

The FCC type acceptance for this product requires professional installation to ensure that the equivalent isotropically radiated power (EIRP) meets FCC Part 15.247. Contact Larus Corporation for engineering assistance and recommended qualified installation contractors.

INDUSTRY CANADA Notice
CANADA RSS-210

Canada ID:

The Industry Canada Rules (Canada 210) define issues concerning radio frequency emission. The Model 9000 equipment complies with Canada 210 which specifies the license-free operation of spread spectrum radio equipment within the 5.725 to 5.850 GHz band reserved for industrial, scientific, and medical (ISM) applications. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

Professional Installation

The Industry Canada Rules type acceptance for this product requires professional installation to ensure that the equivalent isotropically radiated power (EIRP) meets Canada 210. Contact Larus Corporation for engineering assistance and recommended qualified installation contractors.

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Introduction 1

General

This practice presents an overview of the functional operation, features, and applications of the Model 9000 E1/DS1 Spread Spectrum 5.78 GHz Digital Microwave Radio System. It also provides instructions for operating the radio in its common applications.

1.12 This paragraph is reserved for future issue changes. Practice Issue 1 applies to equipment listed in Section 10, Equipment Issue Information.

System Overview

The Larus Model 9000 is a high stability microwave radio system using spread spectrum and forward error correction technology. It offers an exceptionally reliable, license-free solution for short to medium haul digital link requirements with up to four E1 or DS1 lines.

The 9000 radio interconnects digital links between near-end and far-end locations. At each end, the radio system consists of a single antenna and a Radio Frequency (RF) Module and Control Module assembly. (Refer to Figure 1-1). The Model 9000 complies with FCC Part 15.247 and Canada 210, which specify the license-free operation of spread spectrum radio equipment within the 5.730 to 5.845 GHz band reserved for industrial, scientific, and medical (ISM) applications.

An extensive degree of integration and a compact design ensure reliability and make any radio faults easy to diagnose and repair.

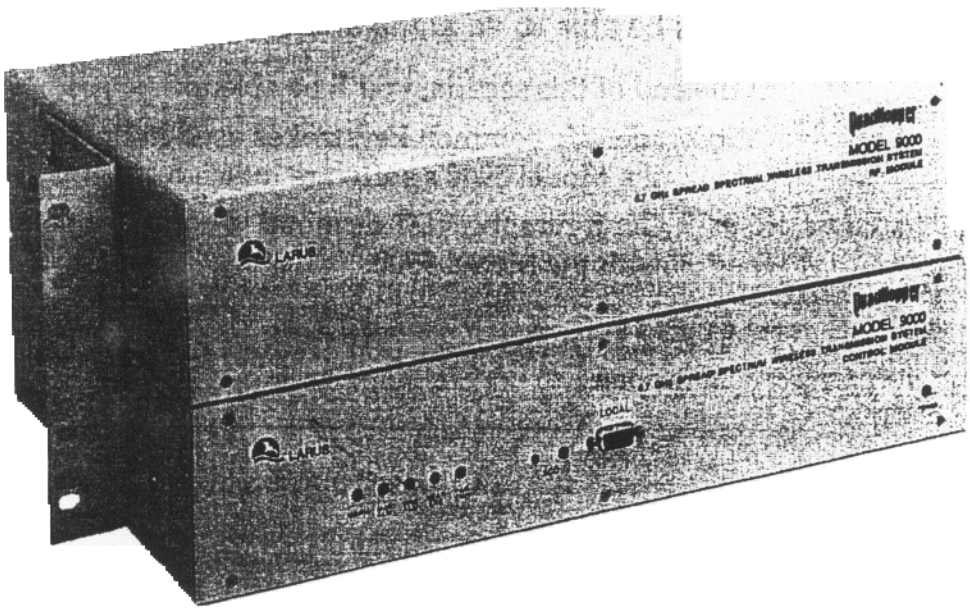


Figure 1-1. Model 9000 Spread Spectrum 5.78 GHz Digital Microwave Radio System

Applications

The Model 9000 is an ideal solution for point-to-point spans where conventional connections provided by the public telephone network are either unavailable, impractical, or not cost-effective. These applications can include:

- Building to building communication across a campus
- Spans across public thoroughfares
- Urban links between separate facilities
- Drop and reinsertion points to long-haul backbones
- Cellular telephone site interconnections
- Emergency communications links
- Spur route feeders
- Mountainous terrain
  Spans over water

2.2 Features

The Model 9000 is configured with standard features that ensure its flexibility for the many applications for which it is suited. These features include:

No FCC or Industry Canada license requirement (complies with FCC Rules Part 15.247 and Canada 210)

- Voice or data capability
- Acceptance of from one to four E1 circuits [120 pulse code modulation (PCM) or 240 adaptive delta pulse code modulation (ADPCM) voice channels] or one to four DS1 circuits (96 PCM or 192 ADPCM)
  Path lengths up to 50 miles
  Built-in diagnostics and alarms
  Field selectable scramble code
  HDB3 line code for E1 interface, alternate mark inversion (AMI) or bipolar eight zero substitution (B8ZS) for DS1
  9600 bps EIA-232D ports for near-end and far-end console operation

Since the Model 9000 complies with FCC Rules Part 15.247 and Canada 210, any number of radio links can be put into operation as required without the need to notify the FCC or Industry Canada for licensing or operating changes. The low-power design of the radio minimizes radio frequency (RF) radiation hazards, allowing it to be installed virtually anywhere that a clear path exists from antenna to antenna.

2.23 The 256 possible scrambling codes ensure that interference from similar nearby transmitters is at an absolute minimum. They also provide a virtually secure communications link. The radio can be remotely configured through either of two maintenance data interfaces on the device, provided that a modem is connected to the far-end port. This feature offers the advantage of setting up the radio or changing its operating parameters from one end. The maintenance data interface ports can also be used to monitor system status and alarms.

Components

2.31 Due to FCC and Canada 210 regulations for equipment operating in the industrial, scientific, and medical (ISM) band, individualized options that affect spectrum spread and output power are not available on a per radio basis. However, the Model 9000 can be ordered in one of two standard configurations. Refer to Table 2-A for ordering information.

Options that the user can set include cable equalization for five different cable lengths and pseudorandom number (PNS) scrambling and descrambling codes.

Material Supplied

2.41 Each end of the radio system consists of a Control Module and RF Module assembly designed for indoor installation and an outdoor antenna. Included with each radio are this manual and the following hardware:

RF Module, High Frequency Transmit/Low Frequency Receive, plus 4 x E1 or DS1 Control Module
RF Module, Low Frequency Transmit/High Frequency Receive, plus 4 x E1 or DS1 Control Module
Installation kit

Table 2-A

Model 9000 Ordering Information

HIGH END		LOW END	
Description	Part Number	Description	Part Number
RF Module, High Freq Xmt and Low Freq Rcv, plus 4 x E1 Control Module	020-02106-000	RF Module, Low Freq Xmt and High Freq Rcv, plus 4 x E1 Control Module	020-02107-000
RF Module, High Freq Xmt and Low Freq Rcv, plus 4 x DS1 Control Module	020-02106-001	RF Module, Low Freq Xmt and High Freq Rcv, plus 4 x DS1 Control Module	020-02107-001
Spare RF Module, High Freq Xmt and Low Freq Rcv	007-02078-000	Spare RF Module, Low Freq Xmt and High Freq Rcv	007-02078-001

OPTIONS	
Description	Part Number
Modem Board, 4 x E1	007-01794-000
Modem Board, 4 x DS1	007-01794-001
Power Supply Board	007-02068-000
Control Module, 4 x E1	007-02079-000
Control Module, 4 x DS1	007-02079-001
Installation Kit, RF/Controller Assembly mounted in 19" or 23" rack	007-02109-000
Antenna Jumper Cable	041-02110-XXX
DS1 Single-ended Route Diversity Switch Circuit Pack (2 required per DS1 per end)	5702 List 1
RouteSwitch™ 12-slot, 19" shelf (6 DS1 capacity)	5702 List 3
Cable with N-type Connectors, RF Module to Waveguide, 3 feet	7509 List 3
Frequency Translator, 5.7 GHz	9020 List 0
DS1 Test Interface (Test Adapter)	9021 List 0
E1 Test Interface (Test Adapter)	9021 List 1

Note: Contact Larus Sales for antenna options, special antenna mounting arrangements, lightning protection, and custom installation.

System Functional Overview 3

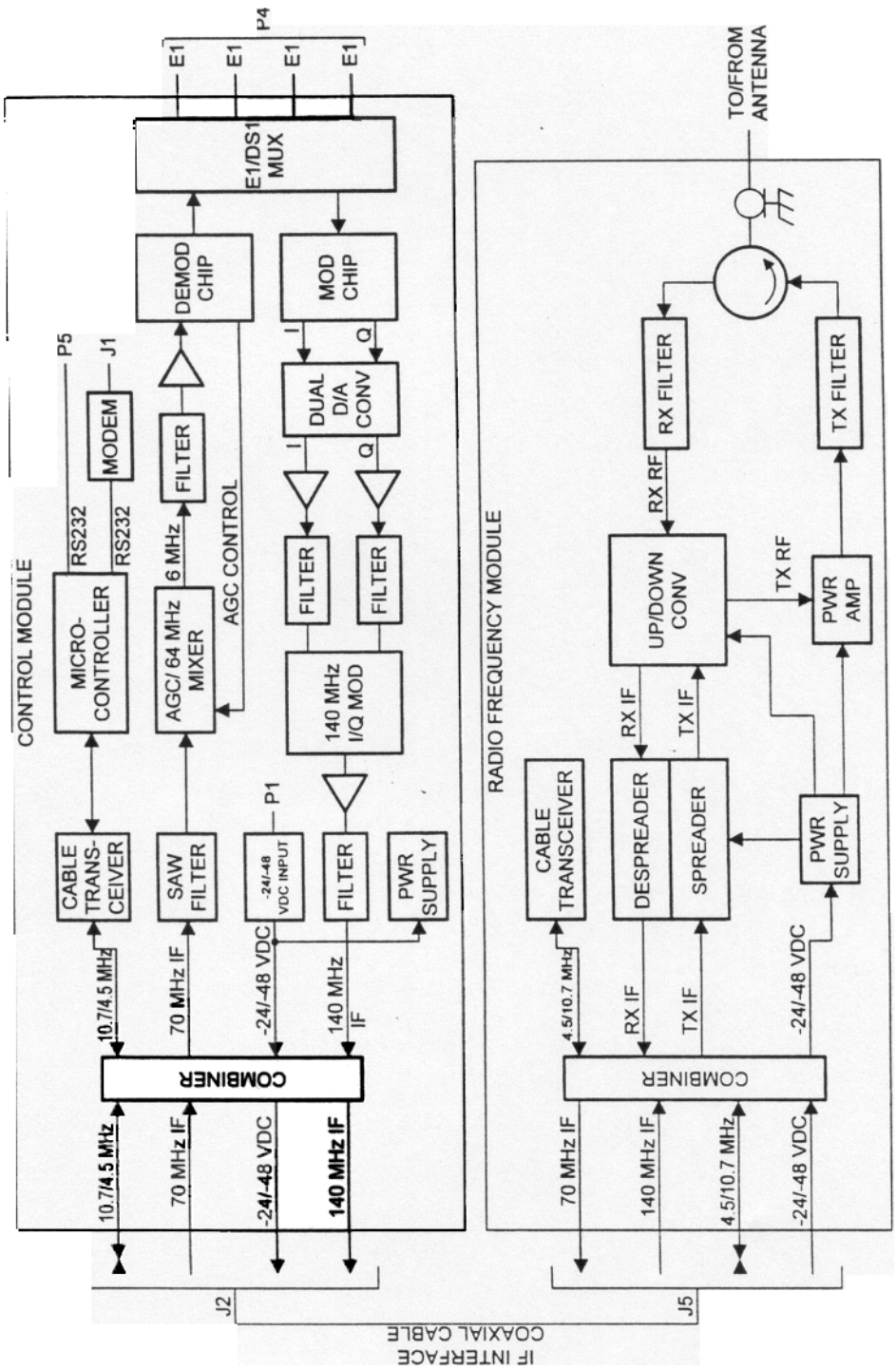
The Model 9000 radio provides a digital interface that interconnects the customer E1 or DS1 signals to the Control Module and provides alarm relay contact and maintenance data connections for customer use. (A block diagram of the radio appears in Figure 3-1.) The customer's local −24/−48 V battery is used to power the Model 9000 units. The radio mounts indoors and is connected to an antenna via coaxial cable (for short runs) or elliptical waveguide (for long runs). A Larus proprietary multiplex/demultiplex (muldem) circuit combines up to four E1 or DS1 signals into a multiplexed transmit signal. The circuit also demultiplexes the demodulated receive signal into up to four E1/DS1 signals for output to the E1/DS1 interface.

The Radio Frequency Module is a complete radio transceiver. The transmitter is a conventional design with a modulator, intermediate frequency (IF) to radio frequency (RF) translation stages, and output circuits with bandpass filter, amplifier, and circulator. In addition, it uses direct sequence signal spreading circuits. The receiver is similarly conventional with a low-noise amplifier and bandpass filter in its front end. The receiver's RF to IF translation stages use the output from the same up/down converter used by the transmitter.

Despreading circuits recover the spread spectrum signal from the IF before the signal intelligence is demodulated as a multiplexed signal from the IF signal. The Larus muldem demodulates the multiplexed signal into four E1 or DS1 signals, after which E1/DS1 interface circuits send the E1/DS1 signals on to the customer. The control module also provides outputs for minor and major alarms and two EIA-232D ports for maintenance communications with the far end.

3.1 Spread Spectrum Frequency Plan

The output signal of the 9000 radio system occupies the 5.730 GHz to 5.845 GHz frequency band assigned for unlicensed, spread spectrum use. Figure 3-2 shows how this spectrum is used by the Model 9000.



Model 9000 Radio Functional Block Diagram

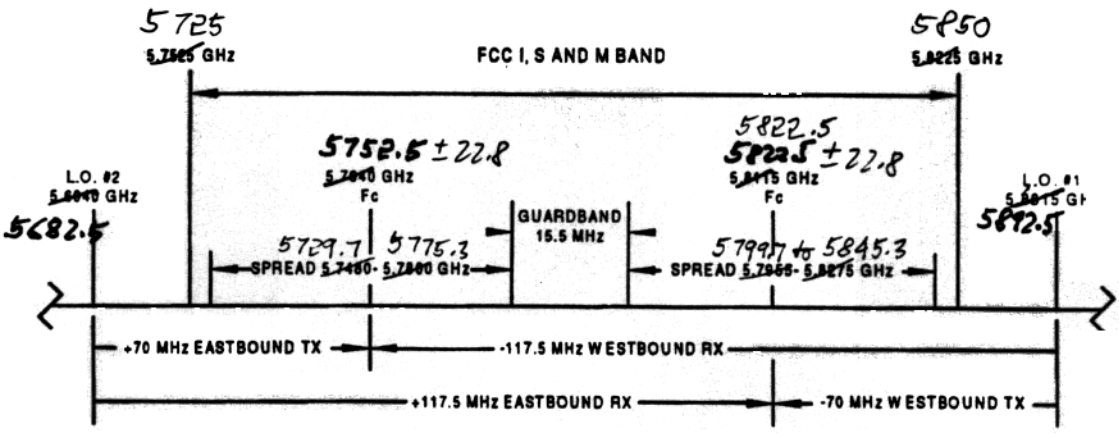


Figure 3-2. Model 9000 Frequency Plan

Frequencies for Unit under test

3.2 Customer E1/DS1 Connections

3.21 Up to four customer E1 or DS1 lines connect to the Model 9000 at the controller. A standard RJ48M (Amphenol 25-pair) connector is the mechanical interface for these connections. Refer to Table 3-A for the E1/DS1 interface connector pin assignments. Adapters are available on request. The RF module has equalization circuits that can be set for different line lengths (0 to 655 feet in five steps).

Table 3-A

E1/DS1 Interface Connector Pin Assignments

E1/DS1 Signal			J7 Connector
Channel 1:	E1/DS1 Transmit out	(TIP)	Pin 1
		(RING)	Pin 26
	E1/DS1 Receive in	(TIP)	Pin 39
		(RING)	Pin 14
Channel 2:	E1/DS1 Transmit out	(TIP)	Pin 2
		(RING)	Pin 27
	E1/DS1 Receive in	(TIP)	Pin 40
		(RING)	Pin 15
Channel 3:	E1/DS1 Transmit out	(TIP)	Pin 3
		(RING)	Pin 28
	E1/DS1 Receive in	(TIP)	Pin 41
		(RING)	Pin 16
Channel 4:	E1/DS1 Transmit out	(TIP)	Pin 4
		(RING)	Pin 29
	E1/DS1 Receive in	(TIP)	Pin 42
		(RING)	Pin 17

3.3 Controller/RF Signal Interface

3.31 The controller/RF interface signals are transmitted via coaxial interface cable. E1/DS1 interface circuits at the controller digital interface and the RF module translate the E1/DS1 signal to the levels required by the internal circuits in each unit. The Larus E1/DS1 multiplexer multiplexes the four E1 or DS1 inputs into a single multiplexed transmit data stream (regardless of whether or not all four E1/DS1 inputs carry data).

Transmitter Overview

3.41 The Model 9000 transmitter consists of an E1/DS1 multiplexer, 16QAM (Quadrature Amplitude Modulation) modulator chip, dual D to A converter, filter and amplifier, 140 MHz modulator, controller unit combiner, RF module combiner circuits, spreading circuits, up/down converter, power amplifier, TX filter, and transmit/receive circulator.

The multiplexed data signal from the E1/DS1 multiplexer is converted to I and Q (In-phase and Quadrature) data streams by the modulator chip and fed to the dual D to A converter which performs the digital to analog conversions. After further amplifications and filtering, the data streams are mixed with 140 MHz carriers that are at quadrature to each other. The resulting 140 MHz 16QAM signal occupies approximately 4 MHz of bandwidth and goes to the spread spectrum circuit via the coaxial cable connecting the controller unit combiner to the RF combiner.

3.43 The controller/RF combiners provide signal paths for the receive 70 MHz IF, transmit 140 MHz IF, and 10.7 and 4.5 MHz controller signals and for the –24/–48 VDC power feed from the controller to the RF module.

Within the spreader circuits, a code multiplier modulates the 16QAM signal with a high-rate spreading signal. The spreading produces a transmit IF signal that occupies 11 times the bandwidth of the original 16QAM signal, i.e., approximately 45 MHz.

The spread spectrum IF signal is applied to the up/down converter to produce the transmit RF signal. The transmit amplifier increases the transmit signal amplitude. A bandpass filter removes mixer products that are outside the transmit signal's allowed bandwidth.

3.46 The transmit signal then goes through a circulator which allows the receiver and transmitter to share a common antenna. The antenna provides gain which depends on its size.

Receiver Overview

The Model 9000 RF unit's receiver is configured with a TX/RX circulator, bandpath filter, up/down converter, despreader circuit, and combiner unit. A coaxial cable interconnects the RF module with the Model 9000 control module. The receive section of the controller consists of a SAW filter, AGC/64 MHz mixer, bandpass filter, amplifier, and demod chip, and the E1/DS1 multiplexer with user interface for four E1 or DS1 circuits.

The up/down converter provides LNA preamplification and 70 MHz translation. From the up/down converter, the 70 MHz IF signal is applied to the despreader circuit.

In the despreader circuits, a detector detects the energy according to the input frequency spectral positions as determined by the pseudo noise sequence. The receiver control circuits generate early, timely, and late codes to correlate the receive signal, plus an uncorrelated signal that is used for AGC control. The despread 70 MHz IF signal is then sent to the RF module combiner circuit.

At the controller interface, the extracted 70 MHz IF signal is passed through a SAW filter. The receive IF is then applied to a 64 MHz mixer/AGC circuit which outputs a 6 MHz (center frequency) signal. After receiving filtering and amplification, the 6 MHz signal is applied to the demod chip.

3.55 The demod chip performs the A to D conversion function. The resulting digital stream is then converted to four E1 or DS1 digital streams by the E1/DS1 multiplexer.

Controller Overview

The controller circuits provide the data interfaces and microcontroller functions. The controller uses conventional microcontroller-based circuits (microprocessor, EPROM, RAM, watchdog timer, clock, serial data transceivers, etc.) for local control and housekeeping chores (refer to Figure 3-3). The modem circuit board has two serial data ports which are used for end-to-end maintenance data communications by way of local RS-232D ports. (See Figures 3-4 through 3-6 for RS-232 port connector information.) Connected either to a local terminal or through a modem to the public telephone network, these ports provide a maintenance circuit to review online reports such as status, alarms, and so on, and to change setup parameters such as the PNS code for the radios at each end. Refer to Section 7, Operating Instructions, for more information.

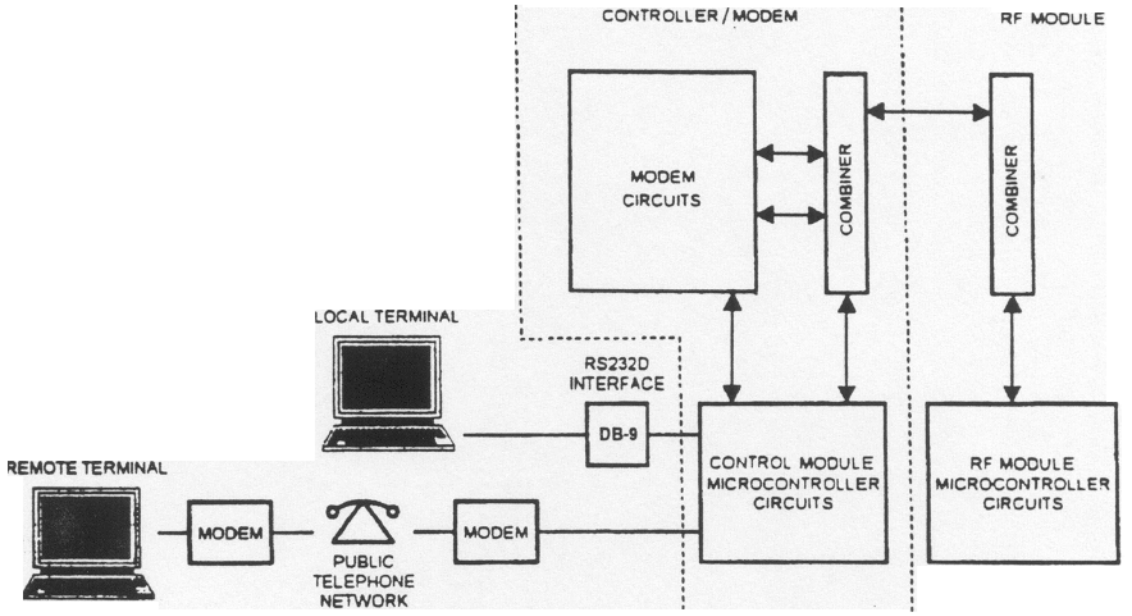


Figure 3-3. Data Circuit Maintenance

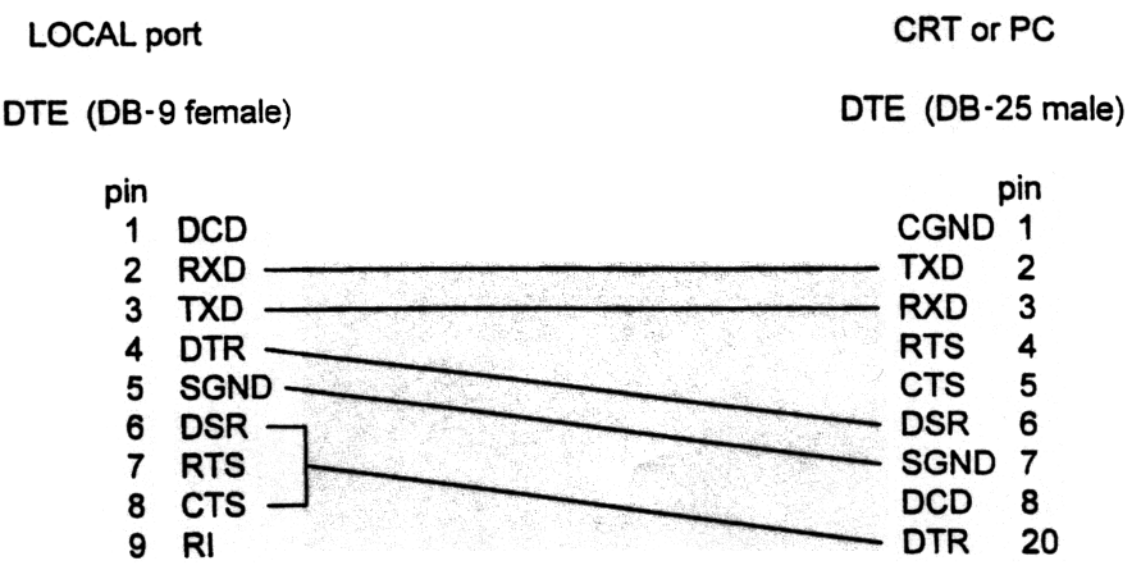


Figure 3-4. LOCAL Port Cable Wiring (9-Pin to 25-Pin)

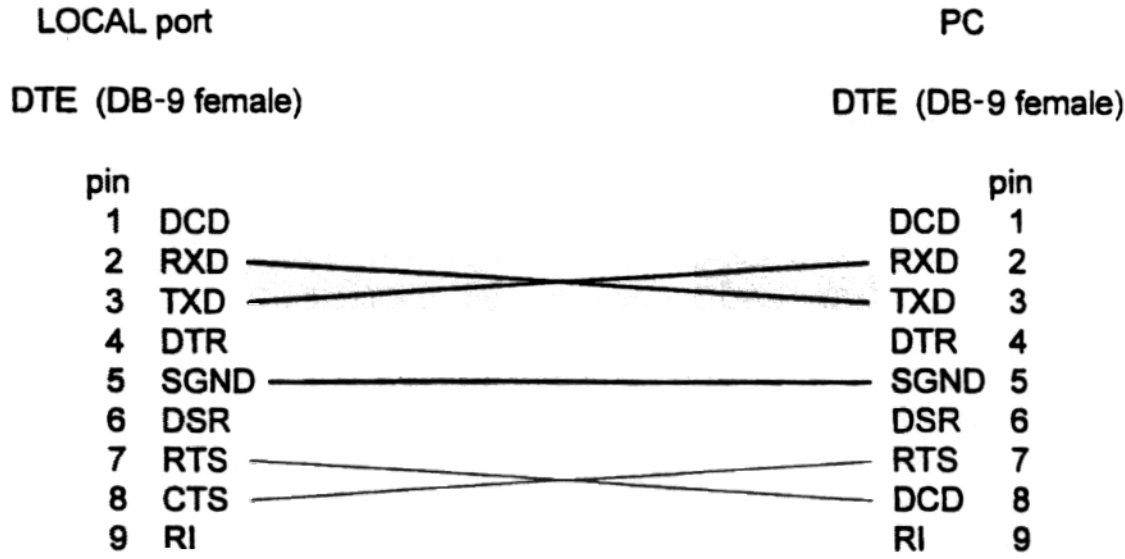


Figure 3-5. LOCAL Port Cable Wiring (9-Pin to 9-Pin)

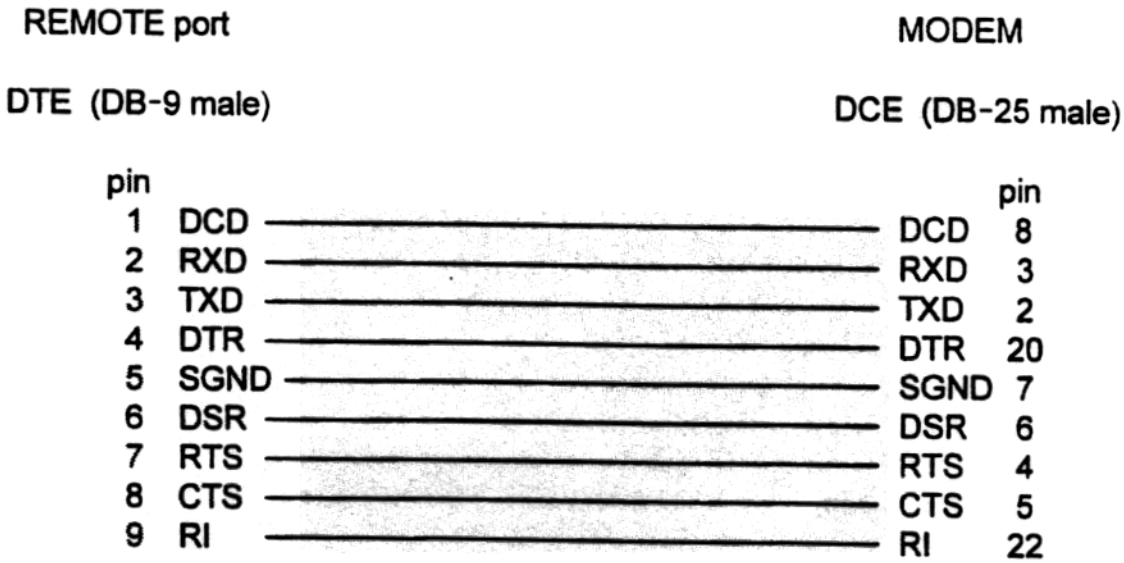


Figure 3-6. REMOTE Port Cable Wiring (9-Pin to 9-Pin)

Primary Power

Two facility battery circuits provide redundant primary power input (–24/–48 V_A and –24/–48 V_B) to the Model 9000. The 9000 control module has a power supply that converts input voltage to power local logic circuits. A single coaxial cable carries primary power from the controller to the RF module.

Alarms

The modem board, internal to the controller, has connections for standard Form A dry relay contact closures for visual and audible minor and major alarms. The major alarm relay is connected failsafe so that, if both primary power inputs are lost, the relay contacts close. A local alarm cutoff (ACO) switch allows current audible alarms to be reset; visual alarm closures remain active until the fault causing the alarm is cleared.

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Physical Characteristics 4

4.01 The Model 9000 system consists of two attached mechanical assemblies (refer to Figure 1-1). The Control and Radio Frequency (RF) Modules are designed for indoor use and can be installed in either a 19-inch or 23-inch rack. The two devices are interconnected via a single coaxial cable. The RF module connects to an antenna through a suitable coaxial cable feedline (see Larus Practice 80-601-281, Site Planning and Preparation).

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The Larus *QuadHopper*™ provides performance equal to, or better than, a standard microwave radio link or cable and conforms to E1/DS1 performance standards as outlined by Bellcore.

A detailed site survey must be performed per Larus specification (refer to Larus Practice 80-601-281) and the system must be installed by trained, professional technicians.

QuadHopper™ Grade of Service

The Larus QuadHopper™ E1/DS1 radio system is designed to provide 99.925 % availability (64.8 seconds unavailable per day) and 98.75 % error free seconds (no more than 1080 errored seconds per day) with fewer than 4 severely errored seconds per day. (Terms are defined on page 5-3.) This assumes that the system has been installed according to the manufacturer's published specification as outlined in Larus Practices. The calculation represents the worst case limits on performance. Availability is averaged over three months and error free and severely errored seconds are averaged over one day.

Over a 3-day period there should be fewer than 3240 errored seconds, 12 severely errored seconds, and 195 seconds of unavailability, measured round trip (both ways). This would verify that the link is two times better than the objective of 99.925 % availability.

The next higher grade of service for an E1/DS1 as defined by Bellcore would affect availability only, and that would increase to 99.995 %. This would equate to fewer than 4.32 seconds of unavailability per day or fewer than 13 seconds in 72 hours.