Contents

Introduction 1

1.1 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.

1.2 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.

2.22 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.

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

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

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

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.

3.03 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.

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.

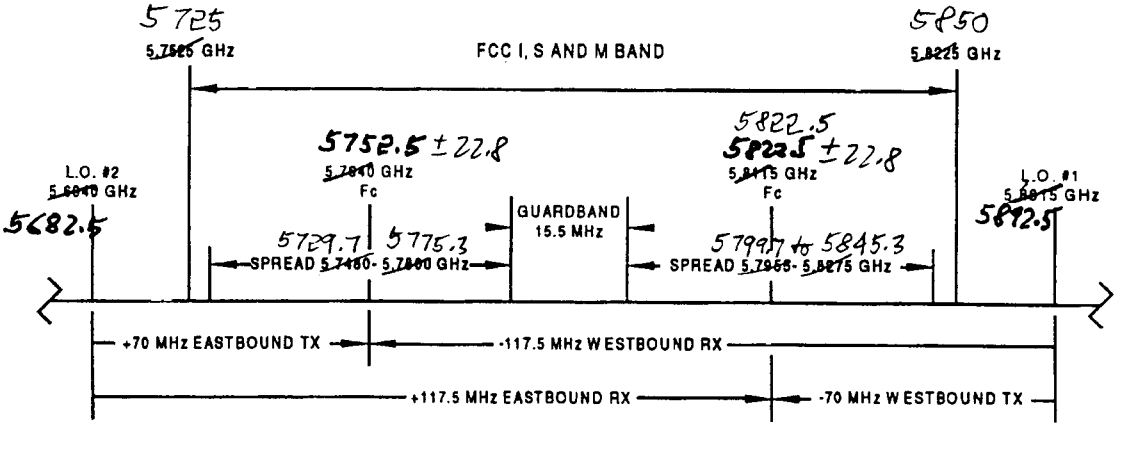

Figure 3-2. Model 9000 Frequency Plan

Frequencies for Unit under test

Transmitter Overview

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.

3.44 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.

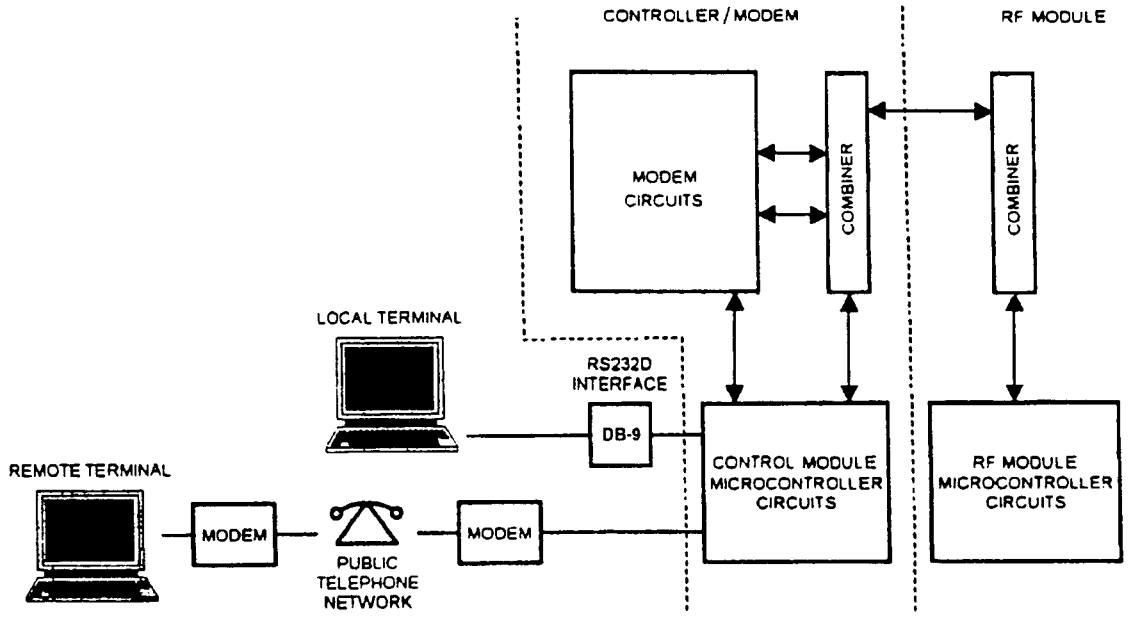

Figure 3-3. Data Circuit Maintenance

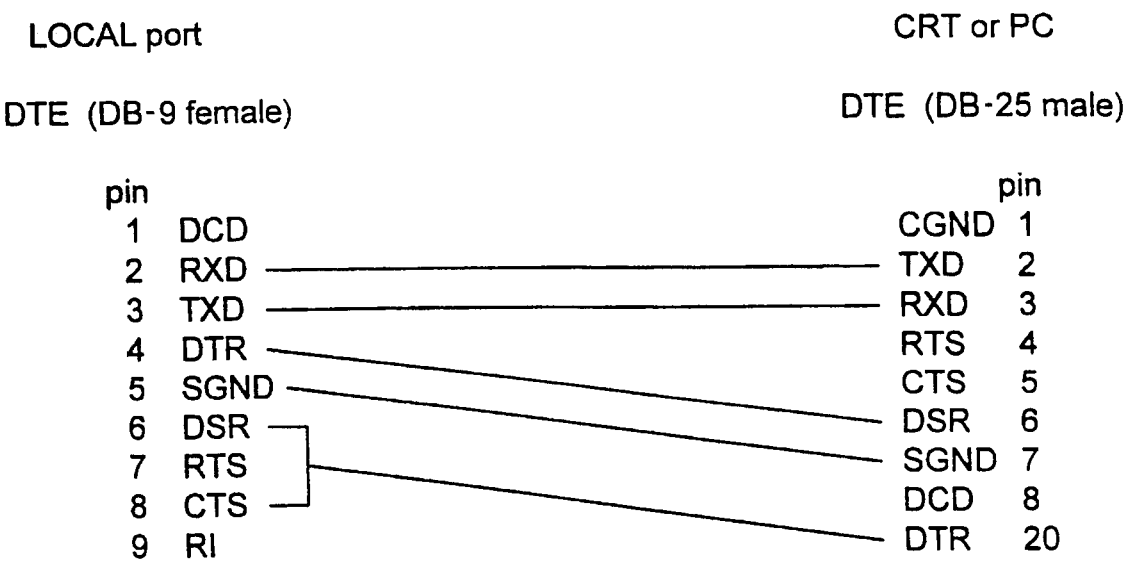

Figure 3-4. LOCAL Port Cable Wiring (9-Pin to 25-Pin)

3.7 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.

3.8 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.

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).