User Manual

NX64A Digital Radio

Doc. 602-11060-01 R: C

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Glossary

A/D, ADC	Analog-to-Digital, Analog-to-Digital Converter
ADPCM	Adaptive Differential Pulse Code Modulation
AES/EBU	Audio Engineering Society/European Broadcast Union
AGC	Auto Gain Control
ATM	Automatic Teller Machine
BER	Bit Error Rate
Codec	Coder-Decoder
CSU	Channel Service Unit
D/A, DAC	Digital-to-Analog, Digital-to-Analog Converter
dB	Decibel
dBc	Decibel relative to carrier
dBm	Decibel relative to 1 mW
dBu	Decibel relative to .775 Vrms
DCE	Data Circuit-Terminating Equipment
DSP	Digital Signal Processing
DSTL	Digital Studio-Transmitter Link
DTE	Data Terminal Equipment
DVM	Digital Voltmeter
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge/Electrostatic Damage
FEC	Forward Error Correction
FET	Field effect transistor
FMO	Frequency Modulation Oscillator
FSK	Frequency Shift Keying
FT1	Fractional T1
IC	Integrated circuit
IEC	International Electrotechnical Commission
IF	Intermediate frequency
ISDN	Integrated-Services Digital Network
kbps	Kilobits per second
kHz	Kilohertz

LED	Light-emitting diode
LO, LO1	Local oscillator, first local oscillator
LSB	Least significant bit
MAI	Moseley Associates, Inc.
Mbps	Megabits per second
Modem	Modulator-demodulator
MSB	Most significant bit
MUX	Multiplex, Multiplexer
µV	Microvolts
NC	Normally closed
NMS	Network Management System
NO	Normally open
PCB	Printed circuit board
PCM	Pulse Code Modulation
PGM	Program
R	Transmission Rate
RF	Radio Frequency
RSL	Received Signal Level (in dBm)
RSSI	Received Signal Strength Indicator/Indication
RX	Receiver
SCADA	Security Control and Data Acquisition
SNR	Signal-to-Noise Ratio
SRD	Step Recovery Diode
STL	Studio-Transmitter Link
THD	Total harmonic distortion
TTL	Transistor-transistor logic
TX	Transmitter
Vp	Volts peak
Vpp	Volts peak-to-peak
VRMS	Volts, root-mean-square
VSWR	Voltage standing-wave ratio

Section 1

System Characteristics

1.1 Introduction

The NX64A Digital Radio Link is a spectrum-efficient digital modem and radio offering a high performance, reliable, and cost-effective alternative to leased lines and conventional analog radios. Available in 297-512 MHz, 790-960 MHz and 1425-1535 MHz frequency bands, the NX64A is capable of transmitting 32-512 kbps over distances up to 35 miles (55 kilometers).

The NX64A Digital Radio Link is available in five data rate configurations (see below).

Table 1-1
Occupied Bandwidth

Data Rate (kbps)	High Efficiency* Bandwidth (kHz)	High Sensitivity** Bandwidth (kHz)
28/32	25	50
56/64	50	100
112/128	100	200
168/192	200	200
224/256	200	400
336/384***	200	400
448/512	400	Contact Factory

* High Efficiency (7 level modulation) = EFF 2 (2 bps/Hz)
** High Sensitivity (3 level modulation) = EFF 1 (1 bps/Hz)
*** 384 kbps in 200 kHz is a special US version

This efficiency serves to make the licensing of usable frequencies in a particular region or area much easier.

With leading edge digital signal processing and error correction schemes, the NX64A digital radios can provide error rate performance of $1\times10E\text{-}8$ over line-of-sight distances of up to 35 miles (55 kilometers). The NX64A can be set up to transmit longer distances by hops, with no degradation of voice and fax messages or corruption of data communications.

Digital radios are increasingly favored throughout the world because they can be set up quickly and easily, as temporary or as permanent installations. In developing countries and in the industrial nations, both rural and urban networks are using digital radios when other transmission facilities are unavailable, inappropriate, or too expensive. The NX64A is especially well suited to these applications because it has been designed for today's multimedia networking environment.

1.2 System Features

Spectral Efficiency

The NX64A requires only 50 kHz of bandwidth to transmit 64 kbps. This makes it twice as efficient as most other radios available in the market place. A lower efficiency option allows users to trade spectral efficiency for system gain.

Constant SNR

The NX64A does not suffer from fade problems generally encountered in analog transmissions. Error performance is independent of received carrier power until digital threshold is reached.

System Gain

The 30 dB SNR threshold of conventional analog radios and the $1\times10E\text{-}4$ error threshold of the NX64A are the same. However, the NX64A delivers 50 dB SNR at digital threshold. An analog system would require 20 dB more signal to deliver 50 dB SNR.

Immunity to Co-Channel Interference

Unlike analog systems that typically require 50 to 60 dB co-channel protection ratios, the NX64A can tolerate co-channel levels as low as 14 dB below the desired signal. Digital modulation eliminates birdies and background chatter.

Direct Digital Connectivity

The NX64A eliminates the need for expensive modems and enables direct connection to Switched 56, fractional T1/E1/CEPT-1, and basic rate ISDN equipment.

Access

The NX64A can transmit over the most difficult terrain—mountains, gulfs, rivers, and jungle areas—where cable installation is not practical.

Degradation-Free Repeater Operation

Digital regeneration enables multi-hop transmission without signal degradation or the need for equalization.

Higher Data Speeds

The data throughput of analog radios is limited by modem technology. The highest rate possible with current modems is 33.6 kbps. The NX64A can handle rates up to 512 kbps.

Mux Option

The optional SL9000DM personality module multiplexes four program channels for simultaneous transmission. Use of two SL9000DM modules allows up to eight channels. The digital data interface for each channel may be configured independently for V.35, RS-449, or RS-232. Additionally, a Voice/Telco interface option is available for direct connection to telephone circuits.

Network Management

Extensive NMS features are available for the NX64A. Real-time on-line and off-line control along with analog and digital loopback are possible at both the local and remote terminals. Event and alarm history can be reported over dial-up circuits, the front panel, or the NMS host.

Service Channel

An optional built-in service channel that is available simultaneously with the composite data can be used for maintenance and signaling.

Supervisory Control

In addition to the extensive NMS features, as an option the NX64A allows for telecontrol of 4 status, 4 telemetry, and 6 command channels on each radio terminal. The NMS channel can optionally be used as an auxiliary data channel.

Source Power Modularity

With modularized power supply options, the NX64A can be converted quickly for AC or DC operation.

Low Power Consumption

The NX64A’s low power consumption allows cost-effective solar operation. Typically, the NX64A consumes less than 45 watts (with standard 5 watt transmitter output and no internal multiplexer module installed).

Security

The radio frequency, modulation, coding, and scrambler circuits in the NX64A make casual interception difficult. Wireline and standard analog FM radios are much more susceptible to tapping.

Quick Payback

Built-in orderwire, alarm and control system, low power consumption, and reduced antenna and transmission line costs will in themselves pay for the NX64A. Use of the SL9000DM multiplexer module can eliminate the need for an expensive, separate multiplexer. The modem and direct data connection savings are more application specific. The NX64A is easy to install and does not require specialized equipment or skills.

Applications

- Integrated, single or multichannel voice, fax, and data communications
- Last-mile tail circuits for VSAT/ISDN/Fractional T1/E1/CEPT-1
- Compressed video for teleconference and security applications
- Transmission of high-speed graphic data for CAD/CAM and interconnection of LANs
- Cost-effective alternative for bank ATM networks and efficient point-of-sale mediums
- Rural radio extensions for single- and multichannel access systems
- High-speed SCADA, point-to-point, and point-to-multipoint networks

Typical End Users

- Utilities and Oil & Gas pipelines
- Banks
- VSAT-based networks
- National PTT
- Private Telecom operators
- Public safety organizations

Additional Product Features

- Microprocessor control and menu-driven operator panel facilitates user-friendly operation.

- Available in 297-512 MHz band with 5 or 9 watt output; in 790-960 MHz band with 5 watt output; in 1425-1535 MHz band with 1 watt output; and in 2300-2500 band with +20 dBm output.

- Selectable data rate operation from 16 kbps to 512 kbps.

- Selectable spectral efficiency of 1 and 2 bps/Hz. Allows tradeoff between system gain and occupied bandwidth.

- Adjustable Bit Error Threshold for monitoring transmission quality.

- Programmable RTS/CTS delays from 1 to 1000 msec.

- Full support for hot and cold standby operation.

- Optional Forward Error Correction for burst-mode interferences.

1.3 System Specifications

1.3.1 System

Frequency	297-512 MHz 790-960 MHz 1425-1535 MHz 2300-2500 MHz Fully synthesized No adjustments required within a 1 MHz band Adjustable within a 20 MHz band without component changes
Tx-Rx Spacing	Internal duplexer limited to the following minimum spacings: 7 MHz 297-327 MHz 4.5 MHz 335-512 MHz band 9 MHz 790-960 MHz band 40 MHz 1425-1535 MHz band Consult Factory for 2300-2500 MHz band External duplexer required for smaller spacings
Frequency Step Size	2.5 kHz to 25 kHz (programmable)
Data Rate	Selectable depending on IF bandwidth and efficiency setting: 16/19.2 kbps 28/32 kbps 56/64 kbps 112/128 kbps 168/192 kbps 224/256 kbps 336/384 kbps 448/512 kbps
Interface	V.35, RS-449, RS-232, EIA-530 (RS-530), G.703 (64/128 kbps)
Spectral Efficiency	Selectable: 1 bps/Hz (3 level modulation/“High Sensitivity”/LOW EFF = 1) 2 bps/Hz (7 level modulation/“High Efficiency”/HIGH EFF = 2)
RTS/CTS Delay	1 ms to 255 ms (programmable)
Diagnostics	Local and remote loopback Local and remote status and control Monitoring of BER, RSL, alarms, status and historical information

1.3.1 System (Continued)

MUX Digital Multiplexer (Option)	8 HP personality module 4 channels per module (two modules may be installed) Independent interface for each channel Available mux interfaces: V.35, Voice/Telco, RS-449, RS-232
NMS: Network Management System (Option)	On line/off line Full routing and configuration Data Rate: 1200 bps (aux channel) Local or remote via configured data path
Remote I/O (Option)	6 command channels: Programmable momentary, momentary pulse, or latching Relay spec: 50V @ 2A 4 status channels: Programmable N.O./N.C., momentary, or latching alarm indication TTL-compatible input standard 4 telemetry channels: Programmable limit Absolute, linear, power-to-linear conversion Resolution: 8 bits
Temperature Range	Full performance: 0 to 50°C Operational: -30 to 65°C
Power Source	Power Consumption <45W with 5W Tx output (nominal configuration) <50W with 9W Tx output <60W with 9W Tx and 1 SL9000DM module <65W with 9W Tx and 2 SL9000DM modules AC Input Module Universal AC: 90 – 260 VAC, 47 - 63 Hz DC Input Modules ±12 VDC: 10 - 20 VDC ±24 VDC: 18 - 36 VDC ±48 VDC: 36 - 72 VDC Isolated chassis gnd standard (switchable to common)
Orderwire (Option)	2-Wire/4-Wire Tel/Line level Line levels Tx -16 dBm, Rx +7 dBm E&M signaling

1.3.1 System (Continued)

Remote Metering (Option)	Allows remote access to front panel LED indications; TTL compatible outputs (unbuffered) RJ45 rear panel "Orderwire" connector
Forward Error Correction: (Option)	Coding: Reed-Solomon, T=10 Auxiliary Data: Async, RS-232, Start, Stop, 8 data, WP, 300, 600, …, 4800. Interface: V.35, RS-499

1.3.2 Transmitter

Power Out	Standard: 5 Watts (37 dBm): 297-512, 790-960 MHz 1 Watt (30 dBm): 1425-1535 MHz +20 dBm: 2300-2500 MHz Option: 9 Watts (40 dBm): 297-512 MHz
Connector Type	50 Ohms type N (female)
Frequency Stability	0.00025% (2.5 ppm); 0 to 50°C 1.5 ppm typical 1.0 ppm optional
Spurious	TX output: -60 dBc Post-duplexer: -70 dBc
Type of Modulation	Continuous phase digital modulator Suitable for use over non-linear amplifier (Suitable for FM analog transmission)

1.3.3 Receiver

Type of Receiver	Dual conversion superheterodyne 1st IF = 70 MHz nominal (= 69.3 MHz factory option; determined by operating frequency) 2nd IF = 10.7 MHz
Image Rejection	80 dB (minimum)
Connector Type	50 ohm type N (female)
Demodulation	Baseband non-coherent discriminator detection Data-coherent clock recovery (Suitable for FM reception)
Frequency Stability	0.00025% (2.5 ppm); 0 to 50°C 1.5 ppm typical 1.0 ppm optional
BER Threshold Mute Adjust	Adjustable 1x10E-3 to 1x10E-8 (for TP64 Transfer Panel applications only)

Table 1-2
BER Threshold, 1 x 10^{-3} at Rx Input
High Sensitivity (EFF=1, 3-Level Modulation)

DATA RATE	32 kbps	64 kbps	128 kbps	256 kbps	384 kbps	512 kbps
Rx input (dBm)	-104	-101	-98	-95	-93	Contact factory
Channel bandwidth spacing (kHz)	50	100	200	400	400	

Notes:
Preselector loss of 4 dB and duplexer loss of 2 dB not included.
1 x 10^{-6} provides 3 dB more signal

Table 1-3
BER Threshold, 1 x 10^{-3} at Rx Input
High Efficiency (EFF=2, 7-Level Modulation)

DATA RATE	32 kbps	64 kbps	128 kbps	256 kbps	384 kbps	512 kbps
Rx input (dBm)	-96	-93	-90	-87	-84**	-84
Channel bandwidth spacing (kHz)	25	50	100	200	200	400

Notes:
Preselector loss of 4 dB and duplexer loss of 2 dB not included.
1 x 10^{-6} provides 3 dB more signal
***Threshold less for FCC mask*

1.4 System Description

1.4.1 NX64A Digital Radio Product Structure

PRODUCT OPTIONS	DESCRIPTION
NX64A Base Unit	CPU/Modem, Chassis
Front Panel NX	Front panel with interface cable
Power Supply Universal AC ±12 VDC ±24 VDC ±48 VDC	Modular power supply
Transmitter 290-305 MHz 320-330 MHz 345-360 MHz 360-400 MHz 400-440 MHz 440-512 MHz 800-870 MHz 870-960 MHz	Transmitter module with interface cable
Receiver 297-327 MHz 330-400 MHz 400-440 MHz 440-470 MHz 470-512 MHz 800-870 MHz 870-910 MHz 910-960 MHz	Receiver module with interface cable and shock mount bracket assembly
IF Filters 25 kHz 50 kHz 100 kHz 200 kHz WIDE	Installed in receiver module (SIMM socket), up to 4 IF filter cards per system (multirate configuration)

1.4.1 NX64A Digital Radio Product Structure (Continued)

Duplexer Options:	
None	No duplexer, includes appropriate RF cables and connectors
External	External rack mount cavity duplexer, includes appropriate RF cables and connectors
406-470 MHz	1 - 4.5 MHz separation
470-512 MHz	1 - 4.5 MHz separation
806-960 MHz	3.6 - 9 MHz separation
Internal	
297-327 MHz	7-18 MHz separation
347-406 MHz	7-18 MHz separation
355-406 MHz	4.5-7 MHz separation
406-450 MHz	4.5-7 MHz separation
450-470 MHz	4.5-7 MHz separation
470-512 MHz	4.5-7 MHz separation
800-960 MHz	9-15 MHz separation
800-960 MHz	15-30 MHz separation
800-960 MHz	30-50 MHz separation
Digital Interface	
RS-449	RS-449 Interface Kit SDR-DTE
V.35	V.35 Interface Kit SDR-DTE (Female)
V.35	V.35 Interface Kit RAD (Male)
RS-232	RS-232 Interface
G.703	G.703 Interface
Remote I/O	Remote Input / Output Interface

1.4.2 System Overview

The NX64A Digital Radio Link is a full duplex digital radio modem. It has a built-in baseband modem, interface stage, an RF pre-amplifier, and an RF amplifier. No external modems are required. Each radio requires a duplexer and an antenna. Refer to Figure 1-1 for a typical block diagram.

NX64A radios are characterized by superior spectral efficiency. This efficiency is achieved by using state of the art 7-level partial response modulation technique. High spectral efficiency allows this family of radios to deliver the maximum utilization of the RF bandwidth.

Since the use of the radio spectrum is highly regulated and limited in availability, it is often very difficult, if not impossible, to get licensed for a large channel capacity. Consequently, the smaller the channel capacity required by the radio, the greater are the chances for obtaining a license.

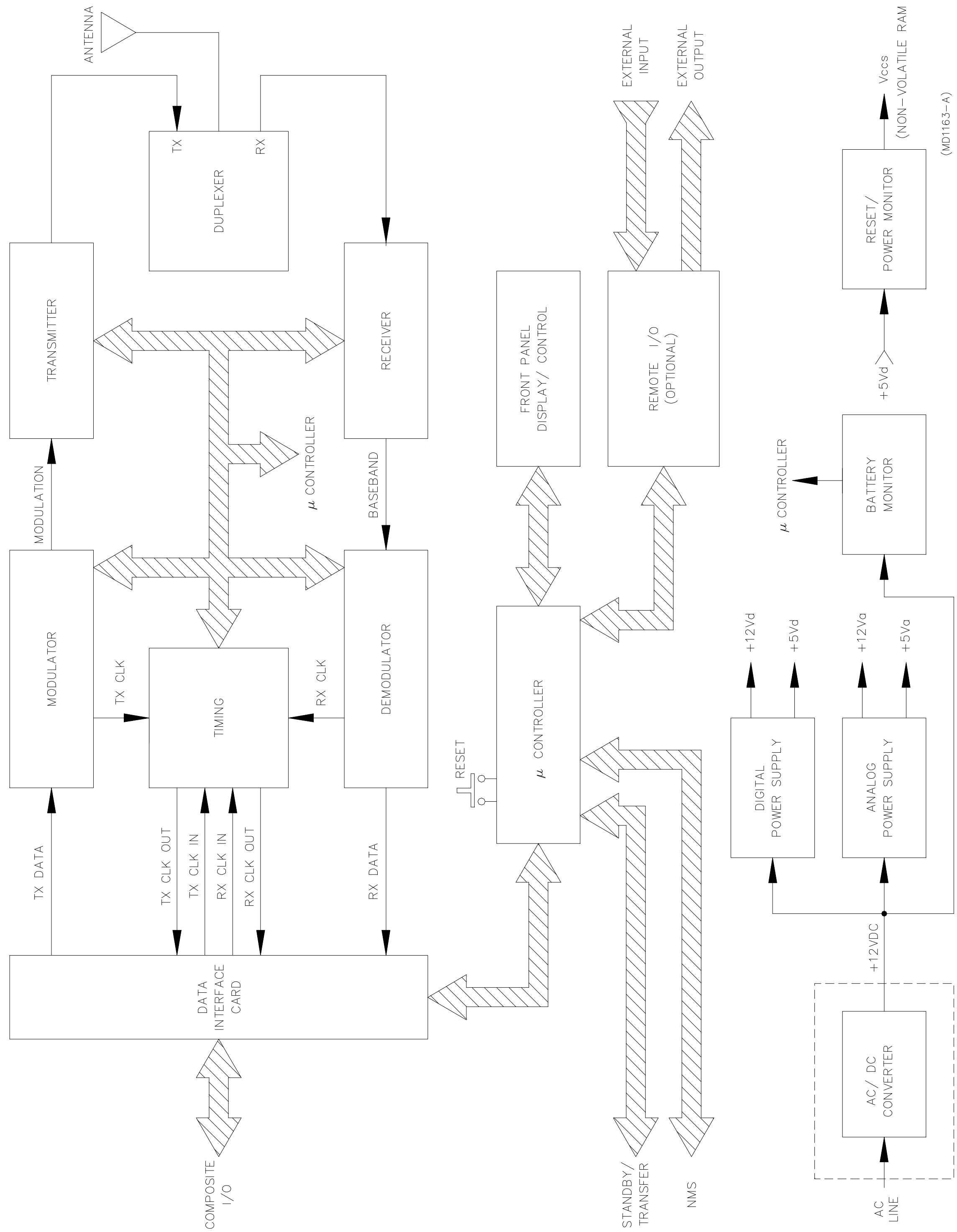

Figure 1-1
System Overview Diagram

1.4.3 Module Subsystem Description

The NX64A Digital Radio Link is configured as a full duplex system. The basic architecture for each of the radios is identical. This description applies to the entire NX64A family of radios. Where applicable, this section will detail the differences between models.

Each radio includes the following:

- CPU/Modem Motherboard
- Transmitter Module
- Receiver Module
- Front Panel
- Power Supply
- Data Interface Card
- Duplexer
- Digital Multiplexer Module (option)
- Remote I/O (option)
- G.703 module (option)
- Forward Error Correction (option)

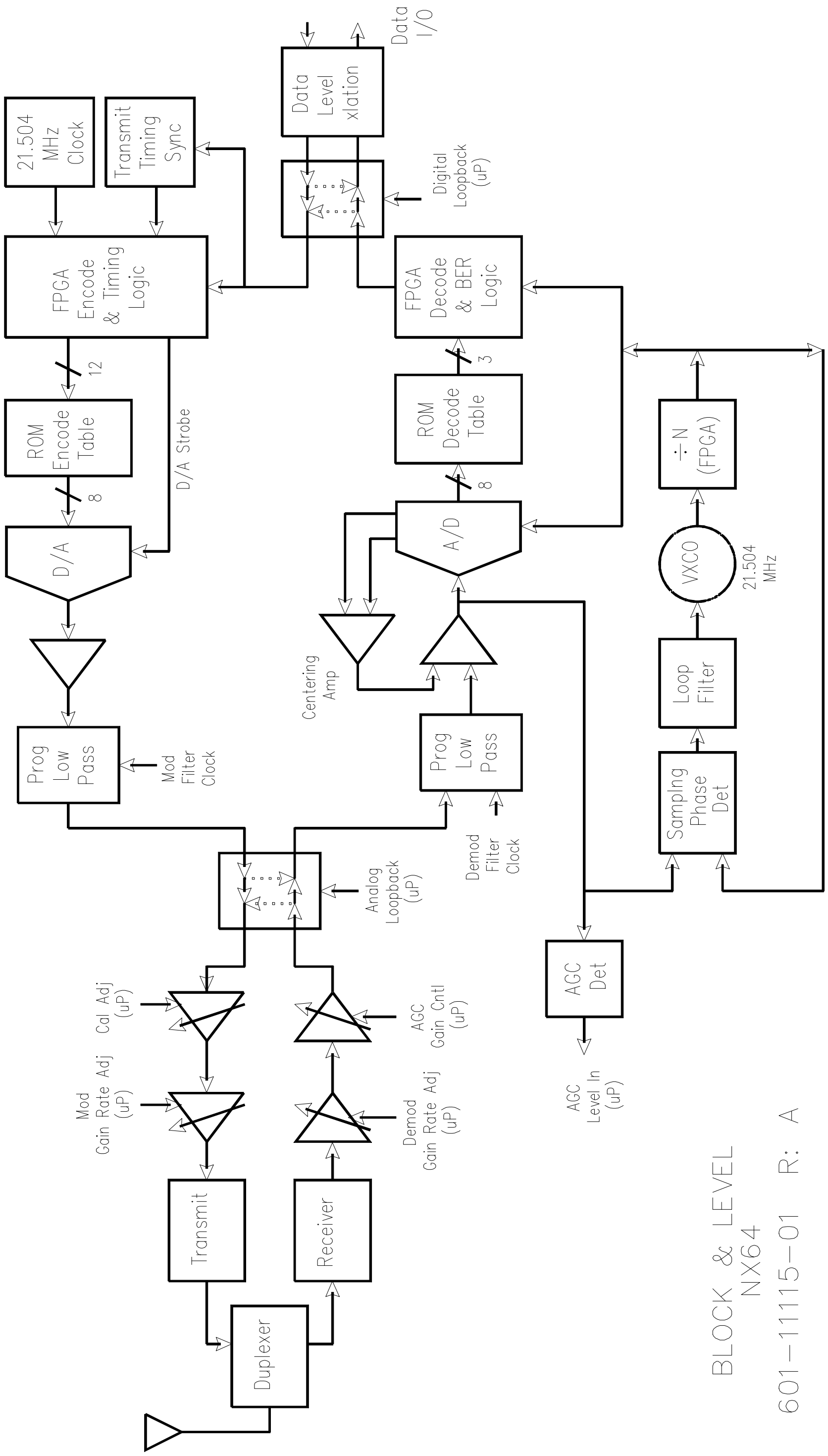

Figure 1-2
System Block Diagram

1.4.3.1 CPU/Modem Motherboard

The CPU/Modem Motherboard provides following subsystems:

- Central Processing Unit
- Digital Modulator
- Digital Demodulator
- Clock Recovery
- Data Recovery
- Digital Data Interface
- Orderwire
- Front Panel Interface
- Power Supply
- Standby/Transfer Panel Interface
- Remote I/O Interface
- NMS Control

Central Processing Unit

The microprocessor in conjunction with the FPGA logic acts as the central controller for the radio. In addition to the microprocessor itself, the central controller consists of the following:

- Reset/Power Monitor
- Parallel I/O controller
- Asynchronous serial I/O controller
- Address decoding and latching
- Real Time Clock
- EEPROM, Nonvolatile RAM and ROM for program and user setup memory requirements
- LED drivers for the front panel

Digital Modulator

The digital modulator consists of scrambler, precoder, and partial response filter. The modulator converts the incoming data into a shaped multilevel spectrally efficient signal, using seven level partial response filtering. The scrambler prevents creation of discrete spectral components. The precoder prevents the propagating of errors in the detection of the data at the receiver/demodulator. The shaping filter produces the multilevel signal and simultaneously band-limits its spectrum. A novel technique is used to implement the precoder and the shaping filter in the digital domain. A D/A converter is used to generate the signal that will FM modulate the transmitter.

Digital Demodulator

The digital demodulator consists of an active lowpass filter, an A/D converter, and a multilevel bit slicer. The timing of the A/D and the slicing is determined by the recovered clock. The noise filter limits the noise bandwidth. The A/D and the bit slicer recreates the precoded signal sent by the digital modulator.

Clock Recovery

The clock is recovered from the signal after the noise filters. A PLL recovers the timing information.

Data Recovery

The original serial data is recovered by passing the output of the slicer through a “reverse precoder” and a descrambler. Error detection logic captures coding violations and triggers the BER counter.

Digital Data Interface

The digital data interface can be V.35, RS-449, RS-232, EIA-530, or G.703.

Orderwire (Option)

An RJ45 connector provides access to the orderwire channel. Transformer-coupled TX and RX ports allow for 2-wire or 4-wire operation. Interface levels are -16 dBm for the inputs and +7 dBm for the output. The orderwire can FM modulate the radio as a subcarrier, and can operate in lieu of the data.

Power Supply

The CPU/Modem power supply circuitry accepts +12 VDC input from the system power supply and generates +5 and +12 VDC (analog and digital). The battery monitor warns the system of low voltage at the input. The reset/power monitor protects the nonvolatile RAM with a battery backup.

Standby/Transfer Panel Interface

Provides the necessary interface I/O lines and software control for transfer panel/standby unit configurations. The transfer panel (TP64) is external to the NX64, and proviides a redundant hot or cold standby connection to another NX64 unit (see Section 2.5 for more information on setups and settings).

Remote I/O Interface (Option)

Provides the necessary interface I/O lines and software control for the Remote I/O option card that installs into connector P41.

NMS Control (Option)

The Network Management System (NMS) option is supported through microprocessor software control.

1.4.3.2 Transmitter Module

The transmitter module is mounted on a heat sink located on the rear of the radio chassis. The transmit module receives the baseband modulated signal and mixes it to achieve the desired center frequency. This modulated carrier is then amplified and sent to the duplexer for transmission. Please refer to the block diagram in Figure 1-3.

The transmit module contains the following subsystems:

- Voltage Controlled Oscillator
- Phase-Locked Loop Synthesizer
- Intermediate Power Amplifier
- Final Power Amplifier

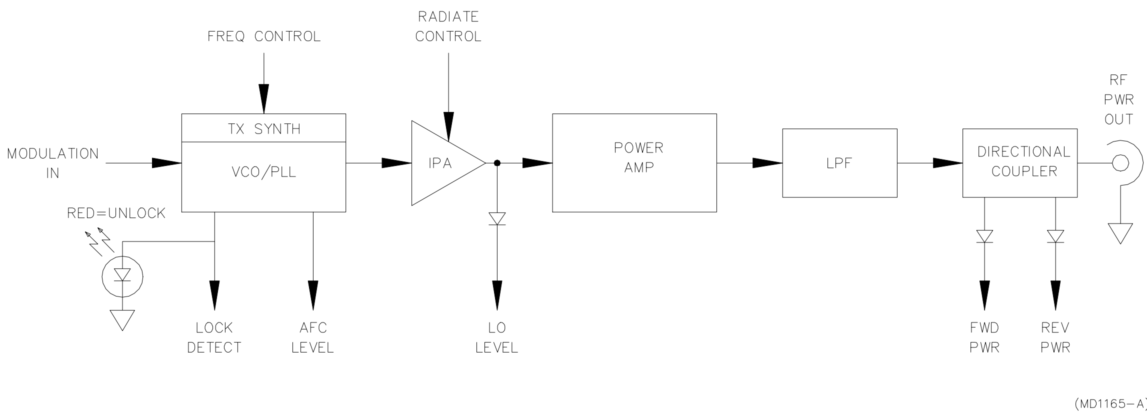

Figure 1-3
Transmitter Block Diagram

Voltage Controlled Oscillator

The voltage controlled oscillator (VCO) is a variable frequency source operating in either the 790-960 MHz band or the 297-512 MHz band. It uses a 1/4 wavelength coaxial resonator configuration for low noise operation. The resonator length determines the general operating frequency of the VCO and is chosen for operation within required frequency bands. Two hyperabrupt variable capacitance diodes (varactors) provide independent and optimized control over the center frequency and modulation (FM) sensitivity. The output of the VCO is buffered by a wideband amplifier that provides an output level of +8 dBm.

Phase-Locked Loop Synthesizer

The digital synthesizer provides digital control of the transmitter's center frequency. Functionally, the synthesizer phase-locks the voltage controlled oscillator (VCO) centered at the required transmitter frequency to a stable crystal reference oscillator. A programmable divider within the synthesizer allows digital control of the VCO frequency in precise programmable frequency steps.

Intermediate Power Amplifier

The buffered output of the VCO drives a wideband Intermediate Power Amplifier (IPA). The IPA provides an output level of +16 dBm in the 790-960 MHz band (+21 dBm in the 297-512 MHz band). This level is required to drive the final RF Power Amplifier (RFA) stage that follows the IPA. Since the RFA output is set by the drive from the IPA, switching off the IPA also disables the RFA. Hence, the IPA is used to switch the transmitter output between "radiate" and "standby" modes.

Final Power Amplifier

The final power amplifier is an efficient class-C, three-stage hybrid device that delivers between 6 and 10 watts of RF power. The device is convection cooled by the extrusion finned heat sink on which it is mounted. The output is low-pass filtered, reducing the second and higher order harmonics to fall within FCC spectral mask requirements. Following the low-pass filter, a directional coupler is used to determine forward and reflected power sampling for transmitter telemetry. The net output power is 5 watts (37 dBm) nominal. The high power option for the 297-512 MHz band provides 9 watts (40 dBm). Transmitters in the 1425-1535 MHz band provide 1 watt (30 dBm).

1.4.3.3 Digital Receiver Module

The Moseley Digital Receiver Down Converter Module consists of two cards:

i. RF Down Converter for 300-512MHz, 790-960MHz, and 1350-1525MHz to 70MHz.

ii. Digital Down Converter and Demodulator that takes a 70MHz signal from the RF card and down reverb filters (?) and FM demodulates the received carrier.

RF Down Converter

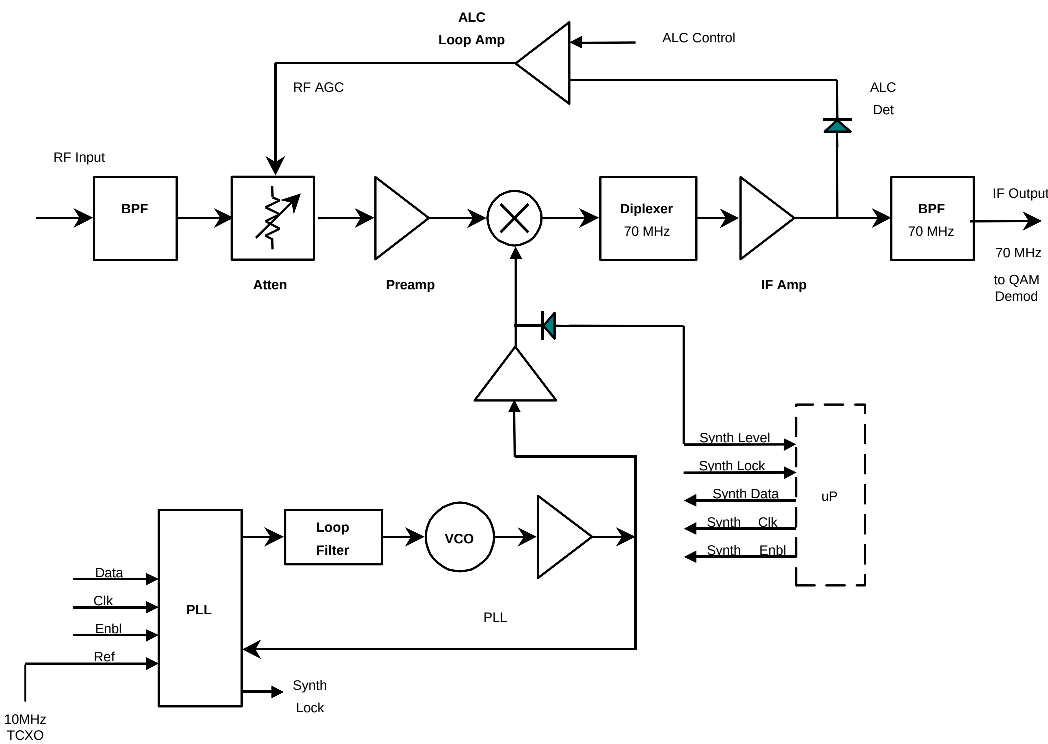

Figure 1-4
RF Down Converter Block Diagram

The receiver handles the traditional RF to IF conversion from the carrier to 70 MHz (see Figure 1-4, above). Considerations are given to image rejection, inter-modulation performance, dynamic range, agility, and survivability. A separate AGC loop was assigned to the RF front end to prevent inter-modulation and saturation problems associated with reception of high level undesirable interference from RF signals resulting from RF bandwidth that is much wider than the IF bandwidth. These problems are tyupically related to difficult radio interference environments that include high power pagers, cellular phone sites, and vehicle location systems.

Digital Down Converter

The Digital Down Converter accepts a signal from the RF board at 70 MHz and delivers a baseband output to the CPU modem with RSSI indication. The Digital Down Converter consists of the following:

i. Input 70 MHz SAW Filter with a 50 dB bandwidth of 1 MHz.

ii. A 80 dB AGC amplifier attenuator assembly that provides 20 DB of attenuation or up to 60 dB of gain.

iii. A 14 bit high sample rate A/D converter sampled at 16 MHz.

iv. A programmable digital down converter assembly that accepts the sub-sample at its IF input and demodulates the RM carrier.

v. D/As for baseband, AGC control and RSSI purposes.

vi. Microprocessor for status control and configuration purposes.

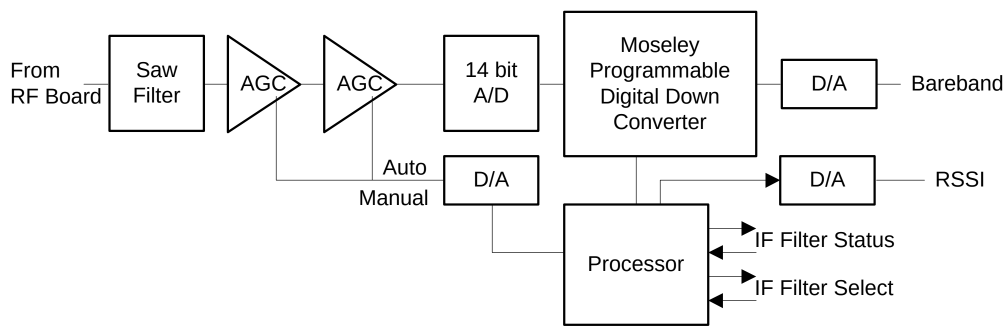

Figure 1-5
Digital Down Converter Block Diagram

The down converter accepts input from the CPU modem to select either a 25, 50, 100, 200 or 400 MHz filter within the down converter chip. This eliminates the need for external analog crystal filters. Each radio can now be run with any of the IF filters. All CPU function menus remain the same as for the older analog filter radios.

Programmable Down Converter

The Moseley Programmable Down Converter (PDC) is an agile digital tuner designed to meet the requirements of a wide variety of communication industry standards. The PDC contains the processing functions needed to convert sampled IF signals to baseband digital samples. These functions include LO generation/mixing, decimation filtering, programmable FIR shaping/bandlimiting filtering, re-sampling, AGC, frequency discrimination and detection.

A top level functional block diagram of the Moseley PDC is shown below. This diagram shows the major blocks and multiplexers used to reconfigure the data path for various architectures.

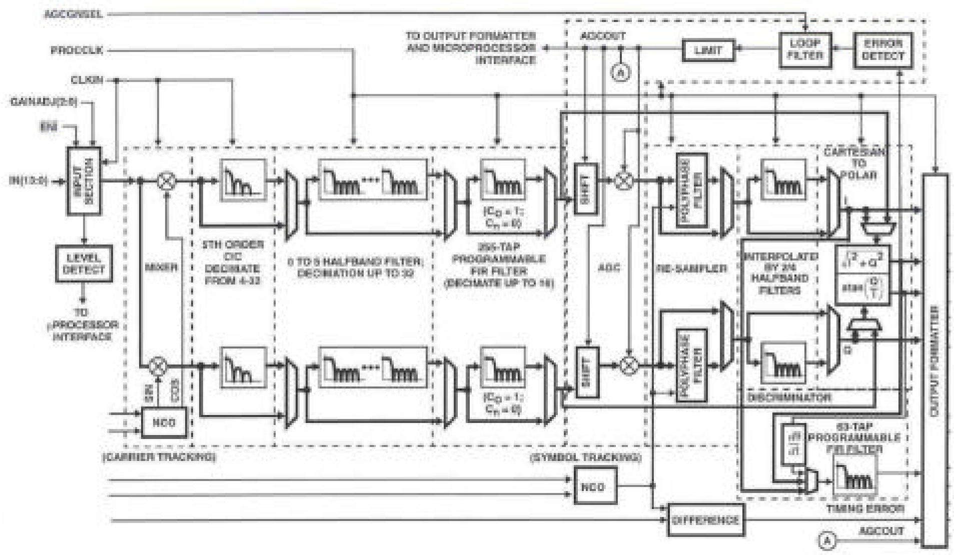

Figure 1-6
Functional Block Diagram of the Moseley Programmable Down Converter

The Moseley PDC consists of 13 different sections: Synchronization, Input, Input Level Detector, Carrier Mixer/Numerically Control Oscillator (NCO), CIC Decimating Filter, 255-Tap Programmable FIR Filter, Automatic Gain Control (AGC), Re-sampler/Halfband Filter, Timing NCO, Cartesian to Polar Converter, Discriminator and Output Sections. All of these sections are configured through a microprocessor interface.

Automatic MSB Adjust Circuit

The AUTO MSB board is an assembly that replaces the manual MSB adjustment circuitry on the NX64 CPU/MODEM board. A block diagram is shown below in Figure 1-7.

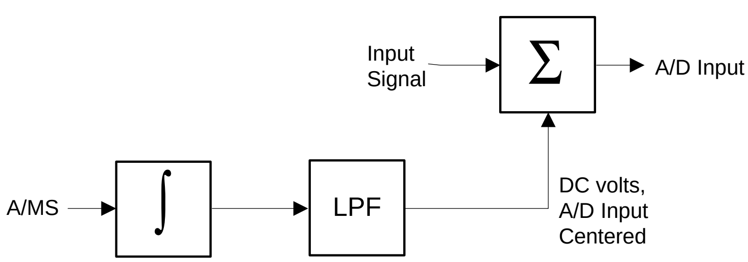

Figure 1-7
MSB Adjustment Circuitry

The circuit consists of an integrator, a low-pass filter, and a summing amplifier that performs the MSB adjusting function automatically. The MSB adjust potentiometer "A/DREF" (R1213) on the CPU/MODEM board becomes inoperative.

Install the AUTO MSB Board

To install the AUTO MSB Board:

1. Unplug the power into the NX64.
2. Remove the top cover.
3. Locate and carefully remove U121 from the CPU/MODEM board, taking care not to bend the IC pins.
4. Install the IC onto the AUTO MSB board; be sure to align pin 1 correctly.
5. Install the AUTO MSB board at location U121.
6. Using a small soldering iron, solder the free end of the purple wire to P120 pin 11.
7. Replace the top cover.
8. Apply power to the NX64.

No other adjustments should be required.

1.4.3.4 Front Panel

The radio is provided with an intelligent front panel. This front panel includes:

- An 80 character (4X20) LCD display module.
- Six switches for configuration and testing.
- Seven LEDs for critical status display.

The LCD module is menu-driven and provides a very easy user interface for configuration setting and testing. In addition, it displays status and events. The transmit and receive frequencies can be set up via the front panel. The front panel allows the control and configuration of the local as well as the remote radio. Refer to the Operation Section (Section 3) for more information.

1.4.3.5 Power Supply Module

The radio is powered with a modular power supply. Modules are available for universal AC (90 - 260 VAC, 47 - 63 Hz) and DC (±12, ±24, or ±48 VDC). These modules are all able to supply the necessary power for a full configuration of the NX64A Radio. Jumpers on the circuit board allow the power supply ground to be common with the chassis ground or isolated (for negative DC inputs). The power supply provides +12 VDC to the CPU/Modem, which generates and distributes the various system voltages.

1.4.3.6 Data Interface Cards

The data interface cards, or digital drivers, provide level translation compatibility for various industry standards. Currently, the supported standards are V.35, RS-449, RS-232, EIA-530, and V.36/G.703 (for 64 / 128 kbps only). The SL9000DM Digital Multiplexer option supports V.35, RS-449, RS-232, and Voice/Telco.

Two types of data interface cards are used by the NX64A. One plugs into the CPU/Modem, providing the digital interface for the composite I/O. The other type of driver cards are used with the SL9000DM Digital Multiplexer option, to interface with the data channels. Each channel uses a separate interface card. An additional card establishes the trunk interface.

The appropriate cables are provided which configure the NX64A as a DCE. Gender mismatches may occur if equipment manufacturers interpret the standards differently. Contact customer service in this event.

1.4.3.7 Duplexers

In full duplex radios with a common antenna, a duplexer provides the necessary isolation between transmit and receive frequencies. Duplexers supplied with NX64A radios provide at least 65 dB isolation.

The duplexer used with the NX64A is a three-port filter device that separates TX and RX carrier signals and routes them to the appropriate system modules. The duplexer is a combination high-pass and low-pass pair. The response is optimized for low insertion loss (at the pass frequency) and maximum attenuation (at the reject frequency). The insertion loss directly affects power out (on the TX side) and sensitivity (on the RX side). The device consists of multiple high-Q, capacitively-tuned TEM cavity resonators. The result is at least 65 dB isolation between the transmit and receive frequencies.

The selection of a duplexer depends on a number of factors, including frequency of operation, separation between these frequencies, minimum required TX/RX isolation, and power level. The NX64A offers a number of duplexer choices. Depending on the physical configuration and size of a duplexer, it can be mounted either inside the NX64A chassis or externally, in a rack.

In the 297-512 MHz band, if the separation is 4.5 MHz or greater, an internal duplexer may be used. If the separation is less than 4.5 MHz, an external duplexer must be used.

In the 790-960 MHz band, if the separation is 9.0 MHz or greater, the duplexer can be mounted inside. If the separation is less than 9.0 MHz, an external duplexer must be used.

1.4.3.8 Digital Multiplexer Module (Option)

The NX64A has card slots allowing the use of up to two SL9000DM Digital Multiplexer modules. The SL9000DM replaces external multiplexer equipment. Each module provides 4 data channels (8 channels with two modules). Each channel is independently configured using a plug-in data interface “daughter card” that determines the communications standard for that channel. Multiplexer interface cards are available for V.35, RS-449, RS-232, and Voice/Telco. In addition, the trunk connection (between the multiplexer and the Communications I/O connector to the CPU/Modem) requires an interface card on the SL9000DM and a matching card on the CPU/Modem.

Set up of the SL9000DM is accomplished through a set up port, using an external computer.

The SL9000DM requires the presence of the backplane at the rear of the card cage to provide power supply connections and bus interconnection between the multiplexer cards.

Detailed information about the SL9000DM is available in a separate manual.

1.4.3.9 Remote I/O (Option)

The Remote I/O option provides remote control functions. The card supplies six relay-isolated control outputs, four optically-isolated status (digital) inputs, and four single-ended analog inputs. The back panel connectors “External Output” and “External Input” are located on this board.

Contact Moseley Associates for more information about the Remote I/O option.

1.4.3.10 Remote Metering (Option)

The Remote Metering option allows the user to access the front panel LED status levels through the rear panel “ORDERWIRE” jack of the NX64A. These logic levels can be monitored by a remote control system such as the Moseley MRC-1620LP or MRC-2.

Contact Moseley Associates for more information about the Remote Metering option.

1.4.3.11 FEC—Forward Error Correction (Option)

To overcome industrial and other man-made impulse noise as well as other burst-mode interferences, powerful Reed-Solomon Forward Error Correction is available as an option. Unfaded BER performance in excess of 10^{-11} offers unparalleled error-free performance.

Contact Moseley Associates for more information about the Remote Metering option.

Section 2

Installation

Continued on following page...

2.1 Introduction

This section guides the user through a detailed procedure for NX64A installation, beginning with unpacking the unit and pre-installation bench tests, to site installation and link alignment. Information regarding connection to external equipment (mux/demux, etc.), data interface options, and equipment timing setup (clock configurations) is also covered.

2.2 Unpacking/Inspection/Inventory

NOTE

Please check for damage to the outside and inside of the shipping container. If any damage is noted, please contact Moseley Customer Service and the shipping carrier to report it.

Your NX64A is shipped in a high-quality cardboard container and packed with high-density molded foam. This packaging can withstand the damage that may occur during shipping, such as may be caused by vibration or impacts, and will still protect its contents. The original packing box and molded foam are the only suitable packaging for shipping the NX64A.

During unpacking, observe how the NX64A is packed. If the equipment must be re-shipped, it must be repacked in exactly the same manner to avoid damage. The packaging includes one large cardboard box, two foam side caps and one accessory box. Retain these items for future use.

The receiver module is shock-mounted to a bracket above the duplexer (see Figure 2-1). The tie-down strap must be removed before operation, and reinstalled before shipping. When re-installing the strap for shipment, be sure it is secure but not so tight that it causes damage.

CAUTION

It is extremely important that you remove the receiver shipping strap prior to operation. The receiver will not perform properly with the strap in place.

Take inventory of the complete package to ensure that all necessary parts are present. A quick review of your pre-installation site survey form, purchase order, and shipping list should reveal any discrepancies.

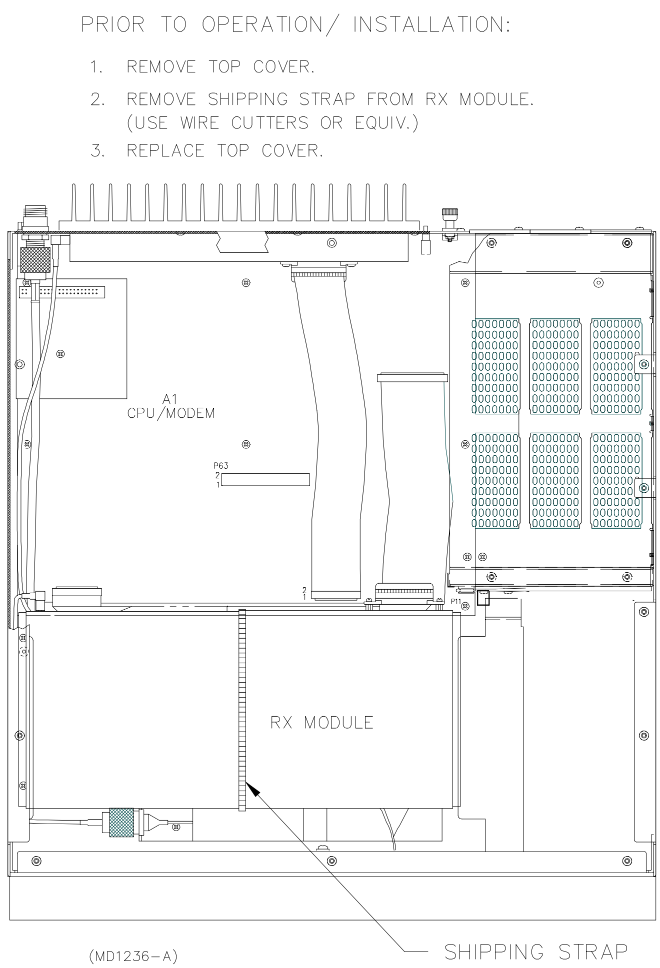

Figure 2-1
Shipping Strap Removal

2.3 Pre-Installation Testing

Please refer to Figure 2-2 (Rear Panel I/O Ports and Controls) for a general overview of the NX64A connector panel.

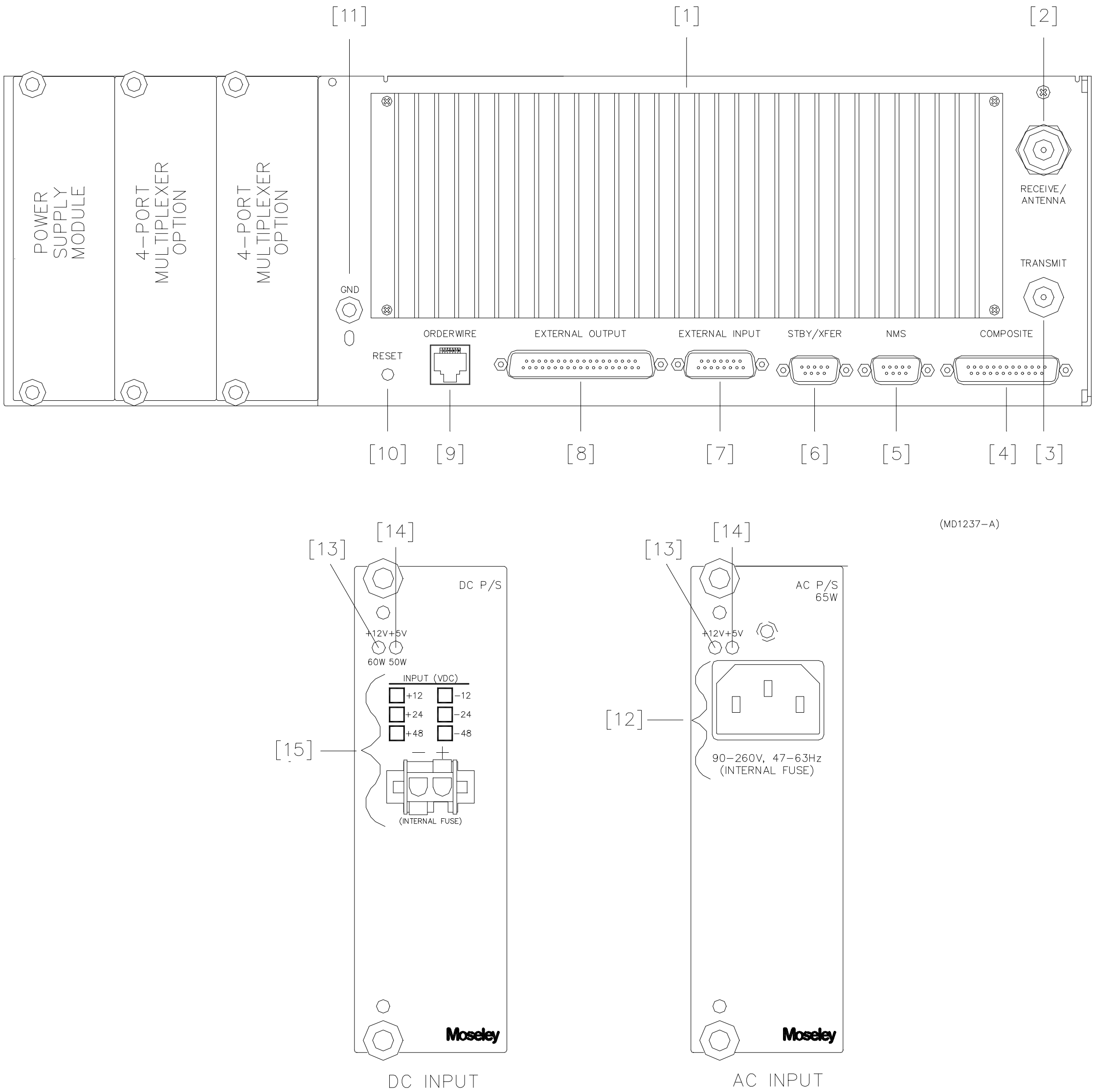

Figure 2-2
Rear Panel I/O Ports and Controls

[1] TRANSMITTER HEAT SINK

[2] TRANSMITTER POWER OUTPUT: Internal duplexer: not required. External duplexer: type N; 5 watts nominal; antenna connection or RF dummy load required at all times.

[3] RECEIVER INPUT OR DUPLEXER ANTENNA PORT: Internal duplexer: duplexer antenna port; type N; combined transmitter and receiver; antenna connection or RF dummy load required at all times. External duplexer: receiver input port; type N; 10 mW (+10 dBm) maximum input level.

[4] COMPOSITE DATA I/O PORT: (25 pin D-female) Primary data bit stream input/output port; factory-configured for V.35, RS-449, RS-232, EIA-530, and G.703 interfaces.

[5] NETWORK MANAGEMENT SYSTEM I/O PORT: (9 pin D-male) NMS I/O option.

[**6**] **STANDBY/TRANSFER PANEL INTERCONNECT:** (9 pin D-female) Connect to TP64 transfer panel for standby unit interface.

[7] EXTERNAL INPUT: (15 pin D-female) Remote I/O option card input status lines.

[8] EXTERNAL OUTPUT: (37 pin D-female) Remote I/O option card output control lines.

[9] ORDER WIRE: (RJ45) Order wire I/O option/remote metering interface option.

[10] CPU RESET BUTTON: Hard boot of system CPU.

[11] CHASSIS GROUND CONNECTION: (Screw Terminal)

[12] AC LINE INPUT: (IEC Standard) 90-260 VAC, 47-63 Hz, 45 watts minimum; internal fuse (refer to the power supply module PC board legend for proper fuse ratings).

[13] +12V LED: Indicates main supply operation (green indicates normal operating condition).

[14] +5V LED: Reserved for other Moseley products.

[15] DC INPUT: Input voltage as indicated on panel. All units are shipped with an isolated ground input. An internal jumper is provided in the power supply module to provide a common chassis connection (negative ground). This may be required to solve system ground loop problems (only possible for positive DC supply installations). Internal fuse: refer to the power supply module PC board legend for proper fuse ratings.

2.3.1 Warnings

Before applying power to the NX64A please be aware of the following:

WARNING

RF radiation may be dangerous above certain exposure levels. ***NEVER*** *stand in front of the antenna when the transmitter is radiating.*

CAUTION

An antenna or dummy load ***MUST*** *be connected to the transmitter if power is applied to the unit and the transmitter is enabled. Failure to observe this precaution can damage the power amplifier of the transmitter.*

DO NOT *connect the transmitter power output (antenna port) to the receiver input! This* ***WILL*** *destroy the receiver.*

When a duplexer is used, ***DO NOT*** *set the transmitter to a frequency which is different than that marked on the duplexer. Failure to observe this precaution can damage the power amplifier of the transmitter.*

2.3.2 Loopback Tests

Loopback tests enable the user to easily determine the operational status of the NX64A. There are two types of internal loopback modes (analog and digital), and two types of external loopback modes (RF and hardwire). The diagrams in Figure 2-3 (Local Loopback Test Setup) and Figure 2-4 (Remote Loopback Test Setup) provide a conceptual block diagram of the loopback configurations. The front panel status indicator marked LBK will illuminate during loopback tests.

Digital Loopback

Digital Loopback connects the digital input to the digital output of the NX64A. This loopback is bilateral and also connects the digital output to the digital input for remote loopback tests. The loopback connection is performed at the modem and is switched in software (use the TEST menu screen, see section 3.4.4).

Analog Loopback

Analog Loopback connects the analog output of the modulator to the analog input of the demodulator. The loopback connection is performed at the modem and is switched in software (use the TEST menu screen, see section 3.4.4).

RF Loopback (external)

RF Loopback requires a “turnaround box” that translates the transmitter carrier frequency to the frequency of the receiver at a much lower power level. This test will check all the subsystems of the NX64A digital radio/modem.

Hardwire Loopback (external)

Hardwire Loopback utilizes a special connector at the Composite I/O port that loops the data back into the NX64A unit. It is nearly identical to the internal digital loopback (above), but this will test the data interface card in a remote loopback test.

2.3.2.1 Local Loopback Testing

Local Loopback testing is a simple method of verifying the performance of a single NX64A unit. Refer to Figure 2-3 (Local Loopback Test Setup) for more information.

Digital Loopback can verify:

- The data interface card is working properly.
- The external mux equipment is communicating with the NX64A.

Analog Loopback can verify:

- The NX64A modem is working properly.

RF Loopback can verify:

- The entire system, including the transmitter and receiver modules, are working properly.

Analog or Digital Loopback Test Procedure:

<u>Required Equipment</u>:

Bit Error Rate Test set (BERT) set with the proper interface connection.
RF power termination (10 Watt min, 50 ohms, “dummy load”).

<u>Procedure</u>:

1. Place the modem into digital loopback (TEST menu) and set the BERT to the proper data rate.
2. Run the bit error rate test for one minute without receiving any errors.
3. Repeat this test using analog loopback in the NX64A.
4. After one minute no errors should be recorded.
5. If errors are recorded in either of these tests and proper connection and operation of the BERT test has been verified, call customer service for further instructions.

RF Loopback Test Procedure:

<u>Required Equipment</u>:

Bit Error Rate Test set (BERT) with the proper interface connection.
RF Turnaround Box that operates at the proper frequency and is low-noise (contact customer service for further information).

<u>Procedure</u>:

1. Disable the modem loopback (CLEAR in the TEST menu) and set the BERT to the proper data rate.
2. Run the bit error rate test for one minute without receiving any errors.
3. If errors are recorded in this test and proper connection and operation of the BERT test has been verified, call customer service for further instructions.

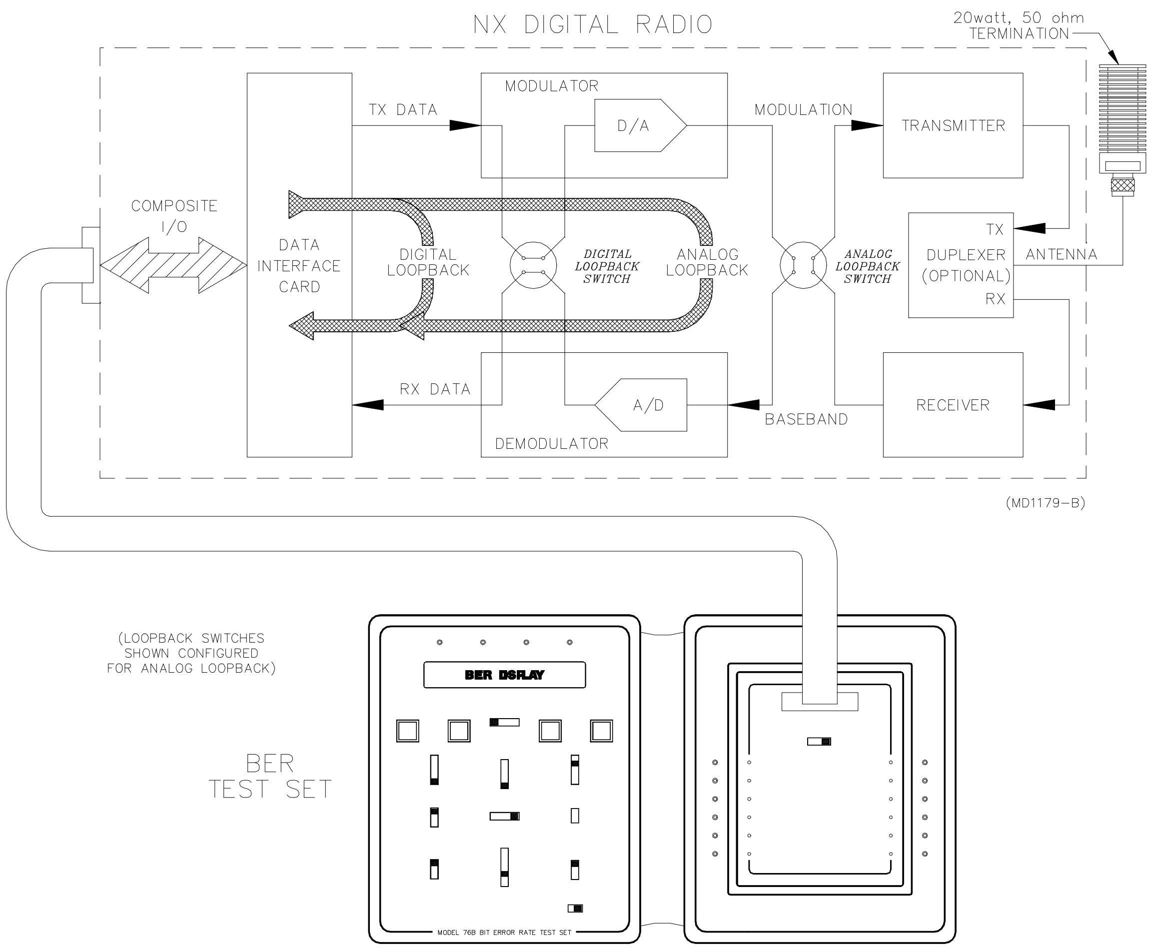

Figure 2-3
Local Loopback Test Setup

2.3.2.2 Remote Loopback (End-to-End) Testing

Remote Loopback testing is a method of verifying the performance of a link (two or more units). In this test, the remote radio performs the loopback function, therefore returning data through to the local unit. Proper operation of the local unit should be verified prior to performing this test. These tests can be performed on the bench before installation (End-to-End), or across an actual RF link after installation. Refer to Figure 2-4 (Remote Loopback Test Setup) for more information.

Digital Loopback can verify:

- The remote RF portion of the link is working properly.

Hardwire Loopback can verify:

- The entire system, including the transmitter and receiver modules, are working properly.

Digital Loopback Test Procedure:

Required Equipment:

Bit Error Rate Test set (BERT) set with the proper interface connection.
RF power termination (10 Watt min, 50 ohms, "dummy load").

Procedure:

1. Place the modem into digital loopback (TEST menu) and set the BERT to the proper data rate.
2. Run the bit error rate test for one minute without receiving any errors.
3. If errors are recorded in this test and proper connection and operation of the BERT test has been verified, call customer service for further instructions.

RF Loopback Test Procedure:

Required Equipment:

Bit Error Rate Test set (BERT) with the proper interface connection.
RF Turnaround Box that operates at the proper frequency and is low-noise (contact customer service for further information).

Procedure:

1. Disable the modem loopback (CLEAR in the TEST menu) and set the BERT to the proper data rate.
2. Run the bit error rate test for one minute without receiving any errors.
3. If errors are recorded in this test and proper connection and operation of the BERT test has been verified, call customer service for further instructions.

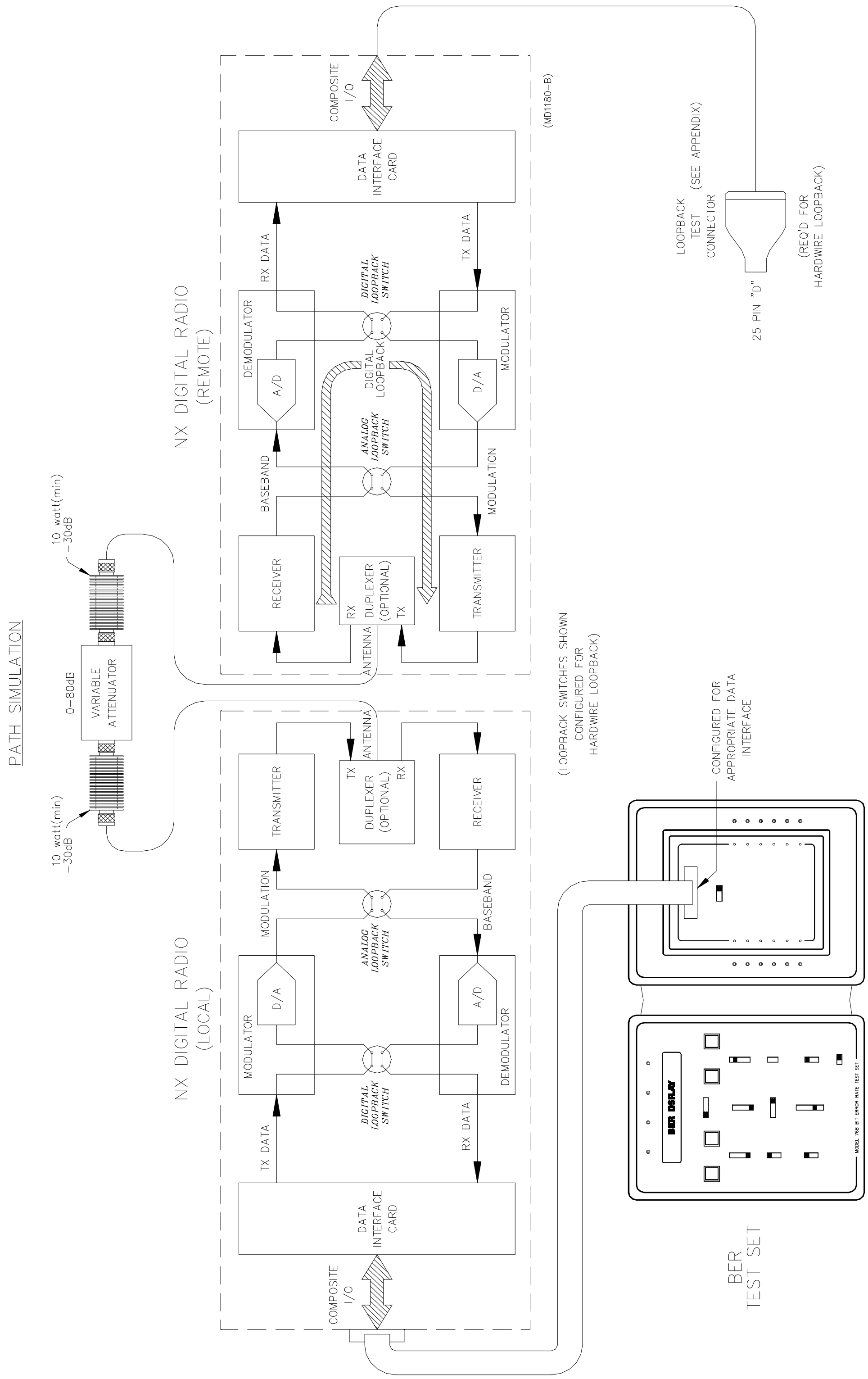

Figure 2-4
Remote Loopback Test Setup

2.4 Interconnection to Other Equipment

This section describes typical interconnections to some external equipment that has been tested and verified. Be careful to note that other manufacturer's equipment may be different than what is referenced here, therefore please refer to all applicable operating manuals for current configurations.

2.4.1 Timing

Incorrect timing and clock settings are the most common causes of all system problems concerning non-synchronization of data and clock contention. It is most important to understand the system requirements and to be able to resolve timing conflicts when dealing with equipment from different manufacturers. Some familiarity with industry terminology is helpful when confronted with timing problems.

All of the equipment should be synchronized to the same timing source. Otherwise, data errors can occur. The user must determine which unit will provide the system clock. When interconnecting and synchronizing various pieces of equipment, it is often helpful to ask two simple questions:

Which piece of equipment is supplying the clock?

Which piece of equipment is receiving the clock?

Figure 2-5 below shows a conceptual diagram of the NX64A modem internal data/clock timing. The external Composite I/O connections are on the left. Note that the demodulator is always synchronized to the recovered data. The RX CLK source only affects the output data synchronizer.

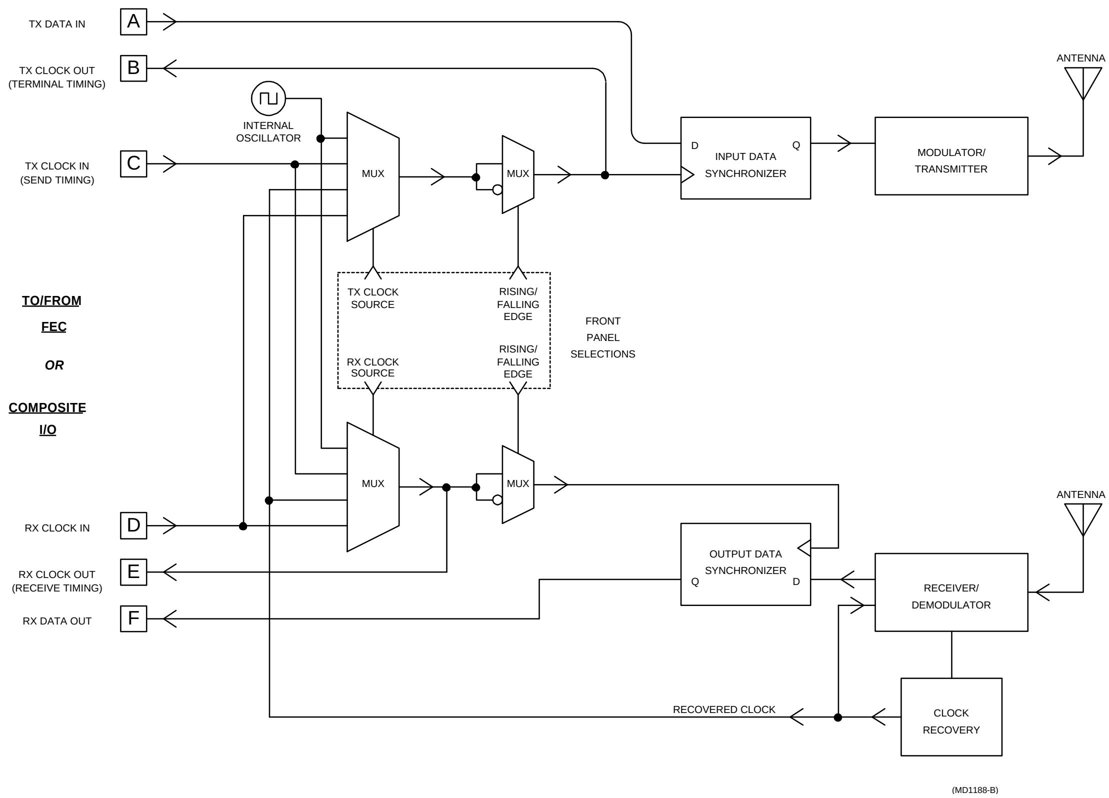

Figure 2-5
Conceptual Diagram
NX64A Modem Internal Data/Clock Timing

Figure 2-6 below shows a conceptual diagram of the NX64A FEC internal data/clock timing. Note that when the FEC option is installed in the unit, the Composite I/Os labeled A through F in Figure 2-5 are connected to FEC board as shown in Figure 2-6.

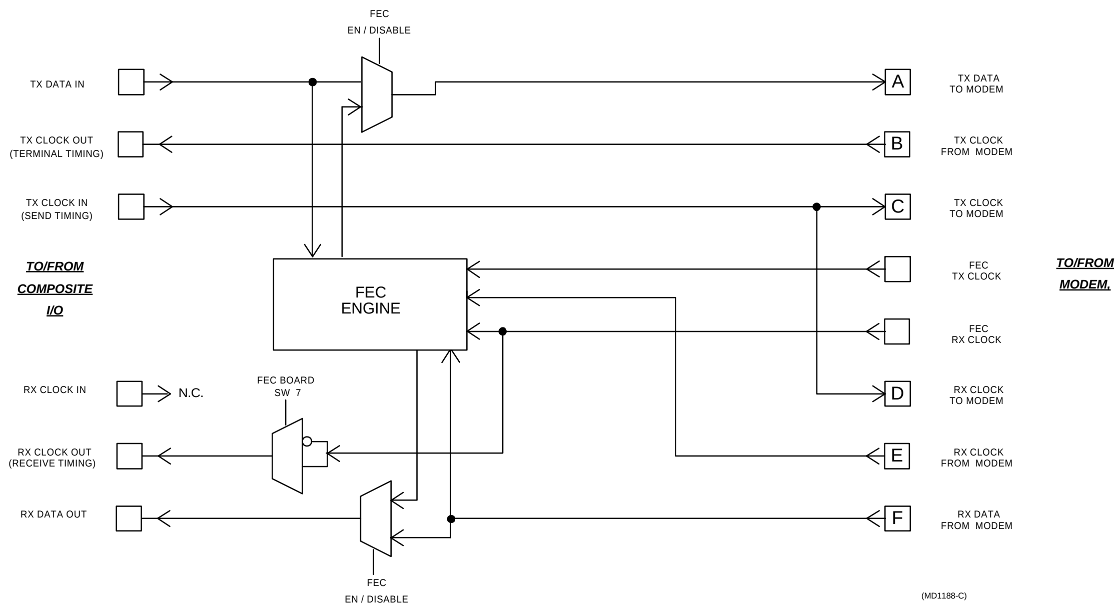

Figure 2-6
Conceptual Diagram
NX64A FEC Internal Data/Clock Timing

Figure 2-7 below shows a situation where the local NX64A is supplying the master clock for the whole system. The local and remote data terminal equipment (DTE) should both be configured to accept clocks from their respective NX64A.

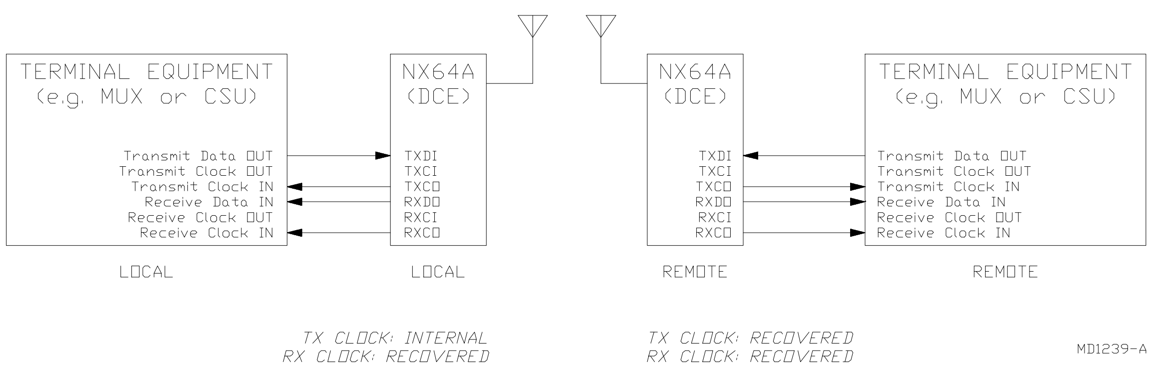

Figure 2-7
NX64A Data/Clock Timing. Example 1.

Figure 2-8 below depicts the local DTE as the “master” clock source. The local DTE can derive its clock internally, or alternately can derive its clock from connected sources or network timing. The local DTE supplies the transmit clock to the NX64A. In this diagram, the remote DTE should be set to accept the transmit clock from the NX64A and to supply (echo) a receive clock to the NX64A.

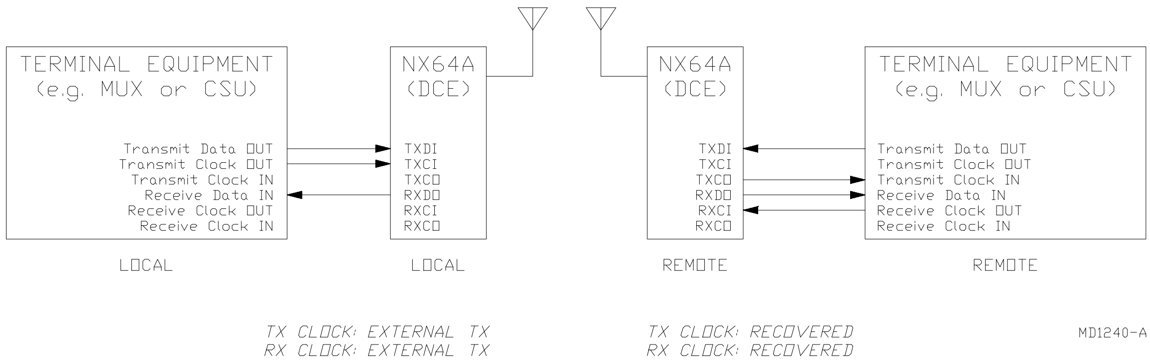

Figure 2-8
NX64A Data/Clock Timing. Example 2.

Figure 2-9 below illustrates some alternate clock connections when the local DTE is the "master" clock source. The local DTE should be configured to supply both a transmit clock and a receive clock to the NX64A. The remote DTE must be configured to accept either a transmit clock, a receive clock, or both.

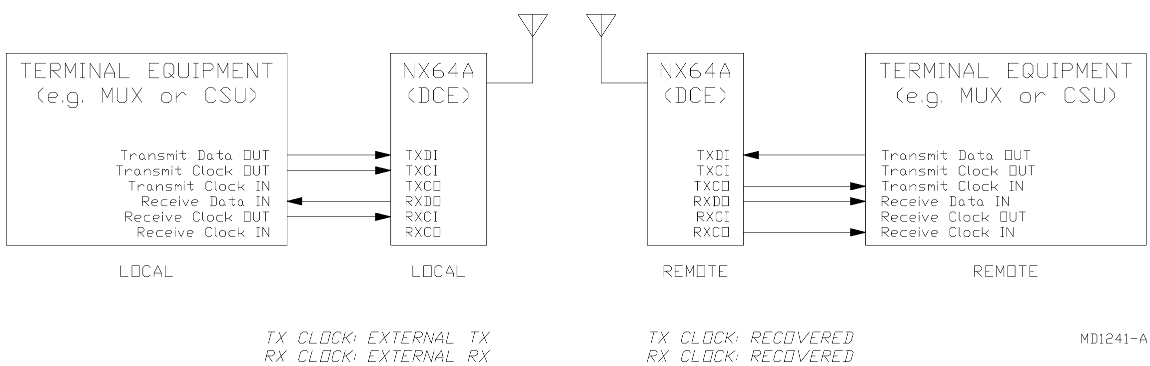

Figure 2-9
NX64A Data/Clock Timing. Example 3.

Figure 2-10 portrays a repeater configuration. In this situation, two NX64As are connected "back-to-back" to repeat the RF data. The NX64As are connected to each other via their COMPOSITE I/O with a "null modem" cable.

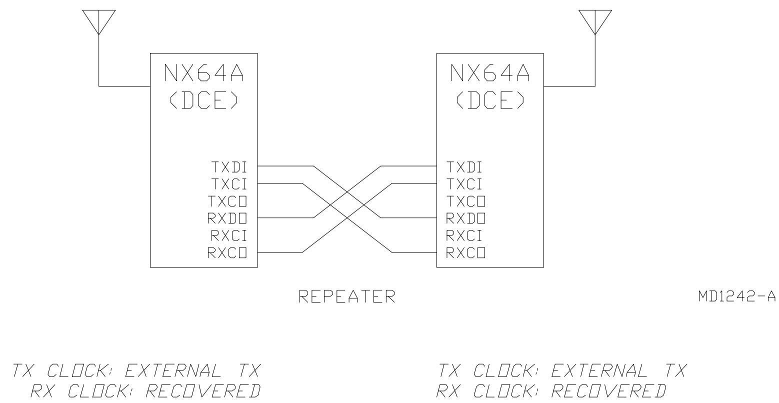

Figure 2-10
NX64A Data/Clock Timing. Example 4.

The previous examples do not represent every possible system configuration, but are intended to give the user enough information to be able to configure the system.

The NX64A requires definition of the source for the transmitter clock (TX CLK) and the receiver clock (RX CLK).

Transmitter Clock Source Options (TX CLK)

- **Internal Oscillator** The transmitter modem clock is synchronized to the NX64A internal system clock. In this case, the NX64A is now supplying the system clock to all connected components.
- **External TX Clock** The transmitter modem clock is synchronized to an externally generated clock, usually an external MUX that is interfacing to the NX64A. In this case, the NX64A is now receiving the system clock.
- **Recovered Clock** The clock is derived from the demodulated incoming bit stream in the receiver. A remote link will normally be set in this mode, as the remote receiver is deriving the system clock from the local NX64A transmitter via its incoming data.
- **External RX Clock** The transmitter is synchronized to an external source supplied to the receiver, usually the external MUX that is interfacing to the remote NX64A. (Same as external Tx Clock when FEC is installed.)

Transmitter Clock Phase

TX CLOCK must be configured for the proper clock phase (RISING EDGE or FALLING EDGE). This choice appears with the clock source, with no separate menu heading.

- **RISING EDGE** The radio/modem samples input data on the rising edge of the clock waveform. This is the normal setting. (Required for FEC enabled.)
- **FALLING EDGE** The radio/modem samples input data on the falling edge of the clock waveform.

Receiver Clock Source Options (RX CLK)

- **Internal Oscillator** The receiver output clock is synchronized to the NX64A internal system clock.
- **External TX Clock** The receiver output clock is synchronized to an externally generated clock supplied to the transmitter, usually the external MUX that is interfacing to the NX64A.
- **Recovered Clock** The receiver output clock is derived from the demodulated incoming bit stream in the receiver. All receivers in the link will normally be set in this mode.
- **External RX Clock** The receiver output clock is synchronized to an external source supplied to the receiver, usually the external MUX that is interfacing to the NX64A. (Same as external TX clock when FEC is installed.)

Note

The modem receiver clock is always synchronized to the Recovered Clock.

Receiver Clock Phase

RX CLOCK must be configured for the proper clock phase (RISING EDGE or FALLING EDGE). This choice appears with the clock source, with no separate menu heading.

- **RISING EDGE** The radio/modem output data changes state on the rising edge of the clock waveform.
- **FALLING EDGE** The radio/modem output data changes state on the falling edge of the clock waveform. This is the normal setting. (Required for FEC enabled.)

FEC Receiver Clock Phase

The FEC Receiver Clock Phase switch is located on the FEC board. The FEC RX CLOCK must be configured for the proper clock phase as determined by the connected equipment.

- **Switch 7 OPEN** Normal RX Clock Out Phase.
- **Switch 7 CLOSED** Inverted RX Clock Out Phase.

Normal Operation

The issue of setting the clocks can be simplified by considering the following settings for normal operation:

- **Local Transmitter** Supplies the system clock
  (TX CLK = INTERNAL OSC)
  <or>
  Receives the system clock
  (TX CLK = EXTERNAL TXC)
- **Remote Transmitter** Normally synchronized to the RECOVERED CLOCK
- **All Receivers in the chain** Normally synchronized to the RECOVERED CLOCK.

External Equipment

When the local transmitter is receiving the system clock, the external equipment must be set up to supply the clock to the NX64A. Refer to the appropriate owner's manual for details.

When the remote NX64A is synchronized to the RECOVERED CLOCK, the external equipment must be set up to receive the clock from the NX64A. Refer to the appropriate owners manual for details.

2.4.2 Repeater Connections

The NX64A can be used as a digital repeater. The typical clock and configuration settings for the equipment are detailed in Table 2-1. The digital connections are shown in Figure 2-11.

Table 2-1
NX64A Repeater Clock Settings

Parameter	**Setting**
TX CLK	External TXC Rising Edge
RX CLK	Recovered CLK Rising Edge

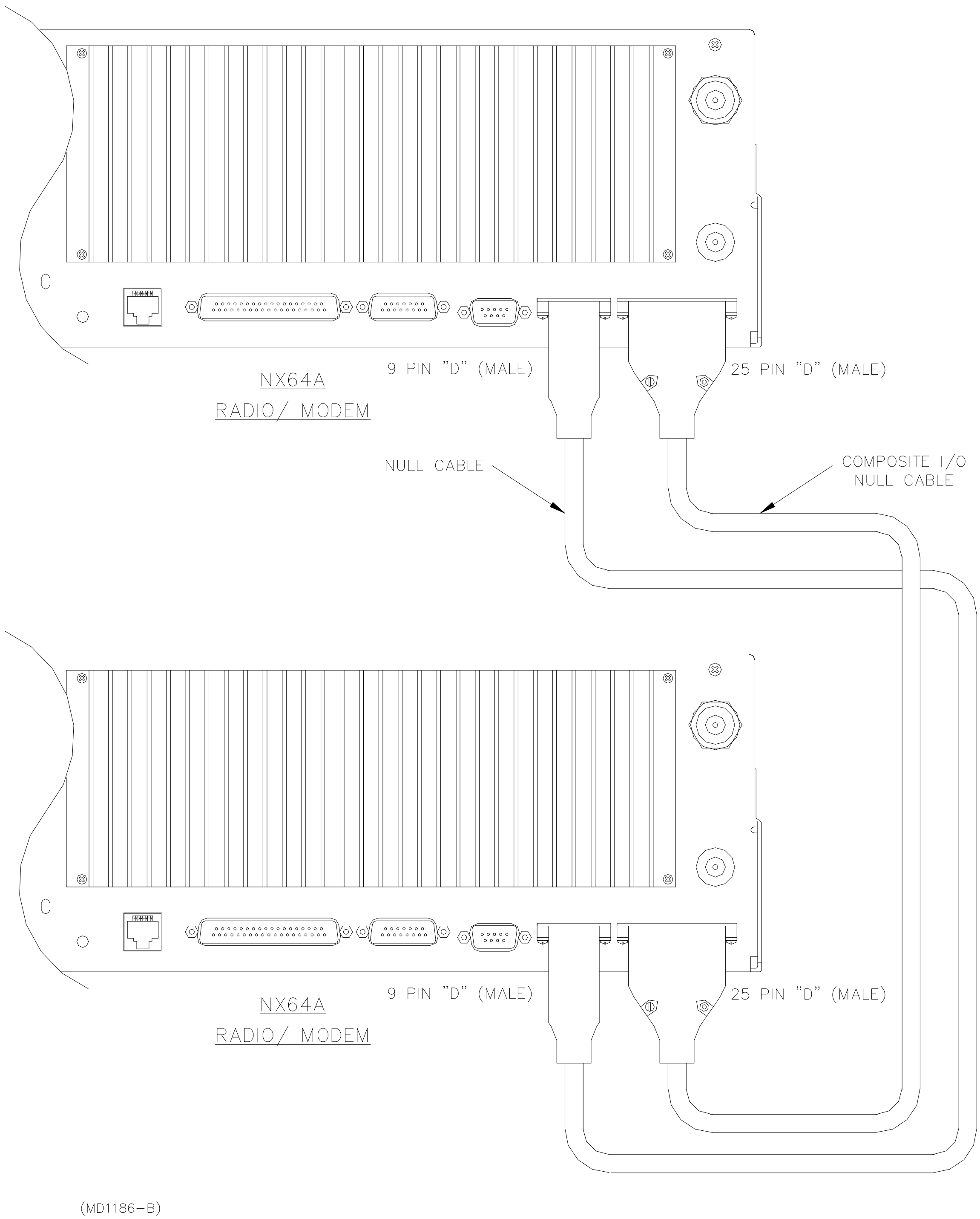

Figure 2-11
NX64A Repeater Interconnection

2.4.3 NX64A to SDM-T (ACT)

Interconnection of the NX64A with the SDM-T MUX, manufactured by ACT (Advanced Compression Technologies), is detailed in this section. Figure 2-12 shows a typical interconnection (V.35 or RS-449). The cable schematic can be found in the Appendix.

The typical clock and configuration settings for the equipment are detailed in Tables 2-2 (NX64A Source) and 2-3 (SDM-T Source).

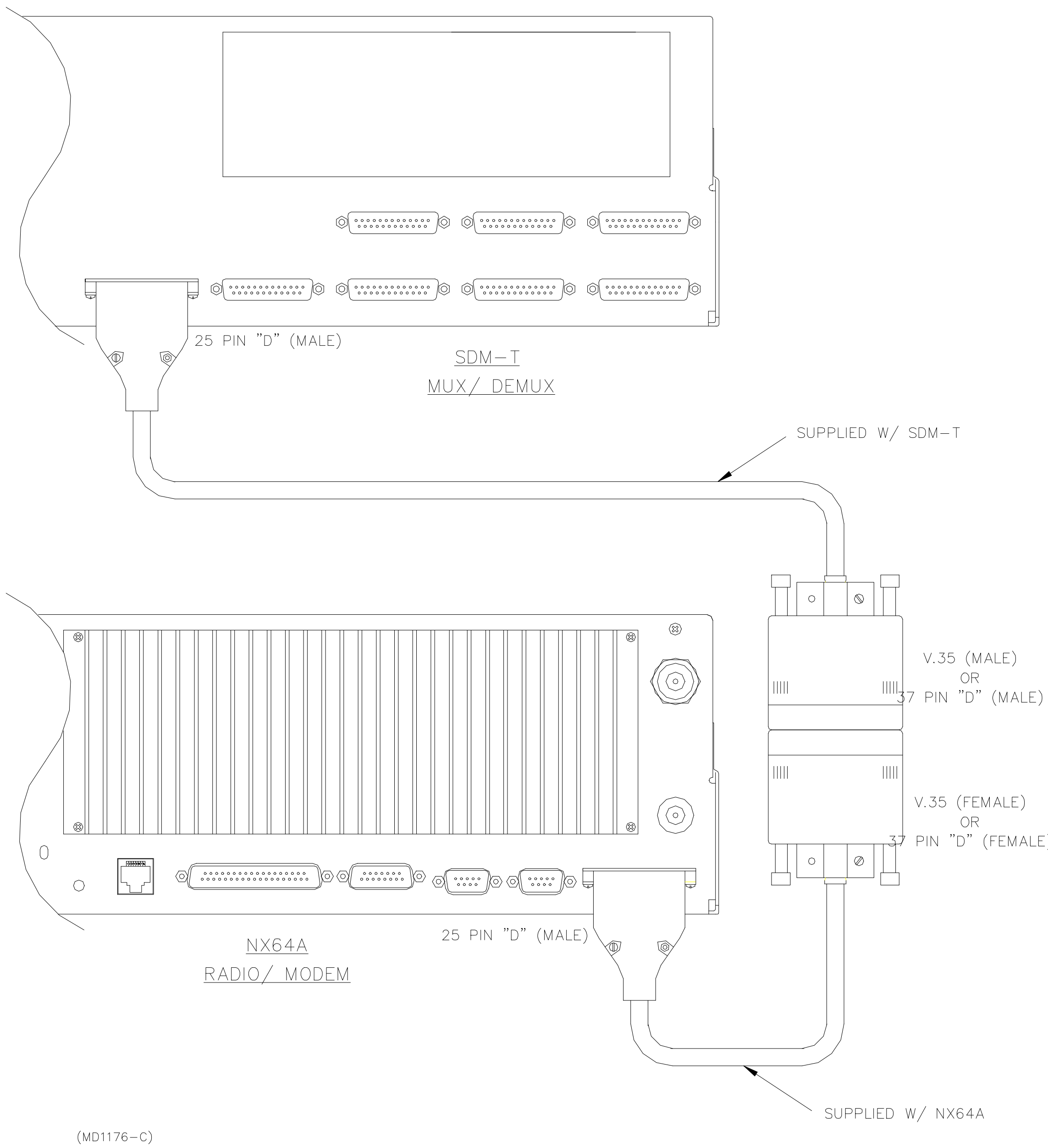

Figure 2-12
NX64A Interconnection to SDM-T

Table 2-2
Clock Settings - NX64A to SDM-T (NX64A Source)

SOURCE CLOCK = NX64A			
	PARAMETER	**“Master”**	**“Slaves”**
SDM-T:			
SYSTEM:	Local Unit	MASTER	SLAVE
	Slave Lock	xxx	xxx
	Super B/W	xxx	xxx
	Vcross	xxx	xxx
	Auto Reset	OFF	OFF
	Loc Ring	xxx	xxx
	Rem Ring	xxx	xxx
	C Code	xxx	xxx
	HS-DBA	xxx	xxx
	System Timing Source		
	Primary	LINK TXC	LINK TXC
	Fallback	---	---
LINK:	Clock	EXTERNAL	EXTERNAL
	Rate	xxx	xxx
	AutoBaud	OFF	OFF
	Framing	xxx	xxx
	Sat Hop Count	1	1
SDR-XX: (NX64A)	Tx Clk	INTERNAL OSC RISING EDGE	RECOV CLK RISING EDGE
	Rx Clk	RECOV CLK FALLING EDGE*	RECOV CLK FALLING EDGE*

note: xxx = don’t care
* 384 kbps: set to RISING EDGE

Table 2-3
Clock Settings - NX64A to SDM-T (SDM-T Source)

SOURCE CLOCK = SDM-T			
	PARAMETER	**“Master”**	**“Slaves”**
SDM-T:			
SYSTEM:	Local Unit	MASTER	SLAVE
	Slave Lock	xxx	xxx
	Super B/W	xxx	xxx
	Vcross	xxx	xxx
	Auto Reset	OFF	OFF
	Loc Ring	xxx	xxx
	Rem Ring	xxx	xxx
	C Code	xxx	xxx
	HS-DBA	xxx	xxx
	System Timing Source		
	Primary	LINK TXC	LINK TXC
	Fallback	---	---
LINK:	Clock	INTERNAL	EXTERNAL
	Rate	xxx	xxx
	AutoBaud	OFF	OFF
	Framing	xxx	xxx
	Sat Hop Count	1	1
SDR-XX: (NX64A)	Tx Clk	EXTERNAL TXC RISING EDGE	RECOV CLK RISING EDGE
	Rx Clk	RECOV CLK FALLING EDGE*	RECOV CLK FALLING EDGE*

note: xxx = don’t care
* 384 kbps: set to RISING EDGE

2.4.4 NX64A to Kilomux (RAD)

The NX64A interconnection with the Kilomux, manufactured by RAD Technologies, is detailed in this section. Figure 2-13 shows a typical interconnection (V.35). The cable schematic can be found in the Appendix.

The typical clock and configuration settings for the equipment are detailed in Table 2-4. Moseley does not recommend using the Kilomux as the clock source.

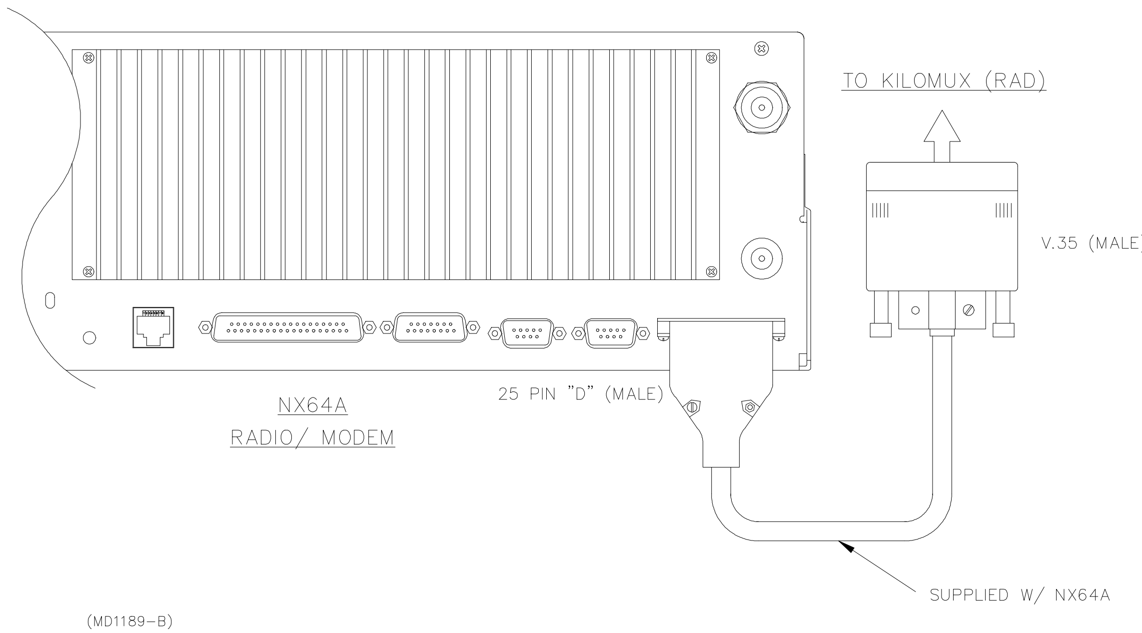

Figure 2-13
NX64A Interconnection to RAD Kilomux

Table 2-4
Clock Settings - NX64A to Kilomux

SOURCE CLOCK = NX64A		
	PARAMETER	**SETTING**
RAD KILOMUX: SYSTEM PARAMETER:	 DWLD_BW ML_MODE ACTIVE_ML	 NO SINGLE AUTO
TEST OPTION ML:	REMOTE LOOP	OFF
LINK PARAMETER:	SPEED TIMING BUFFER SIZE PSR & CTS	(same data rate as NX64A) DTE 8 INT
SP PARAMETERS:	SPEED DATA PARITY INTERFACE MANAGEMENT	AUTO 8 NO DCE NO
NX64A: CONFIGURATION (CLOCK SOURCE):	 Tx Clk Rx Clk	 INTERNAL OSC RISING EDGE RECOVERED FALLING EDGE

2.5 Standby Configuration-TP64

New Installation:

Normally, the TP64 is shipped with the Main and Standby radios per the customer order, and all of the settings are factory set for the system.

The external duplexer (external to the NX64A radio) will be mounted to the rear of the TP64 chassis and the appropriate frequencies will be marked for quick identification.

If using an internal duplexer (internal to the NX64A radio), it is probably a retrofit or temporary situation. See Section 2.3.1 for details.

The shielded ribbon Y-cable is included for making the data I/O connections to the radios.

Main/Standby Retrofit:

If the TP64 is to be installed in an existing site to convert a standalone unit to a main/standby, particular attention must be made to set up all of the parameters as discussed in this manual.

For an NX64A application, it may be more expeditious to send the units to Moseley for setup. Duplexer tuning (if required) must be carefully performed for optimum link performance.

2.5.1 Rack Installation

The TP64 Transfer Panel is normally mounted between the Main and Standby radios to allow the shortest possible lengths of transmission cable.

2.5.2 Power Supply

The TP64 main power (+12/+15 VDC) is supplied by the shielded DB9 (m-f) cable from both radios and therefore requires no external power connection. The Main and Standby radio supplies are summed internally in the TP64 so that if power from one radio fails, power to the TP64 will not be interrupted.

Turn on the internal supply of the TP64 by switching the rear panel power switch up. This supplies the internal electronics of the TP64. This switch should be left ON all the time.

Optionally, a wall-mount AC-DC power converter may be used for added back-up. The converter may also be useful for testing and troubleshooting. If you require an AC power converter, contact Moseley. Specify 115 Volt or 230 Volt when ordering. DC-DC converters may also be used, contact Moseley for availability.

2.5.3 Equipment Interconnection- NX64A

2.5.3.1 External Duplexer (*preferred)

The usual standby configuration uses an external duplexer. This minimizes RF losses and provides independent TX and RX module switching. A duplexer should already be mounted on the TP64 chassis. Alternatively, rack mounted duplexers (typical for tighter channel spacings) may be provided. The connections are the same, although the physical location is different.

A power divider (used to split the signal equally to two receivers) is required in this mode. The input to the power divider connects directly to the duplexer with an N-N (male) adapter.

See Figure 2-14 for installation details.

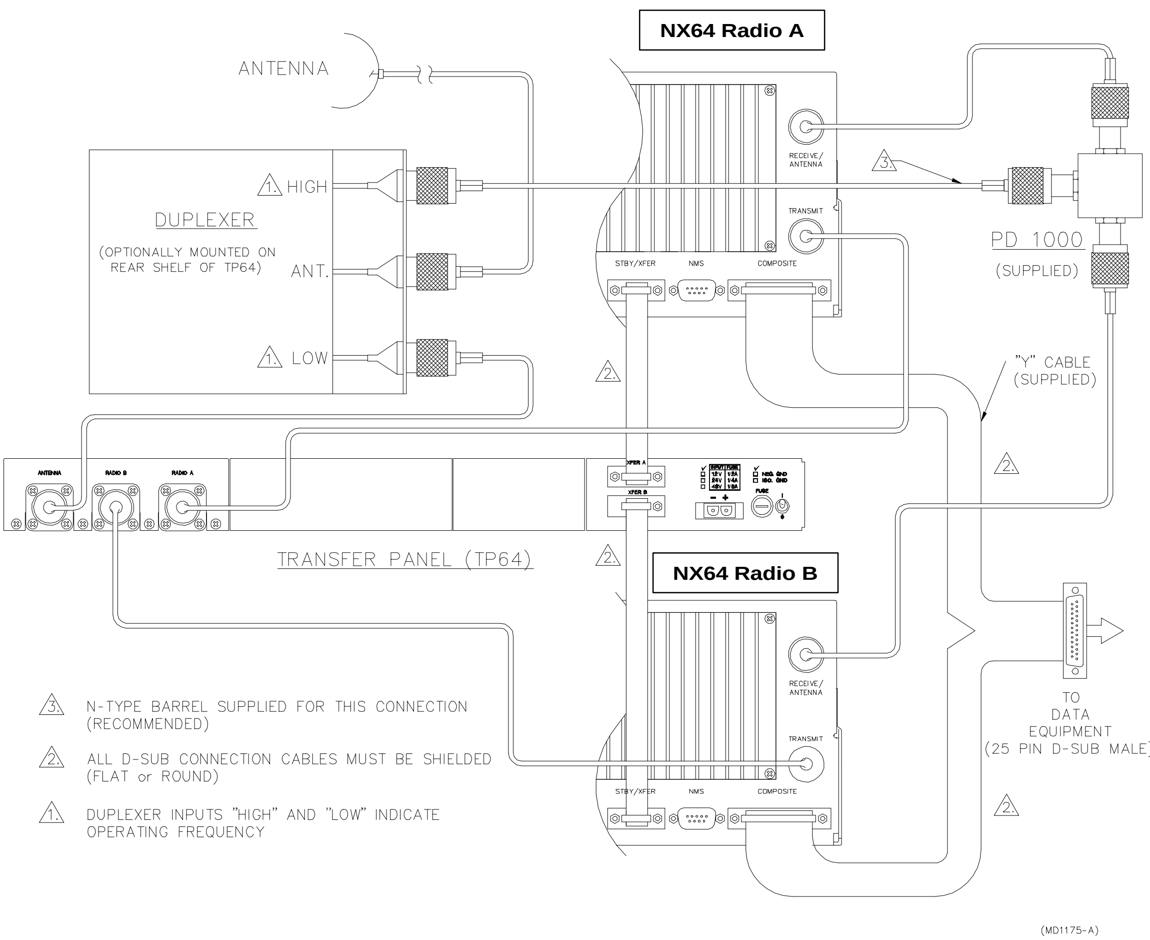

Figure 2-14
External Duplexer Configuration

2.5.3.2 Internal Duplexer

The internal duplexer configuration can be used, although it is not recommended for these reasons: higher RF losses, higher system costs, and reduced flexibility in redundant backup. In this mode, both the transmitter and receiver in one unit are "ganged" together in regards to switchover, since they are functionally "linked" by the internal duplexer.

A power divider is not required when using internal duplexers.

See Figure 2-15 for installation details.

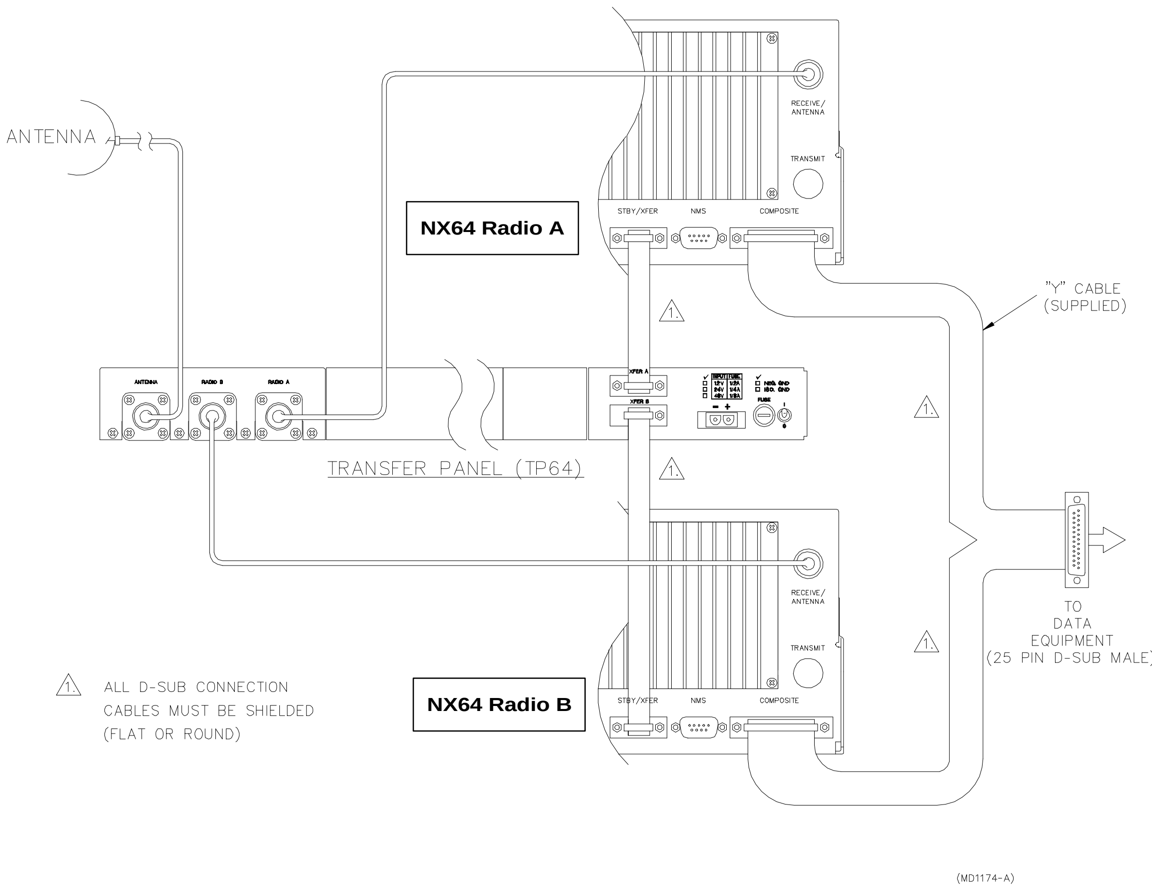

Figure 2-15
Internal Duplexer Configuration

2.5.4 Hot/Cold Standby Modes

2.5.4.1 Hot Standby *(*preferred)*

Hot standby leaves both transmitters in the RADIATE ON condition, and the TP64 controls the RF relay to select the active transmitter, thereby decreasing switchover time. This is the preferred operating mode.

2.5.4.2 Cold Standby

Cold standby can be used in situations where low power consumption is a priority. In this mode, the TP64 will control the RADIATE function of each transmitter, turning the RF output ON (in tandem with the RF relay) as required for switching. This will increase switching time and a corresponding increase in data loss during the switchover.

2.5.5 NX64A Receiver Operation

The two receivers in any NX64A standby configuration are always ON (i.e., receiving). The operational difference between a redundant standby and a standalone unit is in how the output data is switched.

The data and clock lines are physically wired together through the shielded ribbon cable connected to the NX64A composite I/O ports. The TP64 instructs the standby receiver to turn off (or “tri-state”) its data and clock outputs so that there is no collision with the active receiver. This function is activated by the RX XFER setting in the menus.

2.5.6 TP64 Front Panel Controls and Indicators

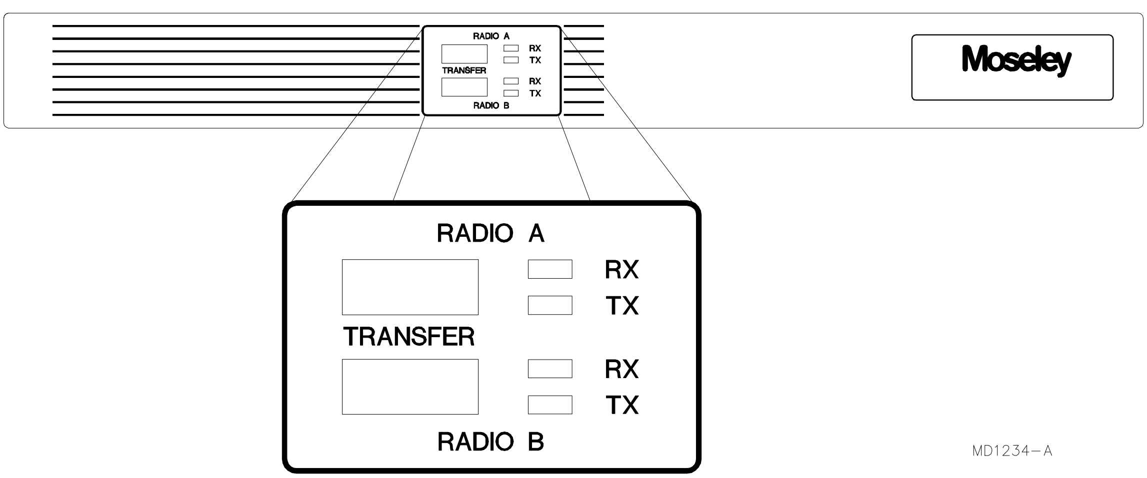

Figure 2-16
TP64 Front Panel

2.5.6.1 LED Indicators

Green: The indicated module is active, and that the module is performing within its specified limits.

Yellow: The indicated module is in standby mode, ready and able for back-up transfer.

Red: There is a fault with the corresponding module. It is not ready for backup, and the TP64 will not transfer to that module.

2.5.6.2 TRANSFER Switches

The RADIO A and RADIO B transfer switches cause the selected radio to become *active*, and the *Master*.

2.5.7 Master/Slave Operation & LED Status

The TP64 operates in a Master/Slave logic mode. In the power up condition, the Master is RADIO A. This means that RADIO A is the default active unit. The following logic applies to hot or cold standby, external or internal duplexer configurations.

> *Note: For the internal duplexer NX64A configuration, the TX and RX modules will switch in tandem with each other, but the A/B Master/Slave logic is the same.*

Table 2-5
TP64 Transmitter Master/Slave Logic

	Selected Master	TXA Status	TXB Status	TXA LED	TXB LED	Active TX	TX Relay Position
A-Master Logic	A	OK	OK	GRN	YEL	A	A
	A	OK	FAIL	GRN	RED	A	A
	A	FAIL	OK	RED	GRN	B	B
	A	FAIL	FAIL	RED	RED	N/A	A
B-Master Logic	B	OK	OK	YEL	GRN	B	B
	B	OK	FAIL	GRN	RED	A	A
	B	FAIL	OK	RED	GRN	B	B
	B	FAIL	FAIL	RED	RED	N/A	B

Table 2-6
TP64 Receiver Master/Slave Logic

	Selected Master	RXA Status	RXB Status	RXA LED	RXB LED	Active RX	RX Data & Clk
A-Master Logic	A	OK	OK	GRN	YEL	A	A
	A	OK	FAIL	GRN	RED	A	A
	A	FAIL	OK	RED	GRN	B	B
	A	FAIL	FAIL	RED	RED	N/A	None
B-Master Logic	B	OK	OK	YEL	GRN	B	B
	B	OK	FAIL	GRN	RED	A	A
	B	FAIL	OK	RED	GRN	B	B
	B	FAIL	FAIL	RED	RED	N/A	None

A-Master Logic (default power-up):

If RADIO A is “good”, the TP64 will remain in RADIO A position, regardless of RADIO B’s status.

If RADIO A fails, the TP64 will switch to RADIO B (assuming that RADIO B is “good”)

If RADIO A then returns to a “good” condition, the TP64 will switch back to RADIO A (the default Master)

Manual Switchover to B-Master Logic:

The front panel switch on the TP64 can be used to manually force the system to a new Master.

By pressing the RADIO B button, RADIO B now becomes the Master, and the TP64 will switchover to RADIO B (assuming that RADIO B is “good”).

The default A-Master Logic will then switch to B-Master Logic, as outlined in Tables 2-5 and 2-6.

> *Note: Manual switching of the Master is often used to force the system over to the standby unit. The user may want to put more "time" on the standby unit after an extended period of service.*
> *In Hot Standby configurations, this will not buy the user anything in terms of reliability. In a Cold Standby, the "burn time" is more significant, since the RF power amplifier device operating life becomes a factor.*

2.5.8 Software Settings

The full array of available settings for the Control and Configuration menus are located in Section 3 of the NX64A User Manual. Shown here are the applicable settings for redundant standby systems.

2.5.8.1 NX64A Clock Settings

For proper operation, the clock settings (located in the Configuration Menu/Clock Source/TX Clk Menu) must be set as follows:

NEAR END of the link:

TX CLK- EXTERNAL TXC

***RISING or FALLING EDGE (system dependent)**

RX CLK- RECOVERED or EXTERNAL TXC (system dependent)

RISING or *FALLING EDGE (system dependent)

**default*

FAR END of the link:

TX CLK- EXTERNAL TXC

***RISING or FALLING EDGE (system dependent)**

RX CLK- RECOVERED or EXTERNAL TXC (system dependent)

RISING or *FALLING EDGE (system dependent)

**default*

2.5.8.2 NX64A Control Settings

These settings configure the unit for hot (or cold) standby, and set the receiver for transfer mode.

It is important that each NX64A unit in the redundant pair is configured identically for proper operation.

Controls #1

TX CONTROL:

XFER: Configures the unit for HOT or COLD STANDBY operation, depending on the setting of TX XFER (next line in menu).

TX XFER: **(select per system requirement)**

HOT: Configures the unit for HOT STANDBY operation.**(preferred)*

COLD: Configures the unit for COLD STANDBY operation.

TX STATUS: **(shown in this menu for ease of use)**

RADIATE: Indicates the transmitter is ON and radiating

OFF: Indicates the transmitter is OFF

Controls #2

RX XFER:

ON: Receiver is in transfer mode, allowing data outputs to be controlled (tri-state buffers)

2.6 Site Installation

The installation of the NX64A involves several considerations. A proper installation is usually preceded by a pre-installation site survey of the facilities. The purpose of this survey is to familiarize the customer with the basic requirements needed for the installation to go smoothly. The following are some considerations to be addressed (refer to Figure 2-17 for Site Installation Details).

Before taking the NX64A to the installation site verify that the digital interface module installed is compatible with the interface of the equipment to be connected. Also, locate the information provided by the path analysis which should have been performed prior to ordering the equipment. At the installation site, particular care should be taken in locating the NX64A in an area where it is protected from the weather and as close to the antenna as possible. Locate the power source and verify that it is suitable for proper installation.

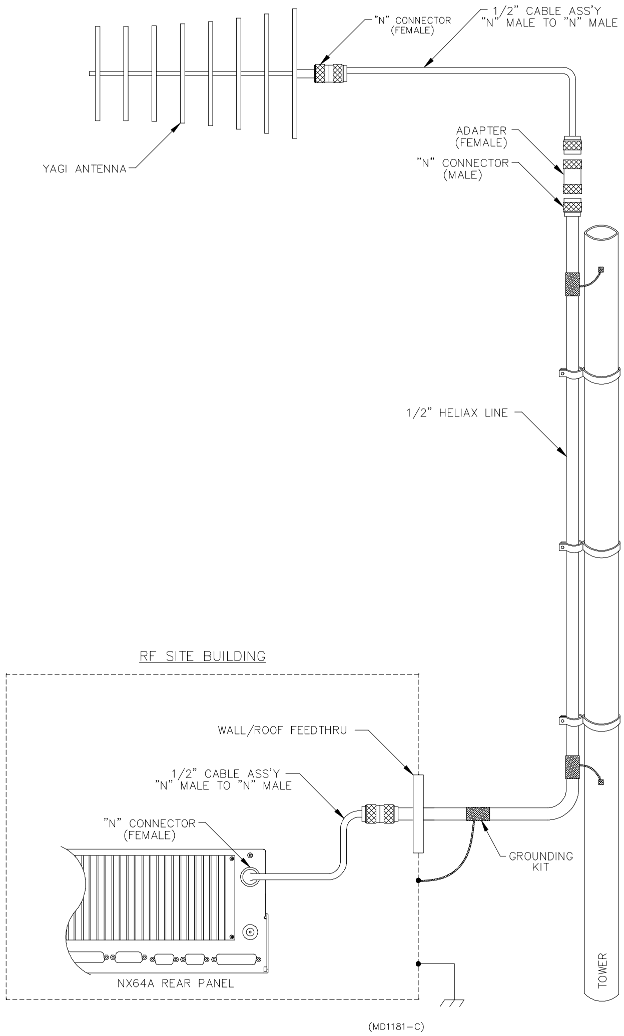

Figure 2-17
Site Installation Details

2.6.1 Physical and Environmental Considerations

The site selected to house the NX64A should follow conventional microwave practice and should be located as close to the antenna as possible. This will reduce the RF transmission line losses to a minimum and will allow for the full range potential of the NX64A. In addition, potential problems encountered with long runs of transmission line, such as bending and kinking in normal electrical conduit and raceways, will be eliminated.

The building or room chosen for installation should be free from excessive dust and moisture. The area should not exceed the recommended temperature range and should provide ready access to PPT/Telco and data cabling. The installation location should allow for ample air flow. Also, allow extra room for service access to cables and wiring.

2.6.2 Power Requirements

The NX64A is adaptable to power sources found worldwide. Verify that the power system used at the installation site provides a proper earth ground. Additionally, verify that the power supply option of the NX64A matches the voltage provided by the facility where the equipment will be located. The source should be stable as well as having lightning protection breakdown devices. If the power source is unpredictable, consider using battery power with a float charger for more reliable operation.

2.6.3 RF Connections

All RF connections should be made with low loss transmission line using the shortest distance possible between the NX64A and the antenna system. All connections should be first wrapped with Scotch #70 tape to form a water-tight seal and then wrapped with Scotch #88 tape to provide mechanical protection. Note that the tape ends should be cut rather than torn. A torn end will unravel and work itself loose in the wind.

2.6.4 Data Connections

The electrical interface between the NX64A and the connected DTE equipment can optionally conform to RS-232, RS-449, V.35, EIA-530, or G.703 specifications. RS-232 connections are not recommended because of the higher data rate used. Normally, the balanced interfaces (RS-449 and V.35) can accommodate cable lengths of up to 1500 feet or more. Please note that the cables should provide shielded twisted pairs.

2.6.5 Rack Mount Installation

The NX64A is designed for mounting in standard 19” rack cabinets, using the brackets (“rack ears”) included with the NX64A. The rack ear kit is designed to allow flush mount or telecom-mount (front extended). See Figure 2-18 for bracket installation.

If the rack will accept chassis rack slides, their use is recommended. The sides of the NX64A chassis have built-in mounting nuts for Chassis Trak C-300-5-1-14 rack slides. If slides are used, be sure to leave at least a 15-inch service loop in all cables to the equipment, and install a stop to prevent the unit from sliding completely through the rack.

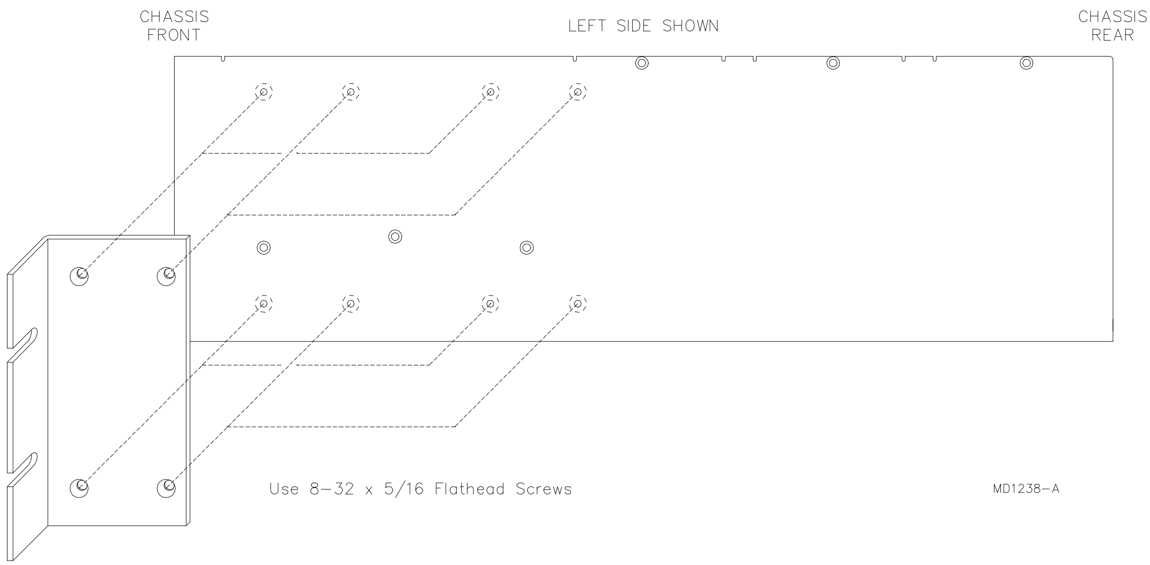

Figure 2-18
Rack Mount Bracket Installation
(Brackets may also be reversed)

2.7 Antenna/Feed System

2.7.1 Antenna Installation

The path analysis study will determine how high the antenna system must be mounted for proper operation. The antenna should be tightly bolted on to a fixed structure. Dual antenna installations not using a duplexer with the NX64A should be cross polarized and separated vertically by at least 40 feet to achieve as much isolation between the transmitter and receiver as possible.

The antenna is usually mounted on a pipe mount or tower, on top of a building, on a tower adjacent to building where the NX64A is installed, or on some structure that will provide the proper elevation. If the tower or antenna mounting mast is to be mounted on a building, an engineer should be consulted to be sure that the structure will support the system in the presence of high winds and ice. The antenna support structure must be able to withstand high winds, ice, and rain without deflecting more than one tenth of a degree. The optimum elevation is determined by the path analysis study. Information on how to perform a site survey and path analysis can be found in the System Planning and Engineering Section (see Section 5).

The antennas used as part of the NX64A system are directional; that is, the energy radiated from an antenna is focused into a narrow beam by the antenna and transmitted toward the other antenna at the remote site. The actual type of antenna used in a particular installation will depend on frequency band and antenna gain requirements. These parameters are determined by the path analysis for each installation.

Mount the antenna onto its mounting structure but do not completely tighten the mounting bolts at this time. The antenna will need to be rotated in the horizontal plane during the path aligning process.

2.7.2 Transmission Line Installation

Run the transmission line in such a manner as to protect it from damage. Note that heliax transmission line requires special handling to keep it in good condition. Particularly, it should be unreeled and laid out before running it between locations. It cannot be pulled off the reel the same way as electrical wire. Protect the line where it must run around sharp edges to avoid damage. A kinked line indicates damage, so the damaged piece must be removed and a splice installed to couple the pieces together.

2.7.3 Testing

After running the transmission line and fastening it in place, connect the antenna end of the transmission line to the antenna feed line, using a short coaxial jumper and a double female barrel adapter. Connect the radio end of the transmission line to a wattmeter (with appropriate frequency and power rating), using the radio feed line and another coaxial jumper (see Figure 2-19). Power-up the radio.

Observe forward power, and check that reverse power is negligible. Turn off power to the radio.

Exchange the wattmeter with the barrel adapter and coaxial jumper at the antenna end of the transmission line. Power-up the radio.

Observe forward power to the antenna, and verify that power loss in the transmission line is within system specifications. Verify that reflected power from the antenna is negligible. Reflected power should be less than 5% of the forward value, and in most cases will be significantly less.

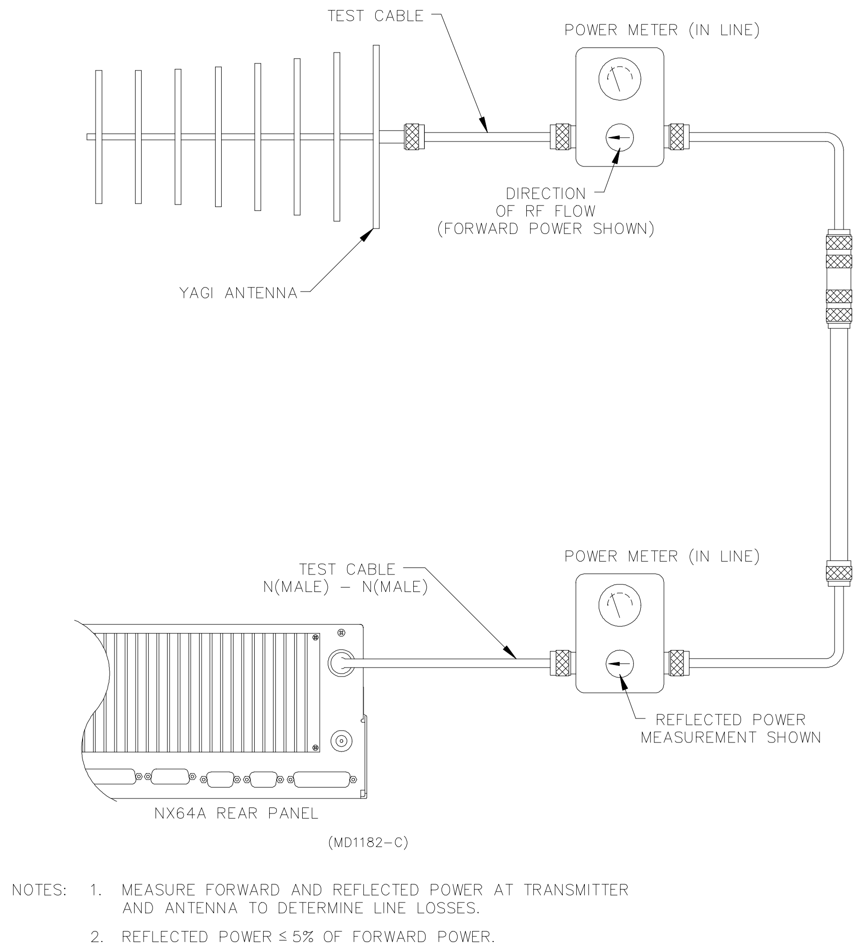

Figure 2-19
Antenna/Feed System Testing

2.7.4 Environmental Seals

The connections at the antenna and the transmission line must be weather-sealed. This is best accomplished by completely wrapping each connection with Scotch #70 tape (or equivalent), pulling the tape tight as you wrap to create a sealed boot. Then, for mechanical protection over the sealed layer, completely wrap the connection again with Scotch #88 (or equivalent). When properly done, this procedure will keep water out of the connectors and will help keep your system operational.

Tape ends must be cut rather than torn—a torn end will unravel and work loose in the wind. Use plenty of tape for cheap insurance against water penetration and the premature cost of replacing the transmission line.

After assuring that the NX64A is properly mounted attach the transmission line to the "N" connector labeled ANTENNA on the rear of the NX64A. Tighten the connector by hand until it is tight. Connect the short RS-449 or V.35 conversion cable to the 25 pin connector on the rear of the NX64A marked COMPOSITE. Screw this connector firmly in place. Connect the cable coming from the DTE to the other end of the conversion cable. Note that the DTE cable must be configured to interconnect to the NX64A, which is a DCE device. If the attached device is also a DCE device, such as the SDM-T, a proper crossover cable must be used.

Power may now be applied to the NX64A.

2.8 Link Alignment

This is very important because if the antennas are not aimed accurately at each other the system may not operate. At initial installation, attempt to determine rough points by map and compass. After installation, align the antennas accurately by accessing the **Rx Status #1** menu and observe the **Rx Signal** level in dBm. Use a helper to establish communications between the radio and antenna sites; and then turn the antenna in small amounts until the maximum signal is displayed. Please note that the signal levels should agree with the initial path calculations plus or minus 6 dBm, or there may be a problem with antenna alignment or the antenna system. Then tighten the bolts to hold the antenna securely.

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Section 3

Operation

Section	**Contents**	**Page**

Continued on the following page…

3.1 Introduction

The Operation section describes the front panel operation of the NX64A digital radio/modem.

- **Section 3.2** Introduces the NX64 front panel LCD display, status indicators, and cursor buttons. Table 3-1 lists the status indicators and their meanings.
- **Section 3.3** Introduces the NX64A screen menus with a very useful flow diagram (Figure 3-2).
- **Section 3.4** Shows each NX64A menu as it appears on the LCD display, summarizes the purpose of every accessible parameter, and provides relevant details in tabular form. The menus are presented in their categories: Control, Status, Configuration, and Test. “Limited Access” menus are included for reference, but a detailed explanation of those functions are located in the Technical Service Manual.

3.2 Front Panel Operation

This section introduces the NX64A front panel LCD display, status indicators, and cursor buttons. The front panel display is shown in Figure 3-1 below. Table 3-1 lists the status indicators and their meanings.

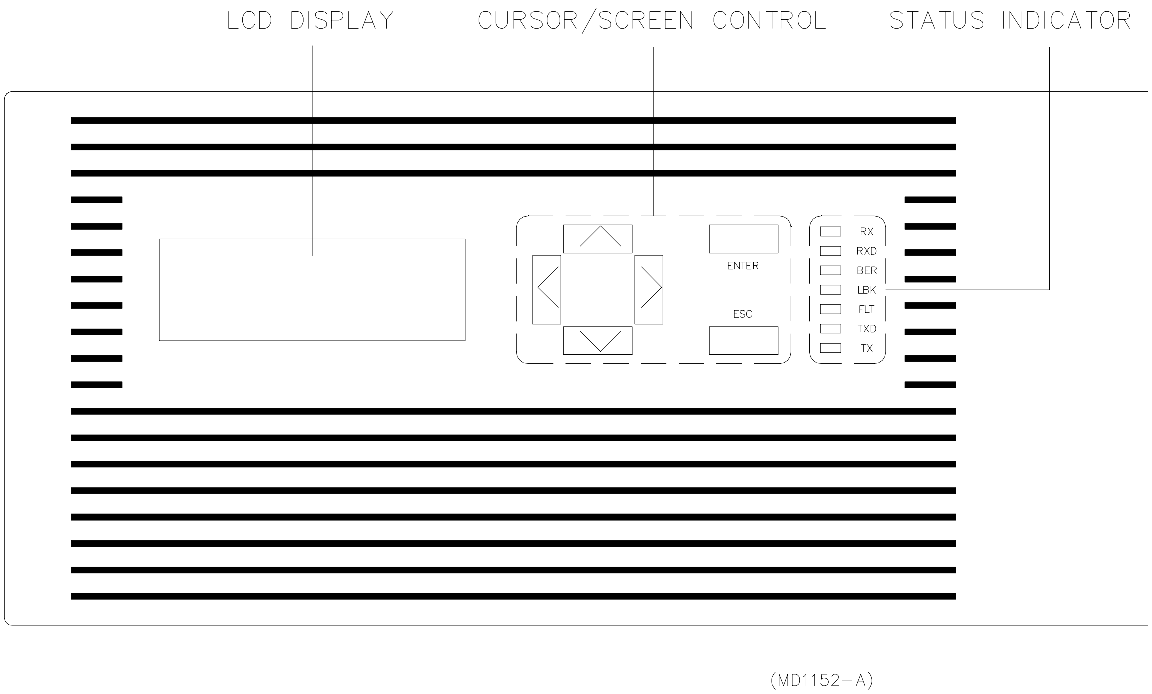

Figure 3-1
Front Panel Display and Controls

3.2.1 LCD Display

The Liquid Crystal Display (LCD) on the NX64A front panel provides user interface and status information. Potentiometer R501, located within the NX64A on the CPU/MODEM board, adjusts display contrast. The various menu screens relating to the main system menus (**CONTROL**, **STATUS**, **CONFIGURATION**, and **TEST**) are explained in detail later in this section.

3.2.2 Cursor and Screen Control Buttons

Six buttons on the NX64A front panel are used for LCD interface and control functions:

<**ENTER**>	Used to accept an entry (such as a value, a condition, or a menu choice).
<**ESC**>	Used to “back up” a level in the menu structure without saving any current changes.
<**UP**>,<**DOWN**>	Used in most cases to move between the menu items. If there is another menu in the sequence when the bottom of a menu is reached, the display will automatically scroll to that menu.
<**LEFT**>,<**RIGHT**>	Used to select between conditions (such as ON/OFF, ENABLED/DISABLED, LOW/HIGH, etc.) as well as to increase or decrease numerical values.

3.2.3 Status Indicators

There are seven status indicator LEDs on the NX64A front panel. Their functions are listed in Table 3-1 below.

Table 3-1
LED Status Indicator Functions

LED	Name	Function
RX	Receiver	Green indicates that the receiver is enabled, the synthesizer is phase-locked, and a signal is being received.
RXD	Receive Data	Green indicates that valid data is being received.
BER	Bit Error Rate	Flashes red for each data error detected.
FLT	Fault	General fault light (red). Consult the STATUS menus for out of tolerance conditions.
LBK	Loopback	Red indicates analog or digital loopback is enabled.
TXD	Transmit Data	Green indicates the modem clock is phase-locked and data is being sent.
TX	Transmitter	Green indicates the transmitter is radiating, and the RF output (forward power) is above the factory-set threshold.

3.3 Screen Menu Overview

The screen menu flow diagram in Figures 3-2 provides a graphic representation of the entire LCD display menu structure.

Generally, <**ENTER**> will take you to the next screen from a menu choice, and <**UP**> or <**DOWN**> will scroll through screens within a menu choice (#1, #2, etc.). Exceptions to this are noted in Section 3.5, Menu Reference Information.

The limited access, or hidden, menus are shown in the menu structure, although these functions are normally accessed only for troubleshooting or repair.

At power-up or reset, the following main menu appears:

```
  NX-64(FEC)    vX.XX
       Main Menu
*CONTROLS  CONFIGURE
STATUS     TEST
```

In the upper right corner, “vX.XX” indicates the current version of the software resident in the processor memory. The asterisk shows the cursor location.

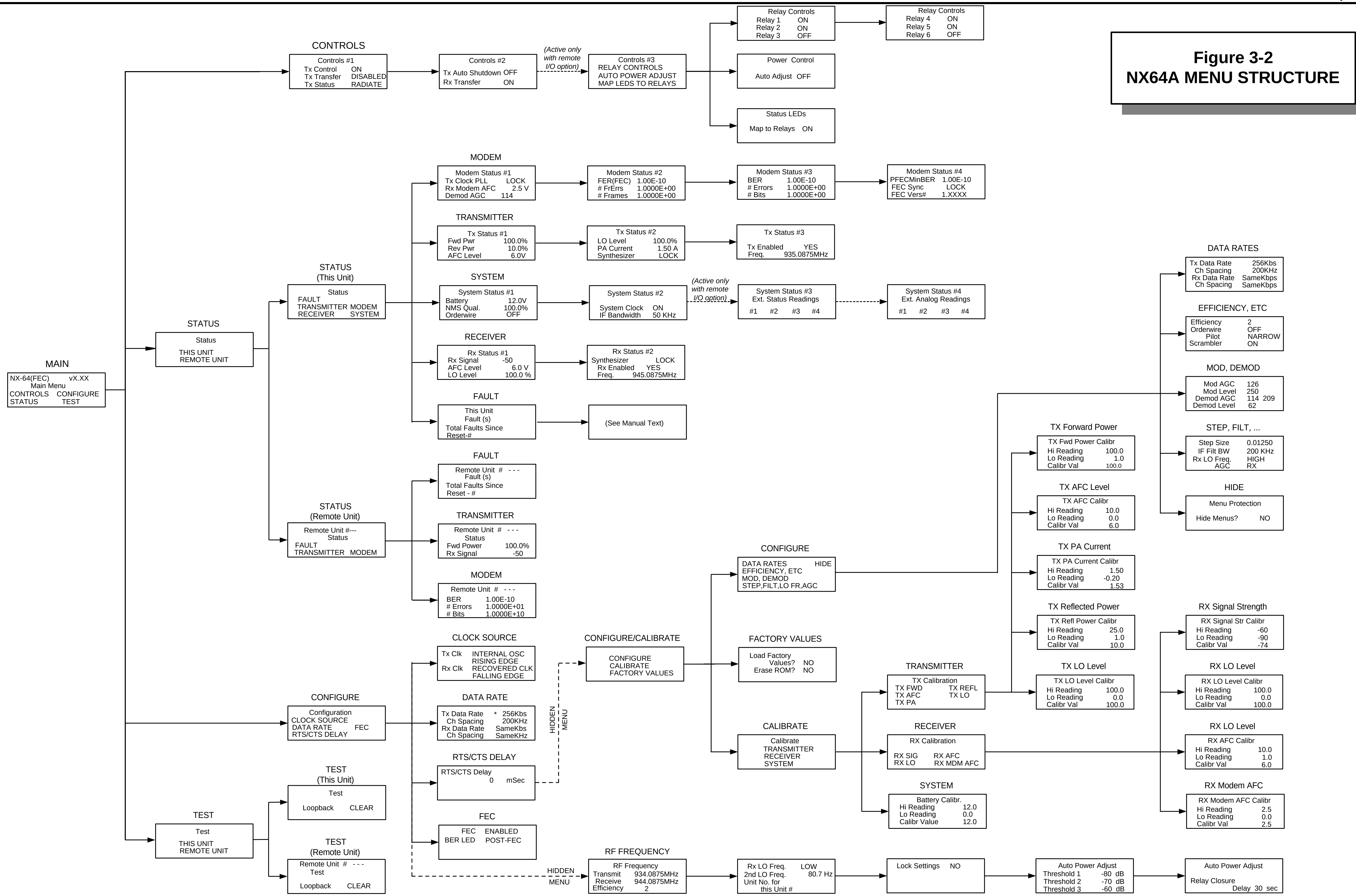

Figure 3-2
NX64A MENU STRUCTURE

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3.4 Screen Menu Summary

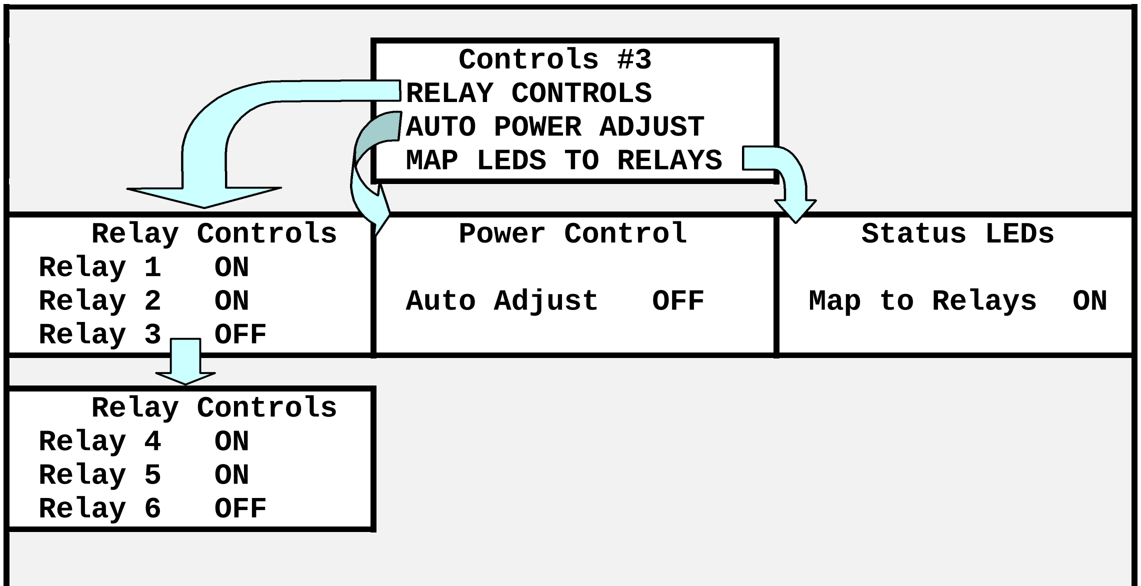
3.4.1 Controls Menu

```
    Controls #1
 Tx Control  *ON
 Tx Transfer DISABLED
 Tx Status RADIATE
```

```
    Controls #2
Tx Auto Shutdown *OFF
Rx Transfer       ON
```

Function	**Settings**	**Summary**
Tx Control	ON OFF XFER	Transmitter always on. Transmitter always off. Transfers power to the RF power amplifier module. Controlled by the external XFER connector (used in standby configurations).
Tx Transfer	HOT COLD	Hot standby or stand-alone operation. Cold standby configuration.
Tx Status	RADIATE OFF	Status provided by unit. User does not configure. Transmitter radiates or transmitter off.
Tx Auto Shutdown	ON OFF	If REV PWR >65%, TX will shut down (in cycle mode). Auto-shutdown disabled
Rx Transfer	ON OFF	Hot standby or stand-alone operation. Cold standby configuration.

continued on next page . . .



Function	Settings	Summary
Relay Controls		Remote I/O option: These parameters are controls for the optional remote I/O board. These menu screens do not appear if the board is not installed.
Auto Power Adjust	ON/OFF	
Map LEDs to Relays	ON/OFF	
RELAY 1 RELAY 2 RELAY 3	ON/OFF ON/OFF ON/OFF	Remote I/O option: These parameters are controls for the output relays on the optional remote I/O board. These menu screens do not appear if the board is not installed.
RELAY 4 RELAY 5 RELAY 6	ON/OFF ON/OFF ON/OFF	

3.4.2 Status Menu

3.4.2.1 Status Unit Selection

```
      Status

   THIS UNIT
   REMOTE UNIT
```

Message	Summary
THIS UNIT	Provides selection menus for status information for the local unit.
REMOTE UNIT	Provides selection menus for status information for a remote unit.

3.4.2.1.1 “This Unit” Fault Status

```
    This unit
       Fault(s)
Total Faults Since
 Reset- #
```

```
    This unit
       Fault(s)
```

```
    This unit
       Fault(s)
```

Message	**Summary**
Total Faults Since Reset	Total number of faults for this unit since last reset.
Additional Fault Details: (found on subsequent screens)	
1. TX LO LEVEL LOW	Transmitter local oscillator output signal below limits; TX Module TP702 < 0.25 Vdc
2. TX SYNTH. UNLOCKED	Transmitter synthesizer not locked. Tx will not radiate, FLT #1 will display, and the TX led will be red; TX Module TP703 = TTL High
3. RX LO LEVEL LOW	Receiver local oscillator output signal below limits; RX Module TP712 < 0.25 Vdc
4. RX SYNTH. UNLOCKED	Receiver synthesizer not locked. Rx will mute, FLT #7 will display, and the RX led will be red. FLT #3 may also display. RX Module TP714 = TTL High
5. NO TX CLOCK	Tx Clock Signal lost or out of sync; CPU module TP81<1.5 V OR >3.5 V
6. NO RX CLOCK	Rx Clock Signal lost or out of sync; CPU module TP114<1.5 V OR >3.5 V
7. RX MUTE	Receiver is in a mute condition; Rx Module TP711= TTL Low
8. LOW BATTERY	+ 12 V supply voltage (Battery or AC/DC converter) below 8 Vdc
9. WRONG IF FILTER	System data rate/ IF bandwidth configuration incorrect or IF filter module not recognized.
10. BER > .001	BER > .001

3.4.2.1.2 “This Unit” Transmitter (Tx) Status

```
    Tx Status #1
Fwd Power     100.0%
Rev Power       1.0%
AFC Level       5.9V
```

```
    Tx Status #2
LO Level      100.0%
PA Current     x.xxA
Synthesizer     LOCK
```

```
    Tx Status #3

  Tx Enabled  YES
  Freq.  xxx.xxxxMHz
```

Parameter	Range	Nominal	Summary
FWD POWER	0 to 100%	100%	Forward (output) RF power sample at the antenna port. Indicates relative power transmission quality of the transmitter to the antenna, feedlines, and duplexer.
REV POWER	0 to 100%	30% or less	Reverse (reflected) RF power. (Antenna connection / VSWR)
AFC LEVEL	2.0 to 11.0 V	6.0 V	Auto Freq. Control level. (Synth lock / Freq. setting)
LO LEVEL	0 to 100%	100%	Local Oscillator signal level quality.
PA CURRENT	0.7 - 2.5 A	see test data sheet	Power amp current draw. (FWD or REV PWR / LO level)
SYNTHESIZER	LOCK/ UNLOCK	LOCK	TX synthesizer lock status
TX ENABLED (Tallyback indication of TP64)	YES NO	***	The transmitter radiate control is ON and the transfer panel has relinquished radiate control to this NX64A. The transmitter radiate control has been set to OFF manually or the transfer panel has toggled it off, relinquishing radiate control to the other unit in a standby system.
FREQ	***	***	TX carrier frequency (See the test data sheet).

*** = system dependent

3.4.2.1.3 “This Unit” Receiver (Rx) Status

```
     Rx Status #1
Rx Signal     -60
AFC Level       5.9V
LO Level      100.0%
```

```
     Rx Status #2
Synthesizer    LOCK
 Rx Enabled  YES
 Freq.   xxx.xxxxMHz
```

Parameter	Range	Nominal	Summary
RX SIGNAL	-10 to -100	***	Approximately equal to received signal strength in dBm.
AFC LEVEL	2.0 to 11.0 V	6.0 V	Auto Freq. Control level. (Synth lock / freq. setting)
LO LEVEL	0 to 100%	100%	Local Oscillator signal level quality.
SYNTHESIZER	LOCK UNLOCK	LOCK	The synthesizer is phase-locked and operating on-frequency. LO1 is not locked on frequency. The receiver will not demodulate the carrier, resulting in no RX operation.
RX ENABLED (Tallyback indication of TP64)	YES NO	***	The transfer panel has relinquished receiver operation to this NX64A. The transfer panel has relinquished receiver operation to the other unit in a standby system, thereby causing the NX64A to mute.
FREQ	***	***	Rx frequency (See the test data sheet)

*** = system dependent

3.4.2.1.4 "This Unit" Modem Status

```
   Modem Status #1
Tx Clock PLL   LOCK
Rx Modem AFC    2.5V
Demod AGC     114
```

```
   Modem Status #2
FER(FEC) 1.00E-10
# FrErrs 1.0000E+01
# Frames 1.0000E+10
```

Parameter	Range	Nominal	Summary
TX CLOCK PLL	LOCK UNLOCK	LOCK	TX modem phase locked to clock. (Check clock source configuration). TX modem clock is not locked.
RX MODEM AFC	0 -10 V	2.5 V	Quality of RX modem lock to recovered transmit clock.
DEMOD AGC	100 - 130	114	Relative to RX baseband gain and center tuning of FM Demod to 10.700 MHz (max. linearity)
FER (FEC) Post Forward Error Correction Bit Error Rate	***	***	System BER (post-FEC) indication since reset. The values are cleared and a new summation started when <**ENTER**> is pressed. At the lower data rates, it may take considerable time to accumulate enough errors for a significant reading.
# FrErrs	***	***	Actual error count (frames) since reset.
# Frames	***	***	Actual bit count (frames) since reset.

*** = system dependent

continued on next page . . .

```
   Modem Status #3
BER      1.00E-10
# Errors 1.0000E+01
# Bits   1.0000E+10
```

```
   Modem Status #4
PFECMinBer 2.65E-02
FEC Sync     LOCK
FEC Vers#    x.xx
```

Parameter	Range	Nominal	Summary
BER (Pre-FEC Bit Error Rate)	***	***	Raw BER (pre-FEC) indication since reset. The values are cleared and a new summation started when <**ENTER**> is pressed. At the lower data rates, it may take considerable time to accumulate enough errors for a significant reading.
# Errors	***	***	Actual error count since reset.
# Bits	***	***	Actual bit count since reset.
PFECMinBER	***	***	Pre-FEC Minimum Bit Error Rate
FEC Sync	LOCK UNLOCK	LOCK	Status of FEC synchronization.
FEC Vers#			FEC Firmware Version.

*** = system dependent

3.4.2.1.4.1 FER vs. Post-FEC BER Discussion

The relationship between Frame Error Rate (FER) and actual Post FEC BER is a function of many parameters. However, the analysis below is a simple way to see the relationship.

First, it should be noted that for a frame to be in error, a minimum total of 10 errors have to occur in 10 separate bytes. As an example, at least 1 error in each of 10 separate bytes out of the 250 bytes for each frame must be noted. [Please note that FEC can correct 1 to 8 errors per byte in a maximum of 10 bytes.]

If the radio gives Pre-FEC BER of 10^{-6}, then:

1 error	In	10^6 bits
10 errors	In	10^7 bits
1 frame	250 * 8	= 2,000 bits

The 10 errors occur in 10^7 / 2000 frames = 5 * 10^3 frames. Thus, there is one frame error every 5 * 10^3 frames. The frame error rate is therefore 2 * 10^{-4}. With this in mind, the worst case Frame Error Rate could be as bad as 2 * 10^{-4} to correspond to a BER of 10^6.

Of course, the probability that the 10 errors out of the 10^7 bits all occurring in one frame is very unlikely. The likelihood of this happening is equal to the impulse duty cycle, which is probably between 1% and 10%. Thus, the real Frame Error Rate is anywhere between 2 * 10^{-5} and 2 * 10^{-6}.

The actual measurements for Pre-FEC BER and Post-FEC BER are as follows:

PRE-FEC	POST-FEC
10^{-3}	10^{-3} to 10^{-4}
10^{-4}	10^{-5} to 10^{-6}
10^{-5}	10^{-7} to 10^{-8}
10^{-6}	10^{-8} to 10^{-9}
10^{-7}	10^{-10} to 10^{-12}
10^{-8}	10^{-12}

3.4.2.1.5 “This Unit” System Status

```
  System Status #1
Battery        12.5V
NMS Qual.       0.0%
Orderwire      OFF
```

```
  System Status #2

System Clock  ON
IF Bandwidth 200 kHz
```

Parameter	Range	Nominal	Summary
BATTERY	0 - 48 V	11.4 – 48 V	Battery or AC/DC converter primary supply voltage.
NMS QUAL	0 - 100 %	100%	Measure of the percentage of good transmission packets received for the internal NMS communications (optional).
ORDERWIRE	ON/OFF	***	OPTION
SYSTEM CLOCK	ON/OFF	***	Internal clock operational.
IF BANDWIDTH	NONE, 25, 50, 100, or 200 kHz, or WIDE	***	Indicates the bandwidth of the IF filter currently in use. The system will automatically choose the appropriate filter if available, from among any IF filters installed in the receiver module. If the correct filter is not available, it will choose the next larger bandwidth filter. If a larger filter is not available, or if no filter is present, it will indicate NONE and the front panel FLT LED will be on.

*** = system dependent

```
System Status #3
Ext. Status Readings
#1  #2  #3  #4
```

```
System Status #4
Ext. Analog Readings
#1     #3
#2     #4
```

Parameter	Range	Nominal	Summary
EXT. STATUS READINGS #1 - #4	ON/OFF	***	Remote I/O OPTION: input status (digital) This menu is available with the optional remote I/O board. It does not appear if that board is not installed.
EXT. ANALOG READINGS #1 - #4	0 - 999.9	***	Remote I/O OPTION: Input status (analog value set in calibration menu). This menu is available with the optional remote I/O board. It does not appear if that board is not installed.

*** = system dependent

3.4.2.2.1 "Remote Unit" Fault Status

```
  Remote Unit #
       Fault(s)
Total Faults Since
 Reset- #
```

```
    Remote Unit #
       Fault(s)
```

Message	Summary
Total Faults Since Reset	Total number of faults for remote unit # since last reset.
Additional Fault Details: (found on subsequent screens)	
1. TX LO LEVEL LOW	Transmitter local oscillator output signal below limits; TX Module TP702 < 0.25 Vdc
2. TX SYNTH. UNLOCKED	Transmitter synthesizer not locked. Tx will not radiate, FLT #1 will display, and the TX led will be red; TX Module TP703 = TTL High
3. RX LO LEVEL LOW	Receiver local oscillator output signal below limits; RX Module TP712 < 0.25 Vdc
4. RX SYNTH. UNLOCKED	Receiver synthesizer not locked. Rx will mute, FLT #7 will display, and the RX led will be red. FLT #3 may also display. RX Module TP714 = TTL High
5. NO TX CLOCK	Tx Clock Signal lost or out of sync; CPU module TP81<1.5 V OR >3.5 V
6. NO RX CLOCK	Rx Clock Signal lost or out of sync; CPU module TP114<1.5 V OR >3.5 V
7. RX MUTE	Receiver is in a mute condition; Rx Module TP711= TTL Low
8. LOW BATTERY	+ 12 V supply voltage (Battery or AC/DC converter) below 8 Vdc
9. WRONG IF FILTER	System data rate/ IF bandwidth configuration incorrect or IF filter module not recognized.
10. BER > .001	BER > .001

3.4.2.2.2 “Remote Unit” Transmitter (Tx) Status

```
   Remote Unit #
      Status
Fwd Power     100.0%
Rx Signal        -50
```

Parameter	Range	Nominal	Summary
FWD POWER	0 to 100%	100%	Forward (output) RF power sample.
Rx Signal	-10 to -100	***	Approximately equal to received signal strength in dBm.

*** = system dependent

3.4.2.2.3 “Remote Unit” Modem Status

```
  Modem Status #3
BER       1.00E-10
# Errors 1.0000E+01
# Bits   1.0000E+10
```

Parameter	Range	Nominal	Summary
BER (Pre-FEC Bit Error Rate)	***	***	Raw BER (pre-FEC) indication since reset. The values are cleared and a new summation started when <**ENTER**> is pressed. At the lower data rates, it may take considerable time to accumulate enough errors for a significant reading.
# Errors	***	***	Actual error count since reset.
# Bits	***	***	Actual bit count since reset.

*** = system dependent

3.4.3 Configuration Menu

3.4.3.1 Clock Source

```
Tx Clk*INTERNAL OSC
       RISING EDGE
Rx Clk RECOVERED CLK
       FALLING EDGE
```

Function	Settings	Summary
TX CLK		All transmitter timing is derived from a phase-locked loop driven from one of the following clock sources. This source must be the same frequency as the transmit data rate.
	INTERNAL OSC	Internal crystal controlled oscillator.
	EXTERNAL TXC	Transmit clock input from the rear-panel composite port.
	RECOVERED CLK	Receiver clock recovered from the received signal.
	EXTERNAL RXC	Receive clock input from the rear-panel composite port.
TX CLK PHASE (function heading not shown on screen)		Determines the timing of data in the transmitter modem.
	RISING EDGE	External device uses a rising edge triggered clock.
	FALLING EDGE	External device uses a falling edge triggered clock.
RX CLK		The clock source for the receiver does not affect any of the internal operations since all receiver functions are clocked from the received signal. This screen only chooses the clock source used to clock the data to the composite port.
	INTERNAL OSC	Internal crystal controlled oscillator.
	EXTERNAL TXC	Transmit clock input from the rear-panel composite port.
	RECOVERED CLK	Receiver clock recovered from the received signal.
	EXTERNAL RXC	Receive clock input from the rear-panel composite port.
RX CLK PHASE (function heading not shown on screen)		Determines the timing of data in an external device from the receiver modem.
	RISING EDGE	External device uses a rising edge triggered clock.
	FALLING EDGE	External device uses a falling edge triggered clock.

3.4.3.2 Data Rate Screen

```
Tx Data Rate *xxxKbs
  Ch Spacing  xxxKHz
Rx Data Rate  xxxKbs
  Ch Spacing  xxxKHz
```

Function	Settings	Summary
Data rates for the transmitter and receiver are adjusted here. The data rate must match the rate of the external equipment. Although it is unusual, the receiver can be set to a different data rate than the transmitter. Usually, the menu choice for "Rx Data Rate" should be SAME. The channel spacing value indicates the necessary channel spacing to support the chosen data rates.		
TX DATA RATE	See table	Sets the data rate for the transmitter modem.
CH SPACING	See table	A tallyback indication of the transmitter channel spacing. Determined by the data rate and IF filter configuration in the system.
RX DATA RATE	See table	Sets the data rate for the receiver modem.
CH SPACING	See table	A tallyback indication of the receiver channel spacing. Determined by the data rate and IF filter configuration in the system.

Table 3-2
Data Rate vs. Channel Spacing

Tx Data Rate	Channel Spacing Eff = 1	Channel Spacing Eff = 2
OFF	_____ kHz	_____ kHz
28 Kbps	50 kHz	25 kHz
32 Kbps	50 kHz	25 kHz
56 Kbps	100 kHz	50 kHz
64 Kbps	100 kHz	50 kHz
112 Kbps	200 KHz	100 KHz
128 Kbps	200 KHz	100 KHz
168 Kbps	200 KHz	200 KHz
192 Kbps	200 KHz	200 KHz
224 Kbps	WIDE	200 KHz
256 Kbps	WIDE	200 KHz
336 Kbps	SPECIAL ORDER and FACTORY SETUP REQUIRED	WIDE
384 Kbps		WIDE
448 Kbps		WIDE
512 Kbps		WIDE

3.4.3.3 RTS/CTS Delay

```
   RTS/CTS Delay

     *0   msec
```

Function	Settings	Summary
Sets the RTS to CTS delay on the composite port. In a half duplex system where only the transmitter or the receiver is on at one time, there is necessarily some delay time from requesting the transmitter on to it turning on. This parameter sets the wait time for the system to settle. The value of this will be determined both by the intrinsic limits of the radio and the limits of the external system. If this value is set to zero, the RTS line is ignored. If it is greater than zero, the unit will only radiate if the RTS line is in the proper state.		
RTS/CTS DELAY	0 to 1000 msec	Sets the wait time for the system to settle, determined by external equipment requirements. 0 = disabled

3.4.3.4 FEC (Forward Error Correction)

```
    FEC  ENABLED
BER LED  PRE-FEC
```

Function	Settings	Summary
FEC	ENABLED / DISABLED	Enables FEC functions.
BER LED	PRE-FEC / POST-FEC	Selects front panel BER LED function.

3.4.3.5 RF Frequency (Limited Access)

```
    RF Frequency
Transmit 950.0000MHz
Receive  942.0000MHz
Efficiency   2
```

```
  Rx LO Freq. *HIGH
2nd LO Freq. 80.7MHz
Unit No, for
   this Unit  0
```

```
  Auto Power Adjust
 Threshold 1  -80 dB
 Threshold 2  -70 dB
 Threshold 3  -60 dB
```

```
  Auto Power Adjust

Relay Closure
        Delay 30 sec
```

Function	Settings	Summary
TRANSMIT	xxx.xxxx MHz	See below*
RECEIVE	xxx.xxxx MHz	Select same as TX
EFFICIENCY	1 2	High sensitivity, 3-level partial response modulation. High efficiency, 7-level partial response modulation. (See below*)
RX LO FREQ.	LOW/HIGH	Low-side or high-side LO1 freq. setting.
2ND LO FREQ	80.7 MHz 80.0 MHz	(Nominal.) Sets LO2 to 80.7 MHz, and sets LO1 to result in IF1 of 70.0 MHz. Sets LO2 to 80.0 MHz, and sets LO1 to result in IF1 of 69.3 MHz. This parameter sets LO2 and LO1 frequencies. In either choice, IF2 will always be 10.7 MHz. This parameter is selected in the factory for optimal performance. Consult your test data sheet for the correct setting.
Unit No, for this Unit	0-255	Identifying # for networking applications
Auto Power Adjust		
Threshold 1 Threshold 2 Threshold 3	-80 dB -70 dB -60 dB	Tx output power attenuated as Rx input level increases.
Relay Closure delay	30 sec	Rx input level must be > setting for 30 seconds to initiate.

*The RF Frequency screen uses the four direction keys somewhat differently:

<**LEFT**>,<**RIGHT**> Select which digit is to be changed.

<**UP**>,<**DOWN**> Increment or decrement the selected digit.

<**ENTER**> Accept the new frequency value and move the cursor to the next field (Receive). At this point the frequency displayed in the menu will be radiating if the synthesizer is still locked and the transmitter is on.

Note

*When in the rightmost allowed position, which may not be the last displayed position, the value is incremented in the step size of the synthesizer, **not in unit values**. For instance, if the step size is at .0125 MHz, the values after the decimal will go from .0000 to .0125, 0250, 0375, etc. All other digits increase or decrease by one.*

CAUTION

If the frequency is changed in units using a duplexer, the receiver may be damaged unless the duplexer is retuned before the transmitter is turned on at the new frequency. It is not advisable to make this menu available to the less qualified operators.

Efficiency: Cycle through the choices with the <RIGHT> or <LEFT> keys, then**:**

<**ENTER**> Accept the new efficiency setting and move the cursor to the next screen (RX LO Freq).

<**DOWN**> Exit the efficiency field without accepting changes and move the cursor to the next screen (RX LO Freq).

<**UP**> Return the cursor to the Receive field without accepting changes made to the efficiency setting.

3.4.4 Test Menu

3.4.4.1 Test Unit Selection

```
      Test

  THIS UNIT
  REMOTE UNIT
```

Message	Summary
THIS UNIT	Provides selection menus for the local unit.
REMOTE UNIT	Provides selection menus for a remote unit.

3.4.4.2 “This Unit” Test Menu

```
        Test

Loopback    *CLEAR
```

Function	Settings	Summary
LOOPBACK		Allows enabling of the various loopback modes. See Figures 2-3 and 2-4.
	CLEAR	Indicates no loopback is enabled. This is the normal operating mode.
	ANALOG	Connects the analog output of the modulator to the analog input of the demodulator. This also connects the demodulator output to the modulator input for remote loopback testing. Front panel LBK status LED is illuminated (red).
	DIGITAL	Connects the digital input to the digital output. This also connects the digital output to the digital input for remote loopback testing. Front panel LBK status LED is illuminated (red).

3.4.4.3 “Remote Unit” Test Menu

```
  Remote Unit #
      Test

Loopback    *CLEAR
```

Function	Settings	Summary
LOOPBACK		Allows enabling of the various loopback modes. See Figures 2-3 and 2-4.
	CLEAR	Indicates no loopback is enabled. This is the normal operating mode.
	ANALOG	Connects the analog output of the modulator to the analog input of the demodulator. This also connects the demodulator output to the modulator input for remote loopback testing. Front panel LBK status LED is illuminated (red).
	DIGITAL	Connects the digital input to the digital output. This also connects the digital output to the digital input for remote loopback testing. Front panel LBK status LED is illuminated (red).

3.4.5 Configure/Calibrate Menu (Limited Access)

3.4.5.1 Configuration

3.4.5.1.1 Data Rate

```
Tx Data Rate *xxxKbs
  Ch Spacing xxxxKHz
Rx Data Rate  xxxKbs
  Ch Spacing  xxxKHz
```

Function	Settings	Summary	
TX DATA RATE	OFF, 28, 32, 56, 64, 112, 128, 168, 192, 224, 256, 336, 384, 448, 512 kbps	Sets the data rate for the transmitter modem.	
CH SPACING	25, 50, 100, 200 kHz, WIDE, ---	A tallyback indication of the transmitter channel spacing. Determined by the data rate and IF filter configuration in the system.	
RX DATA RATE	SAME, OFF, 28, 32, 56, 64, 112, 128, 168, 192, 224, 256, 336, 384, 448, 512 kbps	Sets the data rate for the receiver modem.	
CH SPACING	SAME, 25, 50, 100, 200 kbps, WIDE, ---	A tallyback indication of the receiver channel spacing. Determined by the data rate and IF filter configuration in the system.	

3.4.5.1.2 Efficiency, Etc.

```
Efficiency  *2
 Orderwire   OFF
     Pilot   NARROW
 Scrambler   ON
```

Function	Settings	Summary
EFFICIENCY	1 2	High sensitivity, 3-level partial response modulation. High efficiency, 7-level partial response modulation.
ORDERWIRE	OFF, FM, AM	Sets modulation of orderwire option. OFF = disabled
PILOT	NARROW/WIDE	Narrow pilot highly recommended in all applications
SCRAMBLER	ON/OFF	Required ON unless external equipment has provision for scrambler.

3.4.5.1.3 Mod, Demod

```
   Mod AGC ∗126
  Mod Level  xxx
  Demod AGC  114 169
Demod Level  xx
```

Function	Settings	Summary
MOD AGC	126 (nominal)	Modulator automatic gain control setting
MOD LEVEL	System dependent	Dependent upon data rate and efficiency
DEMOD AGC	114(nominal) 170	Demodulator automatic gain control setting Tallyback indication of operating point
DEMOD LEVEL	System dependent	Dependent upon data rate and efficiency

3.4.5.1.4 Step, Filt, LO FR, AGC

```
 Step Size  ∗0.01250
IF Filt BW   200 kHz
Rx LO Freq.  HIGH
       AGC   RX
```

Function	Settings	Summary
STEP SIZE	.001, .002, .0025, .005, .010, .0125, .020, .025, .050, .100, .200, .250, .500, 1.00 MHz	Synthesizer step size (MHz)
IF FILT BW	25, 50, 100, 200 kHz,WIDE	Used to force IF filter card switch per software requirements.
RX LO FREQ.	LOW/HIGH	Low-side or high-side LO freq. setting. See text.
AGC	RX, RX+TX, OFF	RX used exclusively RX+TX only available for backward compatibility.

3.4.5.1.5 Hide

```
Menu Protection

Hide Menus?  *NO
```

Function	Settings	Summary
HIDE MENUS?	YES/NO	Limited-access security mode.

3.4.5.2 Calibration

Please contact the Factory for information on accessing this section.

3.4.5.3 Factory Values

Please contact the Factory for information on accessing this section.

Use of this option will cause the loss of all customer-programmed data. This returns the unit to factory test values.

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Section 4

Applications

4.1 Introduction

The flexibility and power of the NX64A allows it to be used for numerous applications. A brief subset includes:

- Integrated, single or multichannel voice, fax, and data communications
- Last-mile tail circuits for VSAT/ISDN/Fractional T1/E1/CEPT-1
- Compressed video for teleconference and security applications
- Transmission of high-speed graphic data for CAD/CAM and interconnection of LANs
- Cost-effective alternative for bank ATM networks and efficient point-of-sale mediums
- Rural radio extensions for single and multichannel access systems
- High speed SCADA, point-to-point and point-to-multipoint networks

Typical end users for the NX64A would be in the following industries:

- Utilities and Oil & Gas pipelines
- Banks
- VSAT-based networks
- National PTT
- Private Telecom operators
- Public safety organizations

This section briefly outlines some of the more frequently used applications.

4.2 Rural Telephone Applications

When used with an appropriate low capacity digital multiplexer or an integral digital multiplexer, the NX64A can be used for extension of central office lines to remote subscribers, or central office lines to remote local exchanges. The multirate capability of the NX64A permits higher throughput as traffic demand increases. This application can be seen in Figure 4-1 below.

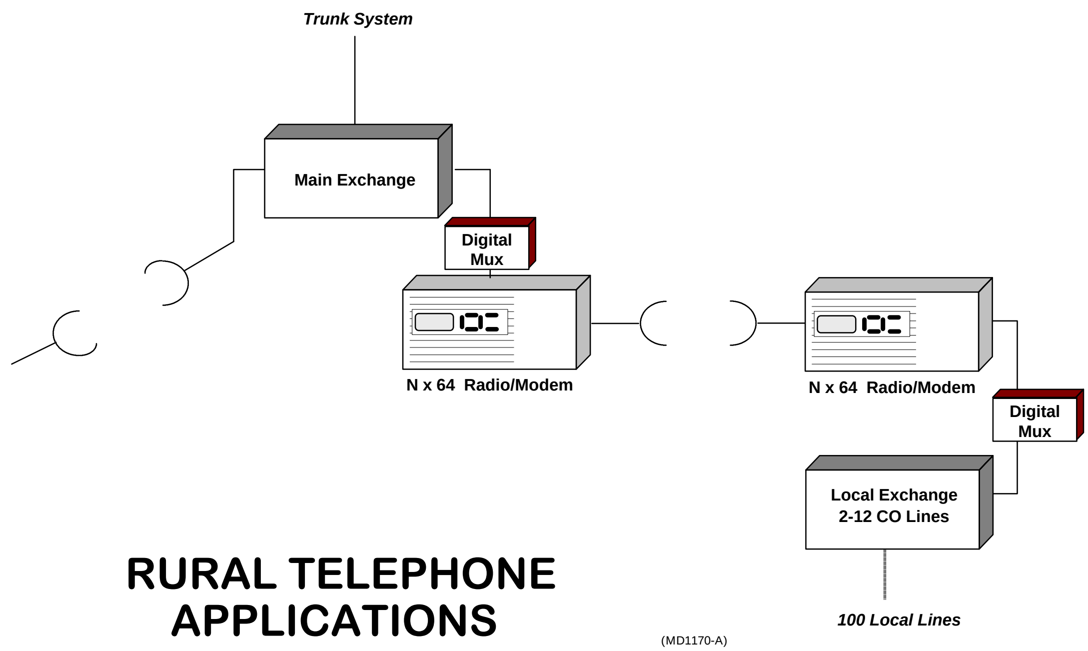


Figure 4-1

4.3 Multichannel Application

Voice, fax, and high speed data can be transmitted between two locations by use of a low capacity digital multiplexer and the NX64A digital radio. High speed digital connectivity allows for PABX tie trunks, hot-circuits, packet switching, video conferencing, and high speed file transfers. By use of CCITT G.721 ADPCM encoding, up to 16 voice channels can be transmitted using 512 kbps of data. Voice compression technology permits toll quality transmission with data rates as low as 8 kbps. When used with these multiplexers, the NX64A can transmit eight voice channels for every 64 kbps of data. This application can be seen in Figure 4-2 below.

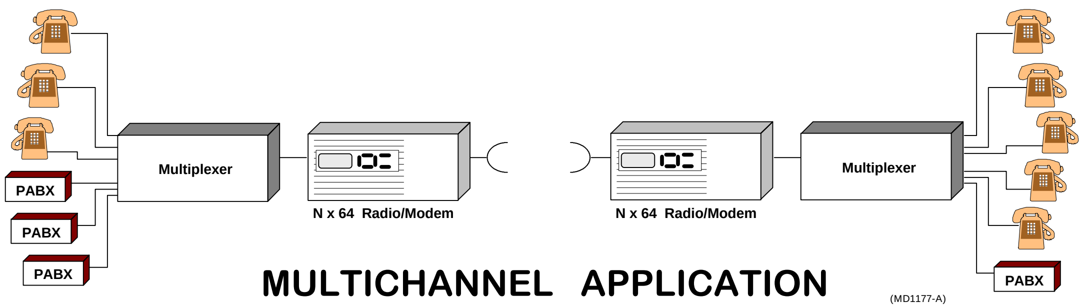


Figure 4-2

4.4 Private Telecom Application

Private telecom operators (such as oil, gas, and electric companies, or commercial common carriers) typically utilize a medium capacity backbone network for their voice/fax/data communication needs. These backbone networks typically operate at either 8 or 34 Mbps, providing between 120 to 480 voice channels. This application can be seen in Figure 4-3 below.

To service requirements for users/offices that are not directly on the backbone, low capacity (two to twelve channels) links are generally utilized. Even though the backbone networks have been digital, the low capacity networks tend to be analog spurs, necessitating A/D conversions at the spur points. The NX64A will accept multiples of 64 kbps from a 2 Mbps drop-and-insert multiplexer and transmit it to local distribution offices all in the digital domain.

When used with an appropriate multiplexer, up to eight voice and data circuits can be dedicated for local distribution offices. The ability of the NX64A to transmit voice and data without the use of expensive modems enables transmission of up to 512 kbps and direct connection to Switch 56, Fractional T1/E1/CEPT-1 and basic rate ISDN equipment.

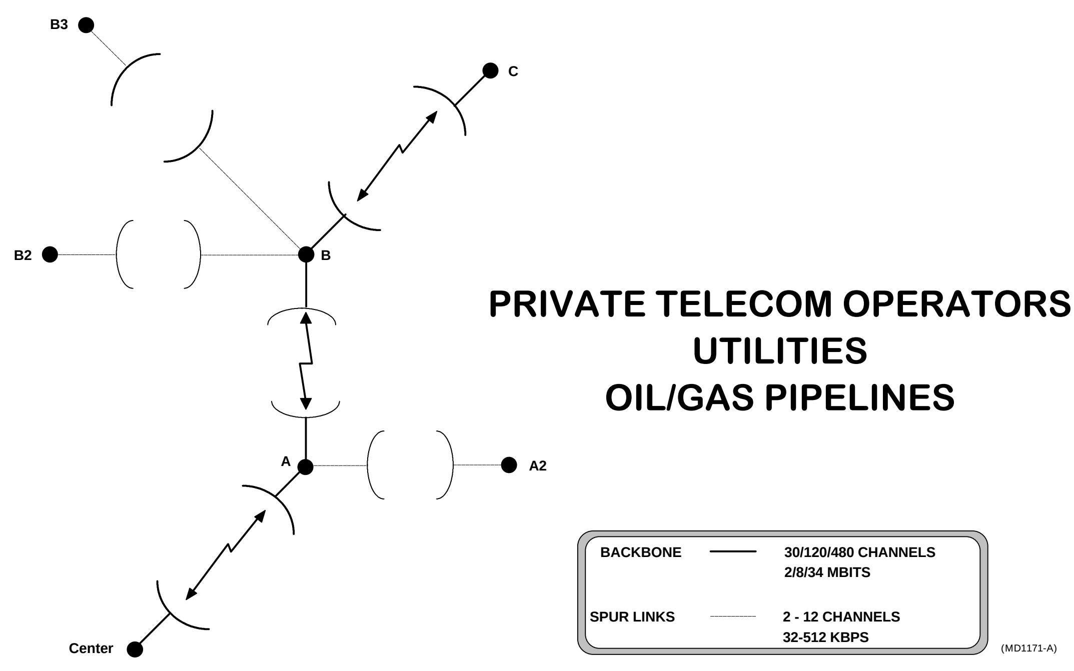


Figure 4-3

4.5 ISDN Application

The NX64A can be used for extending basic rate ISDN from either a digital network or a microwave bearer circuit. Wireless loops can be set up using the NX64A. This application can be seen in Figure 4-4 below.

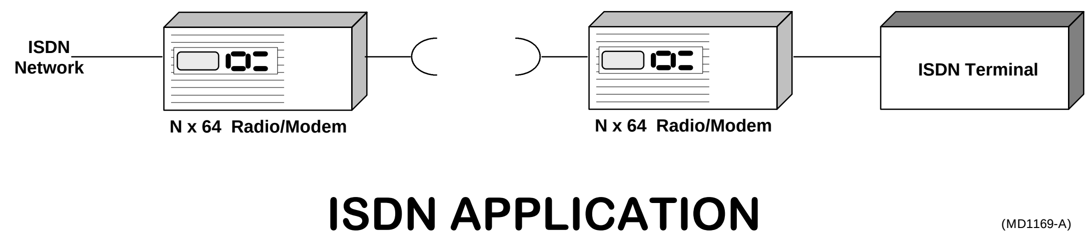


Figure 4-4

4.6 VSAT Tail Circuit Applications

The NX64A can be used to extend the range of VSAT terminals by extending the 56/64 kbps data stream from the local transmitter location to distances up to 35 miles (55 kilometers). This application can be seen in Figure 4-5 below.

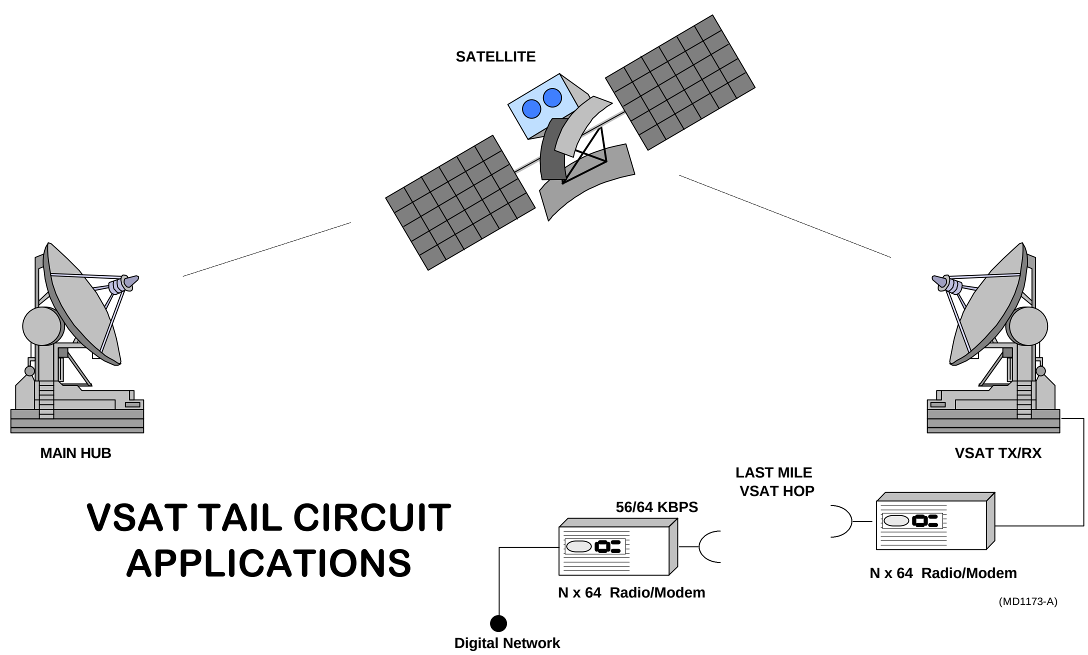


Figure 4-5

4.7 Compressed Video Application

Recent advances in compression technologies have facilitated video conferencing at data rates ranging from 128 kbps to 384 kbps. The NX64A can be used either as a point-to-point network with video codecs connected at each end, or as an extension of a backbone network with the video codec connected to the main transmission center and at the end of the tail circuit. This application can be seen in Figure 4-6 below.

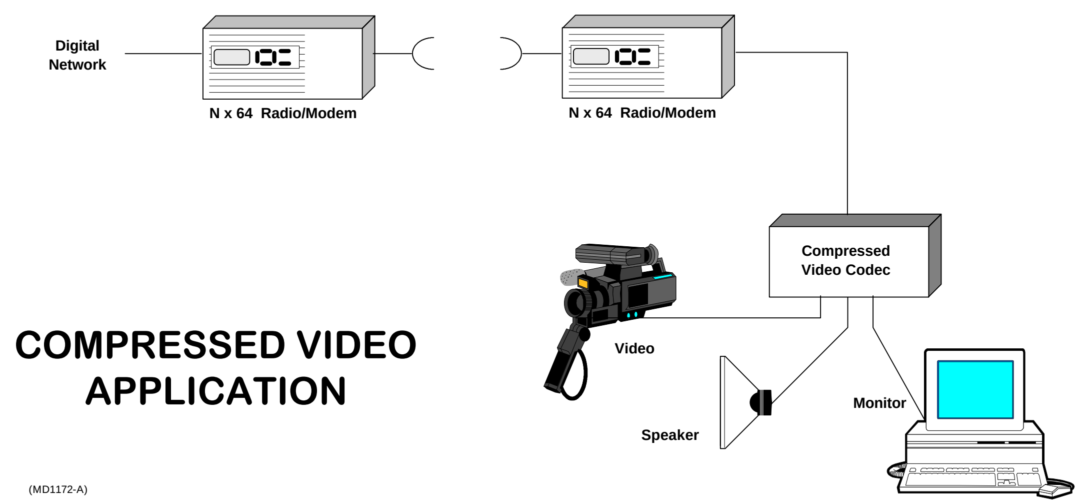


Figure 4-6

4.8 ATM Network

With the rapid expansion in the banking industry of automatic teller machines (ATMs) and point-of-sale transactions, the demand for high speed secure data transmission has greatly increased. The NX64A can be used for transmissions ranging from 19.2 kbps to 64/128 kbps in a point-to-multipoint configuration. This application can be seen in Figure 4-7 below.

Appropriate front-end processing equipment is required at the central processing location. If packet transmission is used, simultaneous transmission of voice and data is possible.

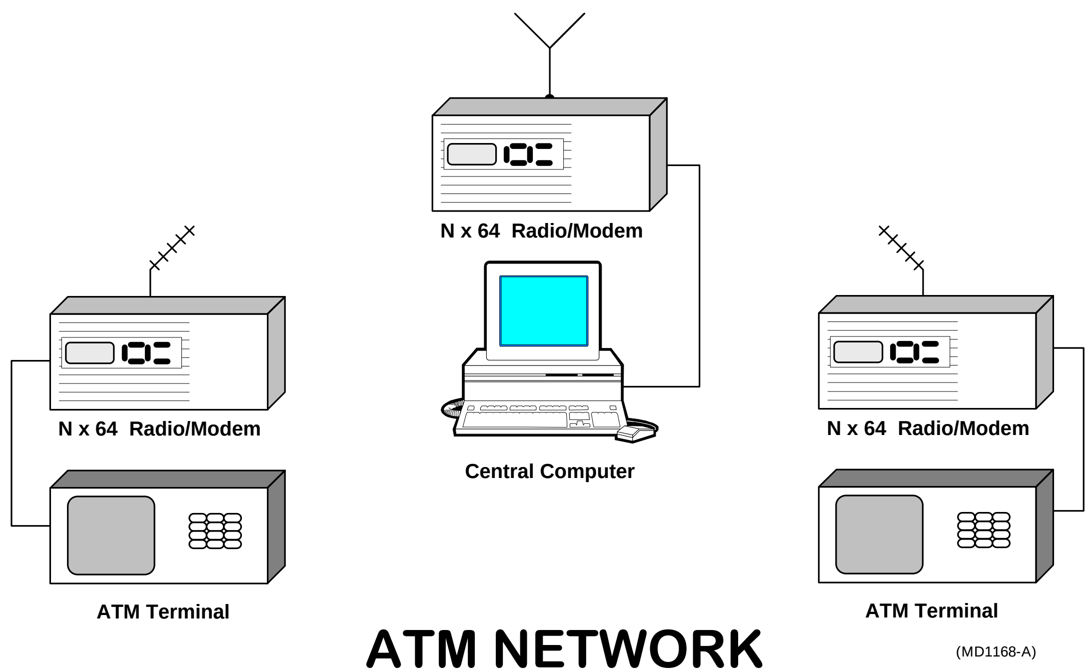


Figure 4-7

4.9 Mobile Public Safety Application

Public safety organizations typically use an assortment of mobile base stations to maintain an extended range, two-way communication system for emergency/public safety requirements. These networks are interconnected by single channel analog VHF/UHF links. Due to limitations of analog transmissions, severe degradation of both audio and data transmission occurs even in the smallest of these networks. With the NX64A, digital regeneration allows for an unlimited number of repeaters. In addition, it is possible to drop and insert channels at various locations for trunking and simulcast applications. This application can be seen in Figure 4-8 below.

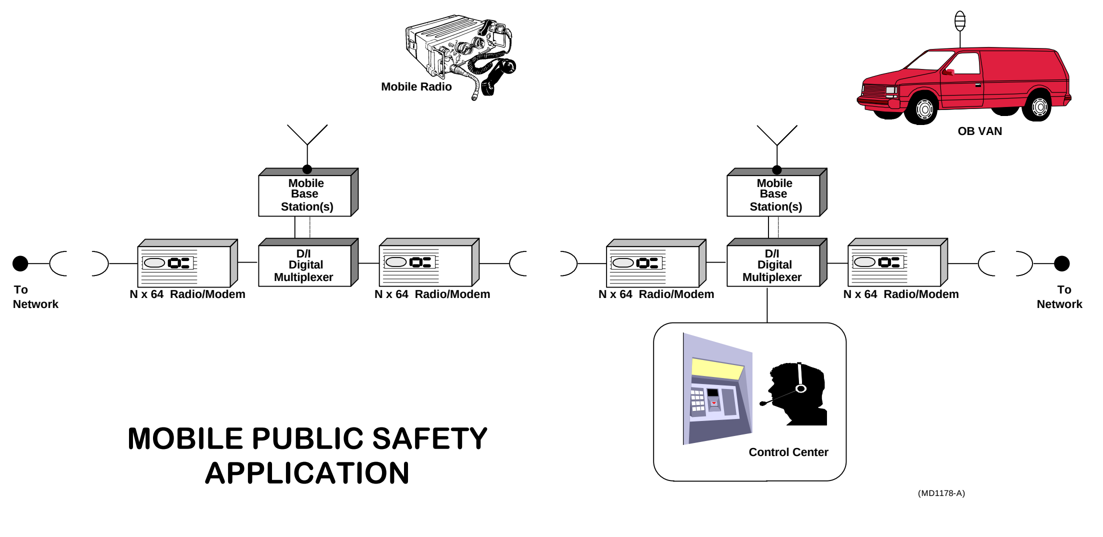


Figure 4-8

Section 5

System Planning & Engineering

5.1 Introduction

5.1.1 Line of Sight

For the proposed installation sites, one of the most important immediate tasks is to determine whether line-of-sight is available. The easiest way to determine line-of-sight is simply to visit one of the proposed antenna locations and look to see that the path to the opposite location is clear of obstructions. For short distances, this may be done easily with the naked eye, while sighting over longer distances may require the use of binoculars. If locating the opposing site is difficult, you may want to try using a mirror, strobe light, flag, weather balloon or compass (with prior knowledge of site coordinates).

5.1.2 Refraction

Because the path of a radio beam is often referred to as line-of-sight, it is often thought of as a straight line in space from transmitting to receiving antenna. The fact that it is neither a line, nor is the path straight, leads to the rather involved explanations of its behavior.

A radio beam and a beam of light are similar in that both consist of electromagnetic energy; the difference in their behavior is principally due to the difference in frequency. A basic characteristic of electromagnetic energy is that it travels in a direction perpendicular to the plane of constant phase; i.e., if the beam were instantaneously cut at right angle to the direction of travel, a plane of uniform phase would be obtained. If, on the other hand, the beam entered a medium of non-uniform density and the lower portion of the beam traveled through the more dense portion of the medium, its velocity would be less than that of the upper portion of the beam. The plane of uniform phase would then change, and the beam would bend downward. This is refraction, just as a light beam is refracted when it moves through a prism.

The atmosphere surrounding the earth has the non-uniform characteristics of temperature, pressure, and relative humidity, which are the parameters that determine the dielectric constant, and therefore the velocity of radio wave propagation. The earth's atmosphere is therefore the refracting medium that tends to make the radio horizon appear closer or farther away.

5.1.3 Fresnel Zones

The effect of obstacles, both in and near the path, and the terrain, has a bearing on the propagation of radio energy from one point to another. The nature of these effects depends upon many things, including the position, shape, and height of obstacles, nature of the terrain, and whether the effects of concern are primary or secondary effects.

Primary effects, caused by an obstacle that blocks the direct path, depend on whether it is totally or partially blocking, whether the blocking is in the vertical or the horizontal plane, and the shape and nature of the obstacle.

The most serious of the secondary effects is reflection from surfaces in or near the path, such as the ground or structures. For shallow angle microwave reflections, there will be a 180° (half wavelength) phase shift at the reflection point. Additionally, reflected energy travels farther and arrives later, directly increasing the phase delay. The difference in distance traveled by the direct waves and the reflected waves, expressed in wavelengths of the carrier frequency, is added to the half wavelength delay caused by reflection. Upon arrival at the receiving antenna, the reflected signal is likely to be out of phase with the direct signal, and may tend to add to or cancel the direct signal. The extent of direct signal cancellation (or augmentation) by a reflected signal depends on the relative powers of the direct and the reflected signals, and on the phase angle between them.

Maximum augmentation will occur when the signals are exactly in phase, which will be the case when the total phase delay is equal to one wavelength (or equal to any integer multiple of the carrier wavelength), and this will be the case when the distance traveled by the reflected signal is longer than the direct path by an odd number multiple of one-half wavelength. Maximum cancellation will occur when the signals are exactly out of phase, or when the phase delay is an odd multiple of one-half wavelength, which will occur when the reflected waves travel an integer multiple of the carrier wavelength farther than the direct waves. Note that the first cancellation maximum on a shallow angle reflective path will occur when the phase delay is one and one-half wavelengths, caused by a path one wavelength longer than the direct path.

The direct radio path, in the most simple case, follows a geometrically straight line from transmitting antenna to receiving antenna. However, geometry shows that there exist an infinite number of points from which a reflected ray reaching the receiving antenna will be out of phase with the direct rays by exactly one wavelength. In ideal conditions, these points form an ellipsoid of revolution, with the transmitting and receiving antennas at the foci. This ellipsoid is defined as the first Fresnel zone. Any waves reflected from a surface that coincides with a point on the first Fresnel zone, and received by the receiving antenna, will be exactly in phase with the direct rays. This zone should not be violated by intruding obstructions, except by specific design amounts. The first Fresnel zone, or more accurately the first Fresnel zone radius, is defined as the perpendicular distance from the direct ray line to the ellipsoidal surface at a given point along the microwave path. It is calculated as follows:

$$F_1 = 2280 \times [(d_1 \times d_2) / (f \times (d_1 + d_2))]^{1/2}\ feet$$

Where,

$\boldsymbol{d_1}$ and $\boldsymbol{d_2}$ = distances in statute miles from a given point on a microwave path to the ends of the path (or path segment).
$\boldsymbol{f}$ = frequency in MHz.
$\boldsymbol{F_1}$ = first Fresnel zone radius in feet.

There are in addition, of course, the second, third, fourth, etc. Fresnel zones, and these may be easily computed, at the same point along the microwave path, by multiplying the first Fresnel zone radius by the square root of the desired Fresnel zone number. All odd numbered Fresnel zones are additive, and all even numbered Fresnel zones are canceling.

5.1.4 K Factors

The matter of establishing antenna elevations to provide minimum fading would be relatively simple were it not for atmospheric effects. The antennas could easily be placed at elevations somewhere between free space loss and first Fresnel zone clearance over the predominant surface or obstruction, reflective or not, and the transmission would be expected to remain stable. Unfortunately, the effective terrain clearance changes, due to changes in the air dielectric with consequent changes in refractive bending.

As described earlier, the radio beam is almost never a precisely straight line. Under a given set of meteorological conditions, the microwave ray may be represented conveniently by a straight line instead of a curved line if the ray is drawn on a fictitious earth representation of radius K times that of earth's actual radius. The **K factor** in propagation is thus the ratio of effective earth radius to actual earth radius. The K factor depends on the rate of change of refractive index with height and is given as:

$$K = 157/157+dN/dh$$

Where,

N is the radio refractivity of air.
dN/dh is the gradient of N per kilometer.

The **radio refractivity** of air for frequencies up to 30 GHz is given as:

$$N = (77.6P/T) + (3.73 \times 10^5)(e/T^2)$$

Where,

P = total atmospheric pressure in millibars.
T = absolute temperature in degrees Kelvin.
e = partial pressure of water vapor in millibars.

The *P/T* term is frequently referred to as the "dry" term and the e/T^2 term as the "wet" term.

K factors of 1 are equivalent to no ray bending, while K factors above 1 are equivalent to ray bending away from the earth's surface and K factors below 1 (earth bulging) are equivalent to ray bending towards the earth's surface. The amount of **earth bulge** at a given point along the path is given by:

$$h = (2d_1 x d_2)/3K$$

Where,

h = earth bulge in feet from the flat-earth reference.
$\boldsymbol{d_1}$ = distance in miles (statute) from a given end of the microwave path to an arbitrary point along the path.
$\boldsymbol{d_2}$ = distance in miles (statute) from the opposite end of the microwave path to the same arbitrary point along the path.
K = K-factor considered.

Three K values are of particular interest in this connection:

1. Minimum value to be expected over the path. This determines the degree of "earth bulging" and directly affects the requirements for antenna height. It also establishes the lower end of the clearance range over which reflective path analysis must be made, in the case of paths where reflections are expected.
2. Maximum value to be expected over the path. This leads to greater than normal clearance and is of significance primarily on reflective paths, where it establishes the upper end of the clearance range over which reflective analysis must be made.
3. Median or "normal" value to be expected over the path. Clearance under this condition should be at least sufficient to give free space propagation on non-reflective paths. Additionally, on paths with significant reflections, the clearance under normal conditions should not fall at or near an even Fresnel zone.

For most applications the following criteria are considered acceptable:

K = 1.33 and CF = 1.0 F_1

K = 1.0 and CF = 0.6 F_1

K = 0.67 and CF = 0.3 F_1

Where CF is the Fresnel zone clearance and F_1 is the first Fresnel zone radius.

5.1.5 Path Profiles

Using ground elevation information obtained from the topographical map, a path profile should be prepared using either true earth or 4/3 earth's radius graph paper. To obtain a clear path, all obstacles in the path of the rays must be cleared by a distance of 0.6 of the first Fresnel zone radius. Be sure to include recently erected structures, such as buildings, towers, water tanks, and so forth, that may not appear on the map. Draw a straight line on the path profile clearing any obstacle in the path by the distance determined above. This line will then indicate the required antenna and/or tower height necessary at each end. If it is impossible to provide the necessary clearance for a clear path, a minimum clearance of 30 feet should be provided. Any path with less than 0.6 first Fresnel zone clearance, but more than 30 feet can generally be considered a grazing path.

5.2 Path Analysis

5.2.1 Overview

Path analysis is the means of determining the system performance as a function of the desired path length, required equipment configuration, prevailing terrain, climate, and characteristics of the area under consideration. The path analysis takes into account these parameters and yields the net system performance, referred to as **path availability** (or **path reliability**). Performing a path analysis allows you to specify the antenna sizes required to achieve the required path availability.

A path analysis is often the first thing done in a feasibility study. The general evaluation can be performed before expending resources on a more detailed investigation.

The first order of business for performing a path analysis is to complete a balance sheet of **gains** and **losses** of the radio signal as it travels from the transmitter to the receiver. "Gain" refers to an increase in output signal power relative to input signal power, while "loss" refers to signal attenuation, or a reduction in power level ("loss" does not refer to total interruption of the signal). Both gains and losses are measured in **decibels** (dB and dBm), the standard unit of signal power.

The purpose of completing the balance sheet is to determine the power level of the received signal as it enters the receiver electronics—in the absence of multipath and rain fading; this is referred to as the **unfaded received signal level**. Once this is known, the **fade margin** of the system can be determined. The fade margin is the difference between the unfaded received signal level and the **receiver sensitivity** (the minimum signal level required for proper receiver operation).

The fade margin is the measure of how much signal attenuation due to multipath and rain fading can be accommodated by the radio system while still achieving a minimum level of performance. In other words, the fade margin is the safety margin against loss of transmission, or transmission **outage**.

5.2.2 Losses

Although the atmosphere and terrain over which a radio beam travels have a modifying effect on the loss in a radio path, there is, for a given frequency and distance, a characteristic loss. This loss increases with both distance and frequency. It is known as the **free space loss** and is given by:

$$A = 96.6 + 20log_{10}F + 20log_{10}D$$

Where,

A = free space attenuation between isotropics in dB.
F = frequency in GHz.
D = path distance in miles.

5.2.3 Path Balance Sheet/System Calculations

A typical form for recording the gains and losses for a microwave path is shown on page____. Recall that the purpose of this tabulation is to determine the **fade margin** of the proposed radio system. The magnitude of the fade margin is used in subsequent calculations of path availability (up time).

The following instructions will aid you in completing the Path Calculation Balance Sheet (see section 5.2.7):

Instructions

A. Line 1. Enter the power output of the transmitter in dBm. Examples: 5w = +37.0 dBm, 6.5w = +38.0 dBm, 7w = +38.5 dBm, 8w = +39.0 dBm (dBm = 30 + 10 Log P_o [in watts]).

B. Lines 2 & 3. Enter Transmitter and Receiver antenna gains over an isotropic source. Refer to the Antenna Gain table below for the power gain of the antenna. Note: If the manufacturer quotes a gain in dBd (referred to a dipole), dBi is approximately dBd +1.1 dB.

Table 5-1
Typical Antenna Gain

ANTENNA TYPE	450 MHz BAND	950 MHz BAND
5 element Yagi	12 dBi	12 dBi
Paraflectors	16 dBi	20 dBi
4' Dish* (1.2 m)	13 dBi	19 dBi
6' Dish* (1.8 m)	17 dBi	23 dBi
8' Dish* (2.4 m)	19 dBi	25 dBi
10' Dish* (3.0 m)	22 dBi	27 dBi

C. Line 4. Total lines 1, 2, and 3, and enter here. This is the total gain in the proposed system.

D. Line 5. Enter amount of free space path loss as determined by the formula given in Section 5.2.2, or see the table below.

Table 5-2
Free Space Loss

DISTANCE	450 MHz	950 MHz
5 Miles (8 km)	104 dB	110 dB
10 Miles (16 km)	110 dB	116 dB
15 Miles (24 km)	114 dB	120 dB
20 Miles (32 km)	116 dB	122 dB
25 Miles (40 km)	118 dB	124 dB
30 Miles (48 km)	120 dB	126 dB

E. Line 6. Enter the total transmitter transmission line loss. Typical losses can be found in Table 5-3.

Table 5-3
Transmission Line Loss

FREQUENCY BAND	LDF4-50 (per 100 meters)	LDF5-50 (per 100 meters)
330 MHz	4.6 dB	2.4 dB
450 MHz	5.5 dB	2.9 dB
470 MHz	5.7 dB	3.0 dB
950 MHz	8.3 dB	4.6 dB

F. Line 7. Enter the total receiver transmission line loss (see Table 5-3 above).

G. Line 8. Enter the total connector losses. A nominal figure of -0.5 dB is reasonable (based on 0.125 dB/mated pair).

H. Line 9. Enter all other miscellaneous losses here. Such losses might include power dividers, duplexers, diplexers, isolators, isocouplers, and the like. Typical Duplexer losses are 1.5 dB per terminal.

Table 5-4
Branching Losses

	Tx Loss	Rx Loss	Total Loss
Non-Standby Terminal (400 MHz)	1.2	1.2	2.4
Hot Standby Terminal (400 MHz)	1.2	4.2	5.4
Non-Standby Terminal (900 MHz)	1.5	1.5	3.0
Hot Standby Terminal (900 MHz)	1.5	4.5	6.0

I. Line 10. Enter obstruction losses due to knife-edge obstructions, etc.

J. Line 11. Total lines 5 to 10 and enter here. This is the total loss in the proposed system.

K. Line 12. Enter the total loss from line 11.

L. Line 13. Enter the total gain from line 4.

M. Line 14. Subtract line 13 from line 12. This is the unfaded signal level to be expected at the receiver.

N. Line 15. Using the information found in Table 5-5 below, enter here the minimum signal required for 1x10E-3 BER.

Table 5-5
Typical Received Signal Strength required for BER of 1x10E-3*

Data Rate Configuration	High Sensitivity (EFF1, 3-Level Modulation)	High Efficiency (EFF2, 7-Level Modulation)
32 kbps	-103 dBm	-95 dBm
64 kbps	-100 dBm	-92 dBm
128 kbps	-97 dBm	-89 dBm
256 kbps	-94 dBm	-86 dBm
512 kbps	-91 dBm	-83 dBm

* Excludes all branching losses

O. Line 16. Subtract line 15 from line 13 and enter here. This is the amount of fade margin in the system.

5.2.4 Path Availability and Reliability

For a given path, the system reliability is generally worked out on methods based on the work of Barnett and Vigants. The presentation here has now been superseded by CCIR 338-6 that establishes a slightly different reliability model. The new model is more difficult to use and, for most purposes, yields very similar results. For mathematical convenience, we will use fractional probability (per unit) rather than percentage probability, and will deal with the **unavailability** or outage parameter, designated by the symbol U. The **availability** parameter, for which we use the symbol A, is given by (1-U). **Reliability**, in percent, as commonly used in the microwave community, is given by 100A, or 100(1-U).

Non-Diversity Annual Outages

Let U_{ndp} be the non-diversity annual outage probability for a given path. We start with a term r, defined by Barnett as follows:

$$r = \text{actual fade probability/Rayleigh fade probability}(=10^{-F/10})$$

Where,

F = fade margin, to the minimum acceptable point, in dB.

For the worst month, the fade probability due to terrain is given by:

$$r_m = a \times 10^{-5} \times (f/4) \times D^3$$

Where,

D = path length in miles.
f = frequency in GHz.
a (terrain factor)
= 4 for smooth terrain.
= 1 for average terrain.
= 1/4 for mountainous, very rough, or very dry terrain.

Over a year, the fade probability due to climate is given by:

$$r_{yr} = b \times r_m$$

Where,

b (climate factor)
= 1/2 for Gulf coast or similar hot, humid areas.
= 1/4 for normal interior temperate or northern regions.
= 1/8 for mountainous or very dry areas.

By combining the three equations and noting that U_{ndp} is equal to the actual fade probability, for a given fade margin F, we can write:

$$U_{ndp} = r_{yr} \times 10^{-F/10} = b \times r_m \times 10^{-F/10}$$

or

$$U_{ndp} = a \times b \times 2.5 \times 10^{-6} \times f \times 10D^3 \times 10^{-F/10}$$

See Table 5-6 for the relationship between system reliability and outage time.

Table 5-6
Relationship Between System Reliability & Outage Time

RELIABILITY (%)	OUTAGE TIME (%)	OUTAGE TIME PER: YEAR	MONTH (Avg.)	DAY
0	100	8760 hr	720 hr	24 hr
50	50	4380 hr	360 hr	12 hr
80	20	1752 hr	144 hr	4.8 hr
90	10	876 hr	72 hr	2.4 hr
95	5	438 hr	36 hr	1.2 hr
98	2	175 hr	14 hr	29 min
99	1	88 hr	7 hr	14.4 min
99.9	0.1	8.8 hr	43 min	1.44 min
99.99	0.01	53 min	4.3 min	8.6 sec
99.999	0.001	5.3 min	26 sec	0.86 sec
99.9999	0.0001	32 sec	2.6 sec	0.086 sec

5.2.5 Methods Of Improving Reliability

If adequate reliability cannot be achieved by use of a single antenna and frequency, space diversity or frequency diversity (or both) can be used. To achieve space diversity, two antennas are used to receive the signal. For frequency diversity, transmission is done on two different frequencies. For each case the two received signals will not experience fades at the same time. The exact amount of diversity improvement depends on antenna spacing and frequency spacing.

5.2.6 Availability Requirements

Table 5-7
Fade Margins Required for 99.99% Reliability,
Terrain Factor of 4.0, and Climate Factor of 0.5

DISTANCE	450 MHz BAND	950 MHz BAND
5 Miles (8 km)	7 dB	10 dB
10 Miles (16 km)	17 dB	20 dB
15 Miles (24 km)	22 dB	25 dB
20 Miles (32 km)	27 dB	30 dB
25 Miles (40 km)	29 dB	32 dB
30 Miles (48 km)	32 dB	35 dB

5.2.7 Path Calculation Balance Sheet

Frequency of operation ____GHz   Distance _____Miles

SYSTEM GAINS

1.	Transmitter Power Output		+_____	dBm
2.	Transmitter Antenna Gain		+_____	dBi
3.	Receiver Antenna Gain		+_____	dBi
4.	Total Gain		+_____	dB

SYSTEM LOSSES

5.	Path loss (___miles)		-______	dB
6.	Transmission Line Loss TX (Total Ft ______; dB/100 ft)		-_____	dB
7.	Transmission Line Loss RX (Total Ft ______; dB/100 ft)		-_____	dB
8.	Connector Loss (Total)		-______	dB
9.	Branching losses		-______	dB
10.	Obstruction losses		-______	dB
11.	Total loss		-______	dB

SYSTEM CALCULATIONS

12.	Total Gain (Line 4)		+_____	dBm
13.	Total Loss (line 11)		-_____	dB
14.	Effective Received Signal	-______________	_____	uV
15.	Minimum Signal Required		_____	dBm
16.	Fade Margin		-_____	dB
17.	Terrain Factor		_____	
18.	Climate Factor		_____	
19.	Annual Outage	______________	_____	min.
20.	Reliability		_____	%

NOTES:

5.3 Additional Technical Information

5.3.1 BER versus Co-Channel Interference

The plot in figure 5-1 below shows the radio performance with a co-channel interfering signal. The data is for the high spectral efficiency mode. For the high sensitivity mode, the required carrier-to-interference ratio is about 6 dB less. These measurements were made with an identical digital modulated carrier as the interference signal. Different results will be obtained for either an unmodulated carrier or an analog modulated signal.

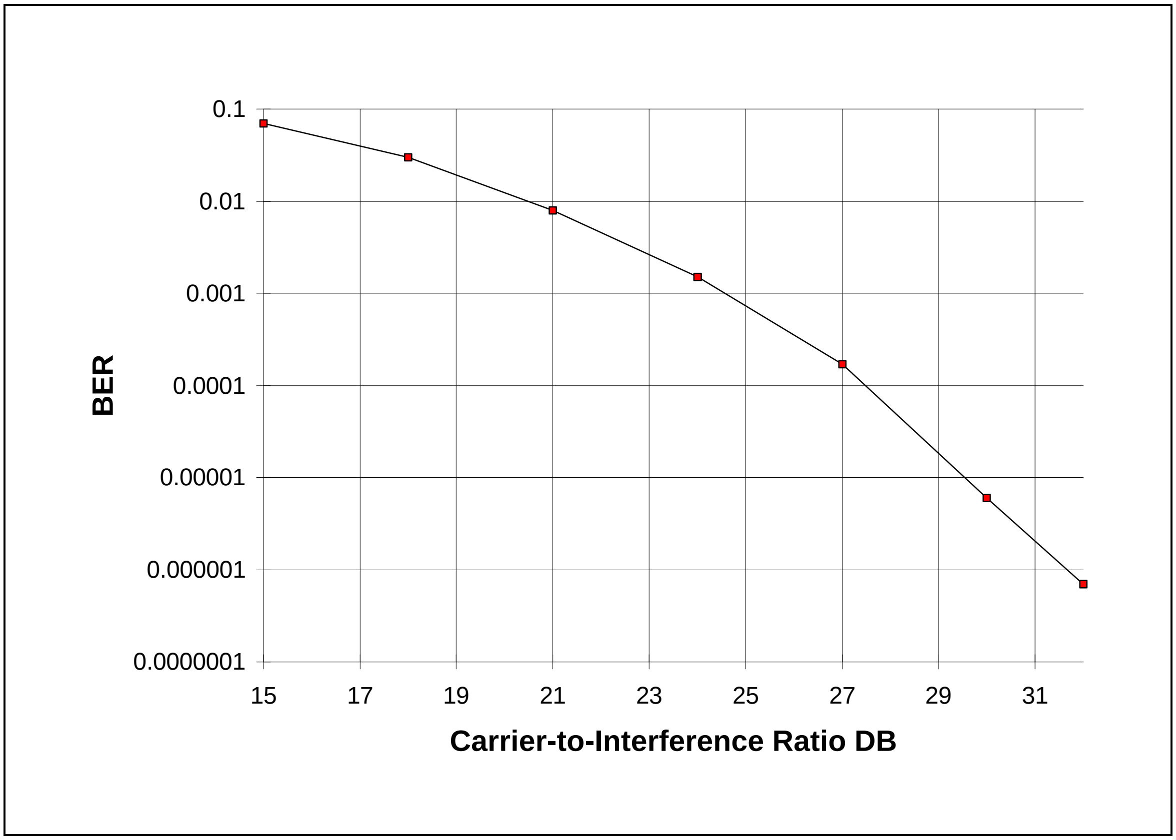


Figure 5-1
BER versus Co-Channel Interference
High Efficiency (EFF2, 7-Level Modulation)

5.3.2 BER versus Adjacent Channel Interference

Figure 5-2 below shows the effects of an adjacent channel interfering signal on the bit error rate. The interfering signal is an identical digitally modulated signal. Different results will be obtained for an unmodulated carrier or an analog modulated signal. These measurements are for the high efficiency mode. The high sensitivity mode will show somewhat higher rejection. The values are a function of the bandwidth of the crystal filter in the IF. For these measurements, a 50 kHz filter was used.

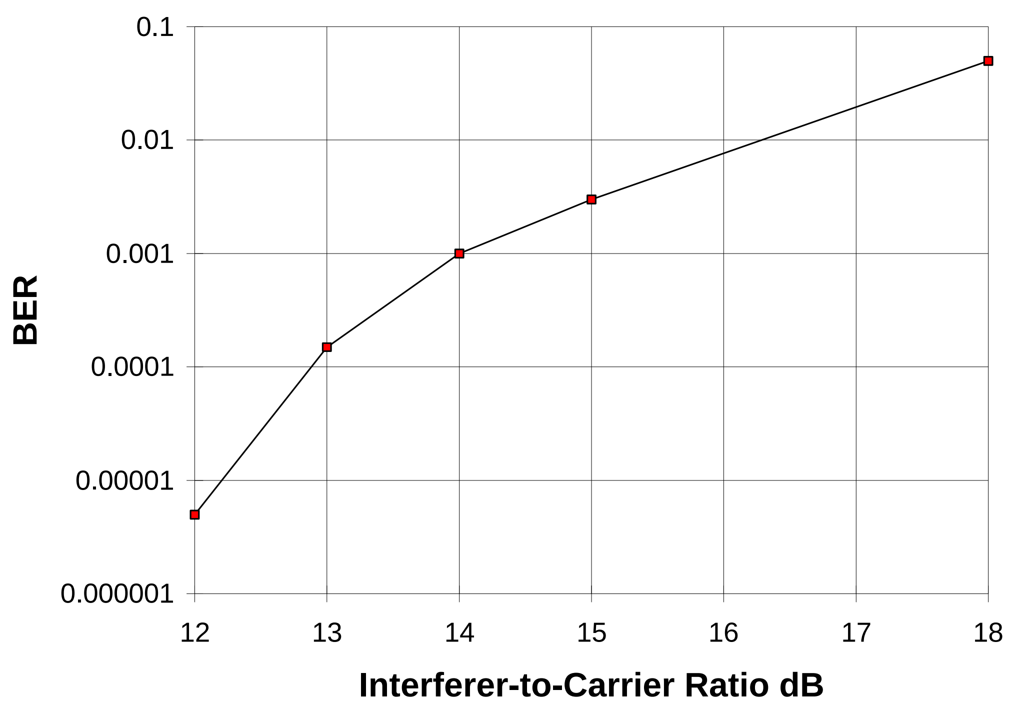


Figure 5-2
BER versus Adjacent Channel Interference
High Efficiency (EFF2, 7-Level Modulation) 50 kHz IF Filter

5.3.3 Interference for 10E-4 BER— Co-Channel and Adjacent Channels

Figure 5-3 below indicates the level of interfering signal necessary to lower the bit error rate to 1×10E-4. The lowest curve is the co-channel interference level. This scales with input level and is about 28 dB lower than the desired signal. This number is set by the requirements for decoding a seven-level partial response signal and is not directly a measure of the radio characteristics. The middle line is the interfering signal level necessary for an adjacent channel signal. This is a measure of the rejection of the crystal filter. Since the value is proportional to the desired signal level, it indicates that there is no saturation taking place. The top two curves are for second and third adjacent channels. At -20 dBm input, there is some compression in a receiver stage, so the values for these two separations are the same. For larger separations, the limiting value approaches -10 dBm, the value where the preamp saturates. This value is maintained until sufficient separation is obtained to allow further attenuation by the front-end preselector filter.

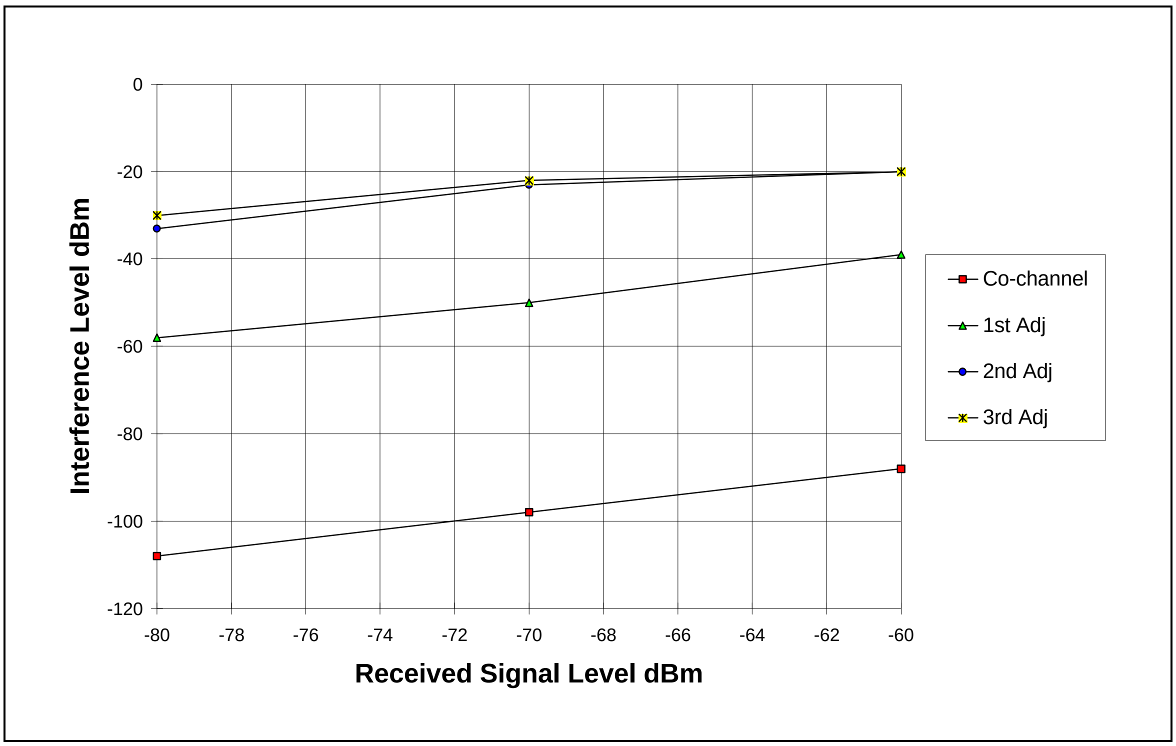


Figure 5-3
Interference for 10E-4 BER —
Co-Channel and Adjacent Channels
High Efficiency (EFF2, 7-Level Modulation)

5.3.4 BER versus SNR at Receiver Output

Figure 5-4 below indicates the BER performance versus signal-to-noise ratio at the receiver output. This is before any additional noise filtering on the modem main board.

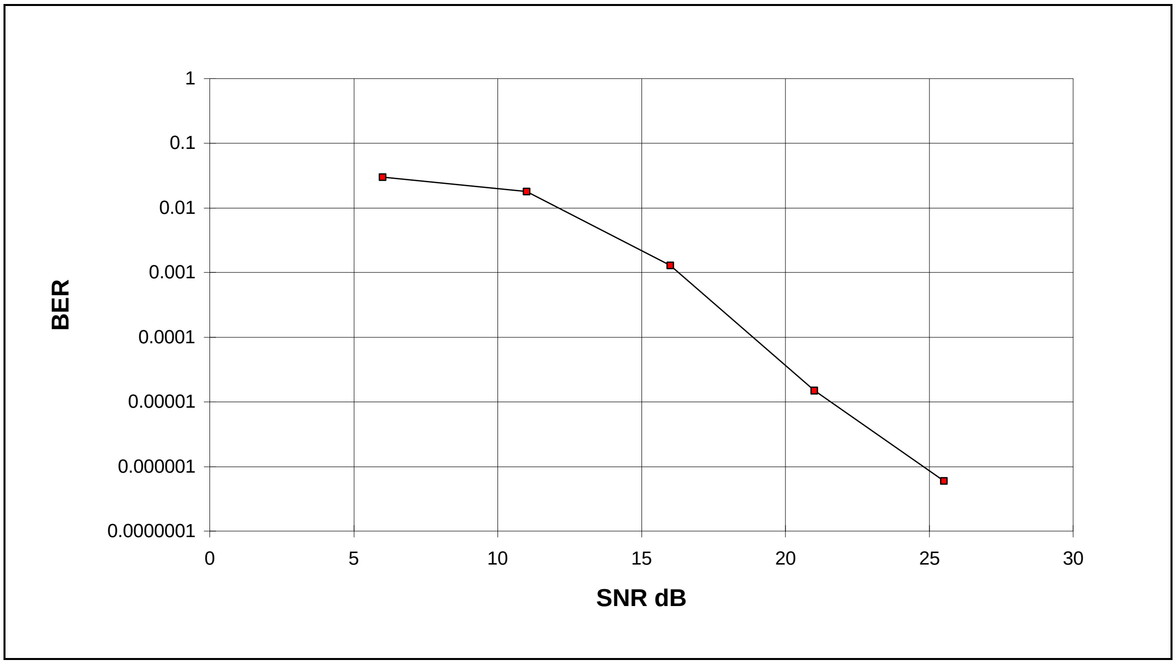


Figure 5-4
BER versus SNR at Receiver Output

5.3.5 SNR versus Signal Level

Figure 5-5 below indicates the signal-to-noise ratio versus signal level at the receiver output at 64 kbps. This is before the additional noise filtering on the modem board.

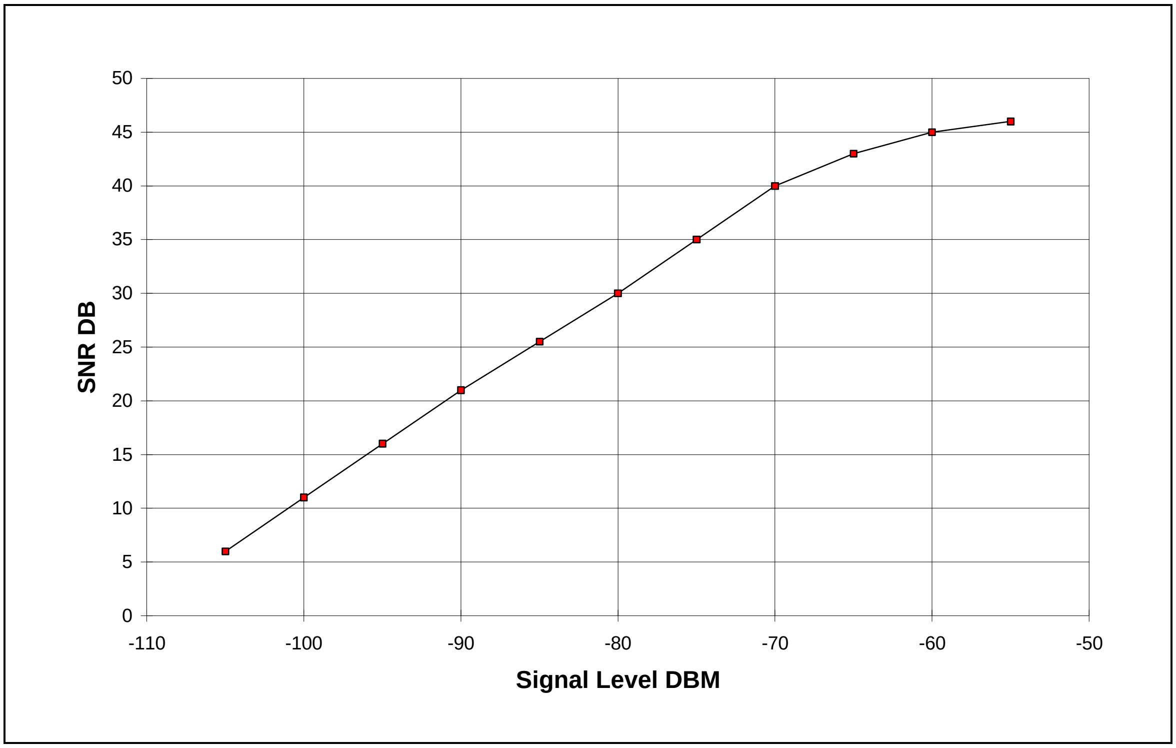


Figure 5-5
SNR versus Signal Level
Data Rate = 64 kbps

5.3.6 RSSI versus Signal Level

Figure 5-6 below shows the DC voltage output of the received signal strength indicator (RSSI) for various signal input levels. The detected voltage is used to calculate the indicated signal strength in dBm on the receiver status menu. Since there is some non-linearity in the curve, the values on the receiver status menu have a limited accuracy and should only be used for relative measurements.

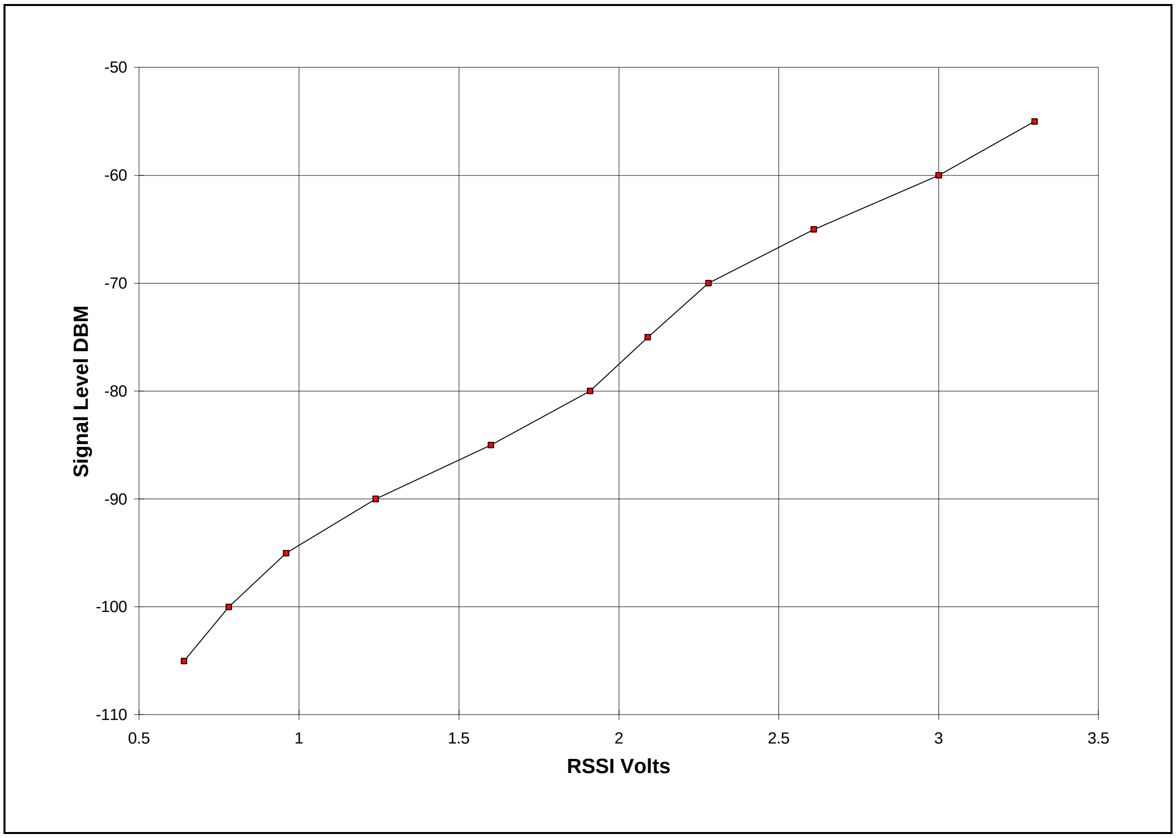


Figure 5-6
RSSI versus Signal Level

5.3.7 Spectral Occupancy

Figures 5-7, 5-8, and 5-9 below show the occupied RF spectrum for the High Sensitivity mode (3-level modulation), the High Efficiency mode (7-level modulation) and the Narrow Bandwidth mode (7-level modulation with reduced deviation).

The three-level mode occupies a spectrum which is approximately 1.5 times the data rate. The digital mask under FCC Part 94 is shown as the heavy line around the data.

Figure 5-8 shows the seven-level occupied spectrum which occupies about 0.75 times the data rate. Again, the digital mask for a narrow channel is shown by the heavy lines.

In a partial response system, occupied bandwidth can be further reduced by simply lowering the deviation. This is shown in Figure 5-9. The deviation has been lowered about 10 dB and the occupied spectrum is about 0.4 times the data rate. The emission mask for the very narrow channel is shown by the heavy lines.

Note that the indicated spectral mask does not go all the way to the 80 dB limit in the plots. This is an artifact of the spectrum analyzer used to create the plots, which has less than an 80 dB dynamic range. The actual occupied spectrum is well below the 80 dB limit imposed by the digital mask.

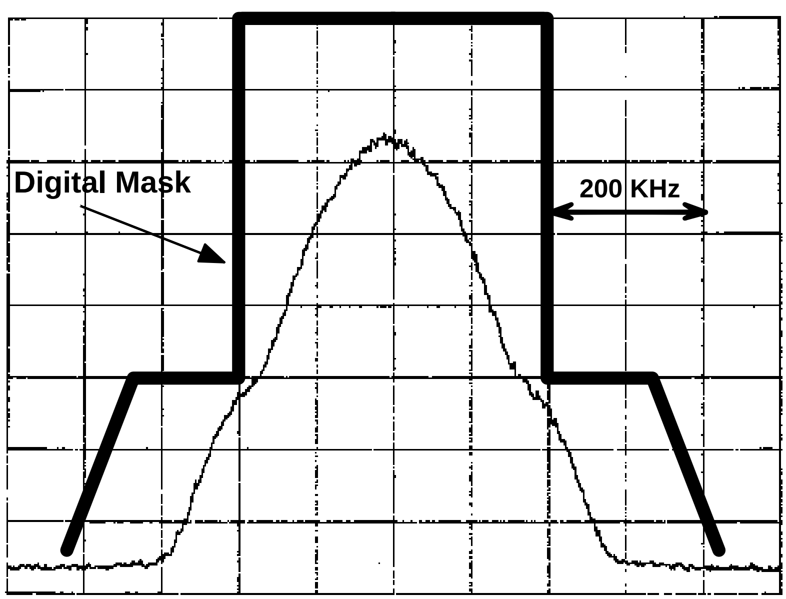


Figure 5-7
Spectral Occupancy
High Sensitivity Mode
(EFF1, 3-Level Modulation) 256 kbps

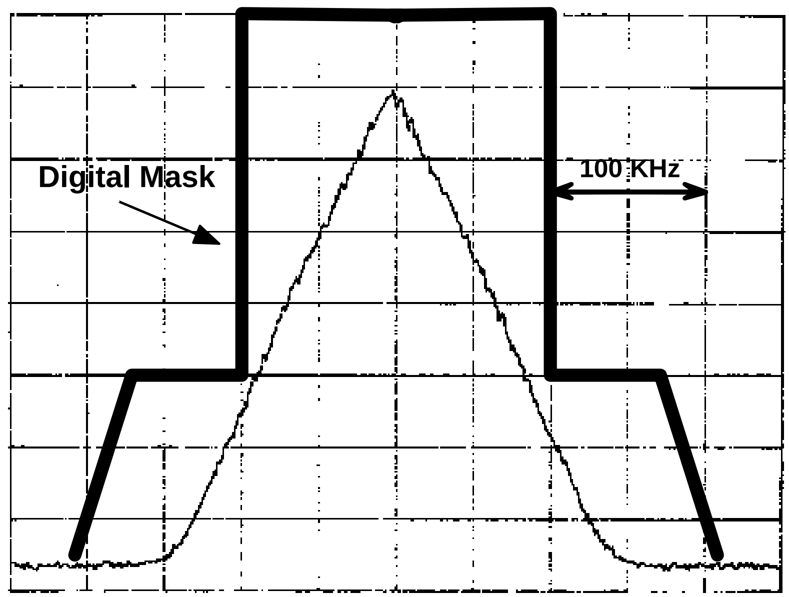


Figure 5-8
High Efficiency Mode
(EFF2, 7-Level Modulation) 256 kbps

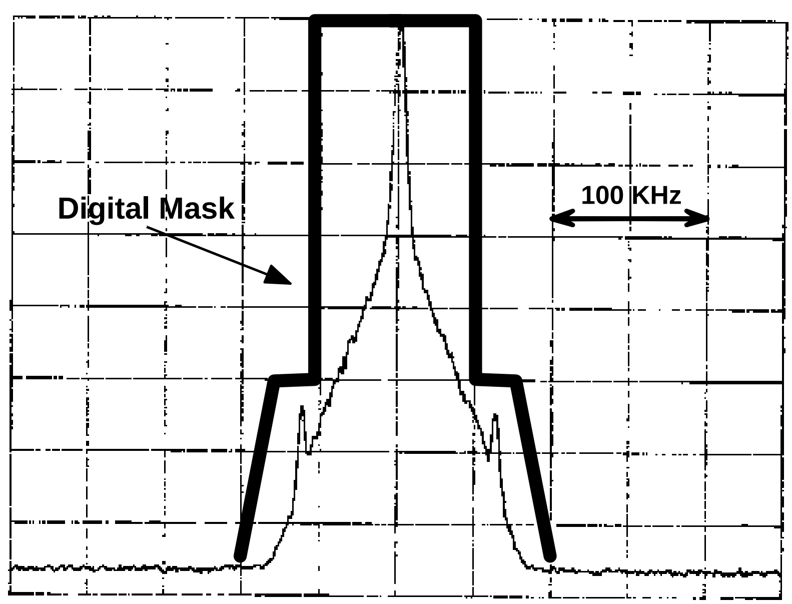


Figure 5-9
Narrow Bandwidth Mode
(7-Level Modulation with Reduced Deviation) 256 kbps

Section 6

Customer Service

6.1 Introduction

Moseley Associates will assist its product users with difficulties. Most problems can be resolved through telephone consultation with our technical service department. When necessary, factory service may be provided. If you are not certain whether factory service of your equipment is covered, please check your product Warranty/Service Agreement.

Do not return any equipment to Moseley without prior consultation.

The solutions to many technical problems can be found in our product manuals; please read them and become familiar with your equipment.

We invite you to visit our Internet web site at **http://www.moseleysb.com/** .

6.2 Technical Consultation

Please have the following information available prior to calling the factory:

- Model number and serial number of unit;
- Shipment date or date of purchase of an Extended Service Agreement;
- Any markings on suspected subassemblies (such as revision level); and
- Factory test data, if applicable.

Efficient resolution of your problem will be facilitated by an accurate description of the problem and its precise symptoms. For example, is the problem intermittent or constant? What are the front panel indications? If applicable, what is your operating frequency?

Technical consultation is available at (805) 968-9621 from 8:00 a.m. to 5:00 p.m., Pacific time, Monday through Friday. During these hours a technical service representative who knows your product should be available. If the representative for your product is busy, your call will be returned as soon as possible. Leave your name, station call letters if applicable, type of equipment, and telephone number(s) where you can be reached in the next few hours.

Please understand that, in trying to keep our service lines open, we may be unable to provide “walk-through” consultation. Instead, our representative will usually suggest the steps to resolve your problem; try these steps and, if your problem remains, do not hesitate to call back.

After-Hours Emergencies

Emergency consultation is available through the same telephone number from 5:00 p.m. to 10:00 p.m. Pacific time, Monday to Friday, and from 8:00 a.m. to 10:00 p.m. Pacific time on weekends and holidays. Please do not call during these hours unless you have an emergency with installed equipment. Our representative will not be able to take orders for parts, provide order status information, or assist with installation problems.

6.3 Factory Service

Arrangements for factory service should be made only with a Moseley technical service representative. You will be given a Return Authorization (RA) number. This number will expedite the routing of your equipment directly to the service department. Do not send any equipment to Moseley Associates without an RA number.

When returning equipment for troubleshooting and repair, include a detailed description of the symptoms experienced in the field, as well as any other information that well help us fix the problem and get the equipment back to you as fast as possible. Include your RA number inside the carton.

If you are shipping a complete chassis, all modules should be tied down or secured as they were originally received. On some Moseley Associates equipment, printing on the underside or topside of the chassis will indicate where shipping screws should be installed and secured.

Ship equipment in its original packing, if possible. If you are shipping a subassembly, please pack it generously to survive shipping. Make sure the carton is packed fully and evenly without voids, to prevent shifting. Seal it with appropriate shipping tape or nylon-reinforced tape. Mark the outside of the carton "Electronic Equipment - Fragile" in large red letters. Note the RA number clearly on the carton or on the shipping label, and make sure the name of your company is listed on the shipping label. Insure your shipment appropriately. All equipment must be shipped prepaid.

The survival of your equipment depends on the care you take in shipping it.

Address shipments to:

MOSELEY ASSOCIATES, INC.

Attn: Technical Services Department
111 Castilian Drive
Santa Barbara, CA 93117

Moseley Associates, Inc. will return the equipment prepaid under Warranty and Service Agreement conditions, and either freight collect or billed for equipment not covered by Warranty or a Service Agreement.

6.4 Field Repair

Some Moseley Associates equipment will have stickers covering certain potentiometers, varicaps, screws, and so forth. Please contact Moseley Associates technical service department before breaking these stickers. Breaking a tamperproof sticker may void your warranty.

When working with Moseley's electronic circuits, work on a grounded antistatic surface, wear a ground strap, and use industry-standard ESD control.

Try to isolate a problem to a module or to a specific section of a module. Then compare actual wave shapes and voltage levels in your circuit with any shown on the block and level diagrams or schematics. These will sometimes allow the problem to be traced to a component.

Spare Parts Kits

Spare parts kits are available for all Moseley Associates products. We encourage the purchase of the appropriate kits to allow self-sufficiency with regard to parts. Information about spares kits for your product may be obtained from our sales department or technical service department.

Module Exchange

When it is impossible or impractical to trace a problem to the component level, replacing an entire module or subassembly may be a more expedient way to correct the problem. Replacement modules are normally available at Moseley Associates for immediate shipment. Arrange delivery of a module with our technical services representative. If the shipment is to be held at your local airport with a telephone number to call, please provide an alternate number as well. This can prevent unnecessary delays.

Field Repair Techniques

If an integrated circuit is suspect, carefully remove the original and install the new one, observing polarity. Installing an IC backward may damage not only the component itself, but the surrounding circuitry as well. IC's occasionally exhibit temperature-sensitive characteristics. If a device operates intermittently, or appears to drift, rapidly cooling the component with a cryogenic spray may aid in identifying the problem.

If a soldered component must be replaced, do the following:

- Use a 40W maximum soldering iron with an 1/8-inch maximum tip. Do not use a soldering gun. Excessive heat can damage components and the printed circuit. Surface mount devices are especially heat sensitive, and require a lower power soldering iron. If you are not experienced with surface mount components, we suggest that you do not learn on critical equipment.

- Remove the solder from the component leads and the printed circuit pads. Solder wicking braid or a vacuum de-solderer are useful for this. Gently loosen the component leads and extract the component from the board.

- Form the leads of the replacement component to fit easily into the circuit board pattern.

- Solder each lead of the component to the bottom side of the board, using a good brand of rosin-core solder. We recommend not using water soluble flux, particularly in RF portions of the circuit. The solder should flow through the hole and form a fillet on both sides. Fillets should be smooth and shiny, but do not overheat the component trying to obtain this result.

- Trim the leads of the replacement component close to the solder on the pad side of the printed circuit board with a pair of diagonal cutters.

- Completely remove all residual flux with a cotton swab moistened with flux cleaner.

- For long term quality, inspect each solder joint – top and bottom – under a magnifier and rework solder joints to meet industry standards. Inspect the adjacent components soldered by the Moseley Associates production line for an example of high reliability soldering.

Appendix

A. Test Connector Schematics

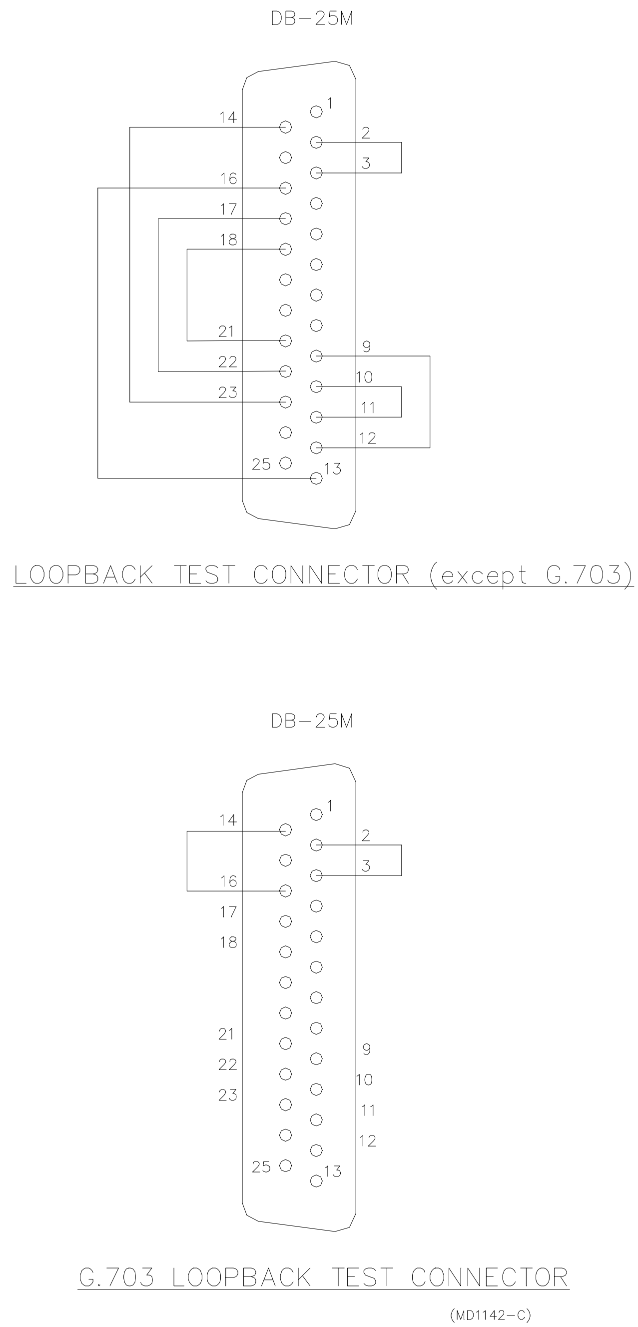


Figure A-1

B. Interface Cables Schematics

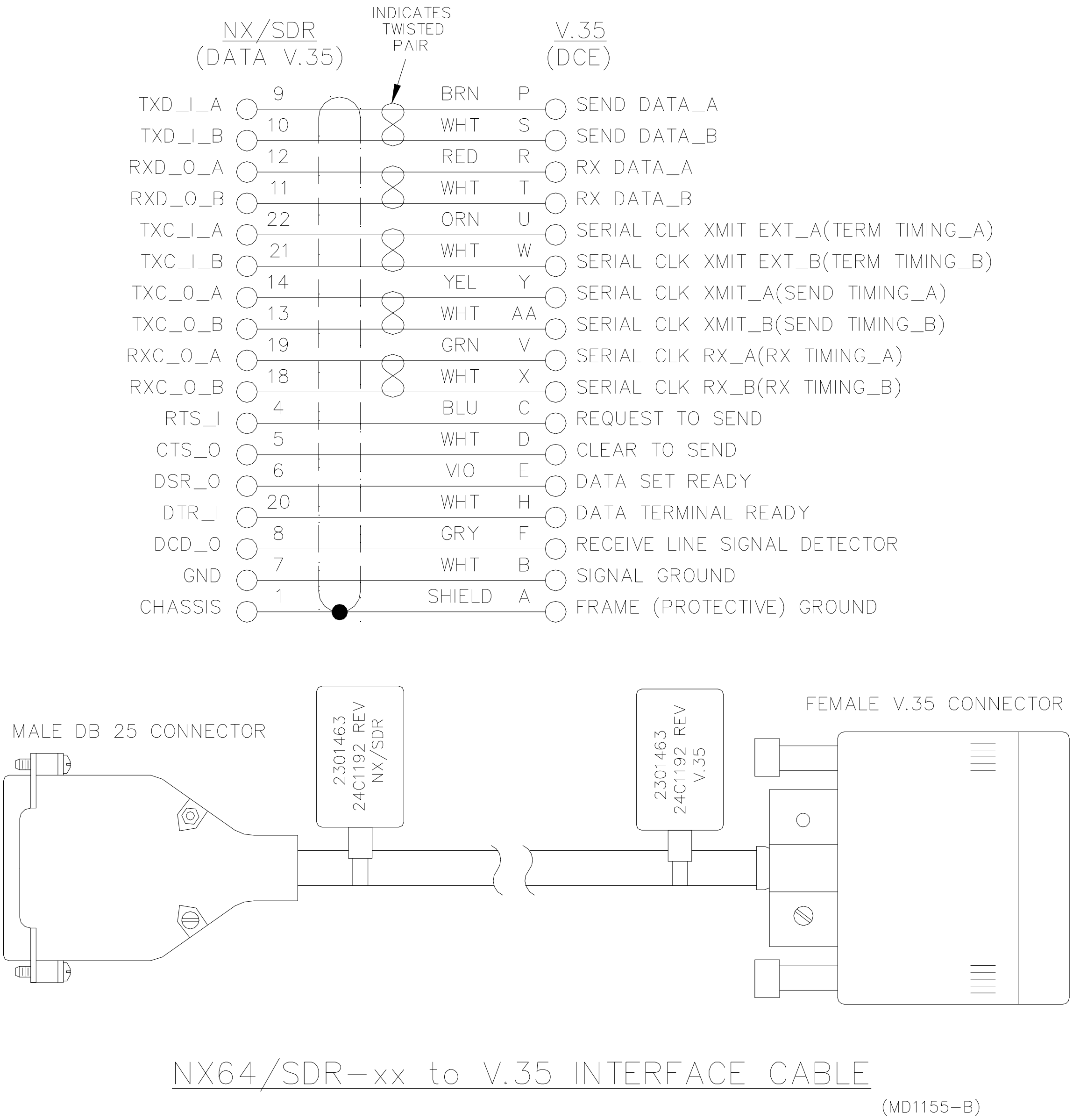
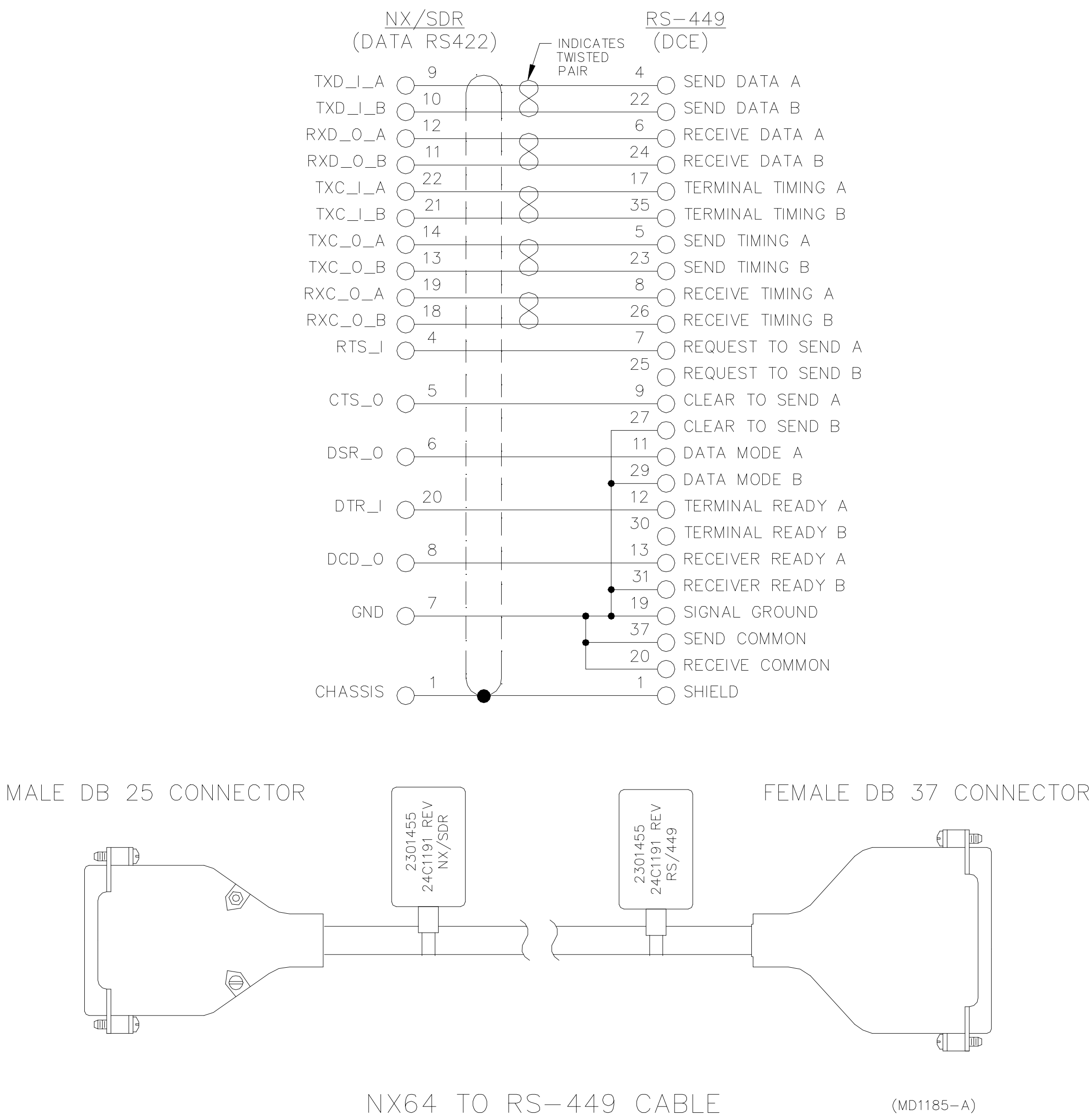


Figure B-1



NX/SDR
(DATA RS422)
INDICATES TWISTED PAIR
RS-449
(DCE)
TXD_I_A 9 — 4 SEND DATA A
TXD_I_B 10 — 22 SEND DATA B
RXD_O_A 12 — 6 RECEIVE DATA A
RXD_O_B 11 — 24 RECEIVE DATA B
TXC_I_A 22 — 17 TERMINAL TIMING A
TXC_I_B 21 — 35 TERMINAL TIMING B
TXC_O_A 14 — 5 SEND TIMING A
TXC_O_B 13 — 23 SEND TIMING B
RXC_O_A 19 — 8 RECEIVE TIMING A
RXC_O_B 18 — 26 RECEIVE TIMING B
RTS_I 4 — 7 REQUEST TO SEND A
25 REQUEST TO SEND B
CTS_O 5 — 9 CLEAR TO SEND A
27 CLEAR TO SEND B
DSR_O 6 — 11 DATA MODE A
29 DATA MODE B
DTR_I 20 — 12 TERMINAL READY A
30 TERMINAL READY B
DCD_O 8 — 13 RECEIVER READY A
31 RECEIVER READY B
GND 7 — 19 SIGNAL GROUND
37 SEND COMMON
20 RECEIVE COMMON
CHASSIS 1 — 1 SHIELD
MALE DB 25 CONNECTOR
FEMALE DB 37 CONNECTOR
2301455
24C1191 REV
NX/SDR
2301455
24C1191 REV
RS/449
NX64 TO RS-449 CABLE
(MD1185-A)

Figure B-2

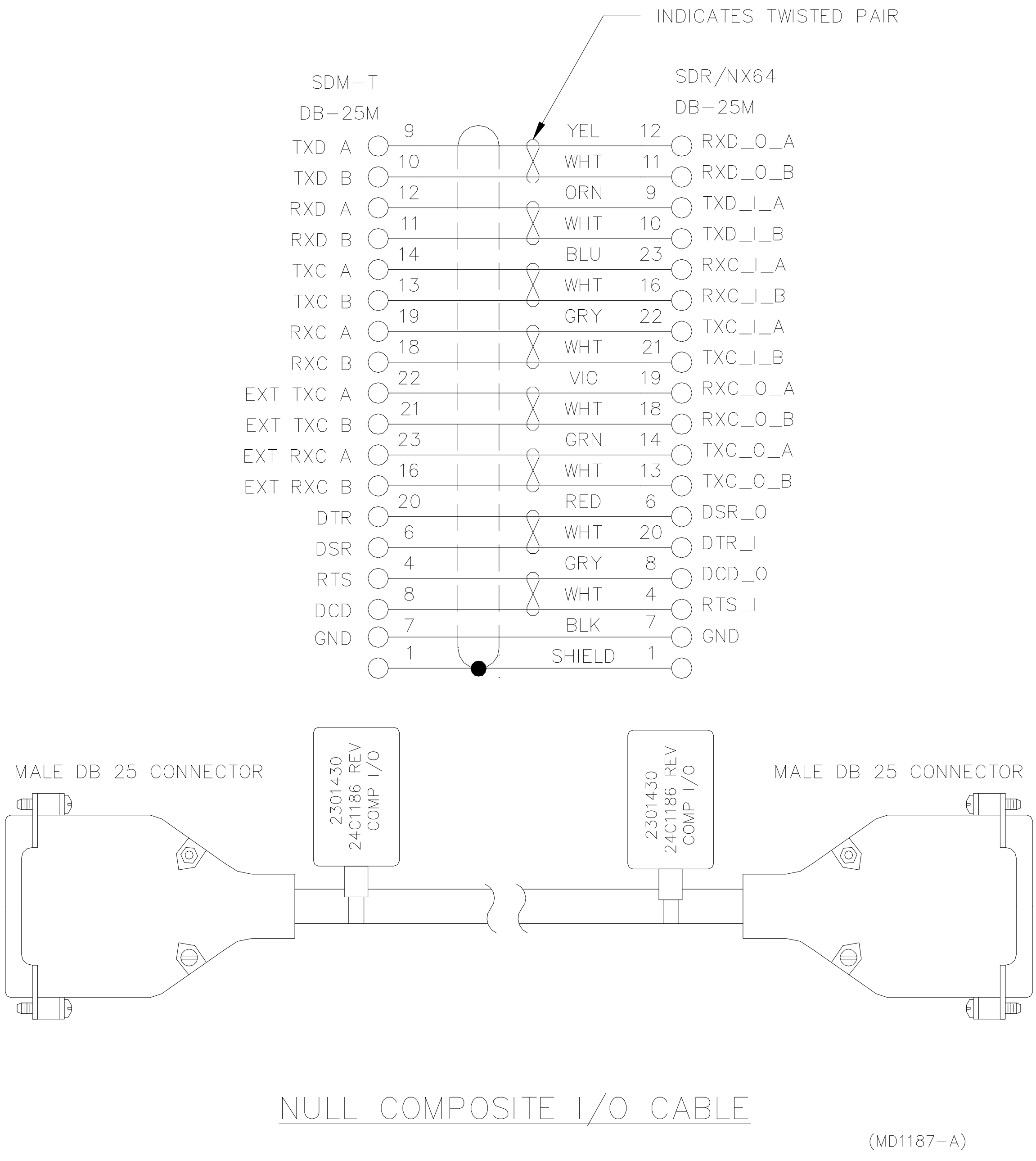

INDICATES TWISTED PAIR
SDM–T
DB–25M
SDR/NX64
DB–25M
TXD A
TXD B
RXD A
RXD B
TXC A
TXC B
RXC A
RXC B
EXT TXC A
EXT TXC B
EXT RXC A
EXT RXC B
DTR
DSR
RTS
DCD
GND
9 YEL 12 RXD_O_A
10 WHT 11 RXD_O_B
12 ORN 9 TXD_I_A
11 WHT 10 TXD_I_B
14 BLU 23 RXC_I_A
13 WHT 16 RXC_I_B
19 GRY 22 TXC_I_A
18 WHT 21 TXC_I_B
22 VIO 19 RXC_O_A
21 WHT 18 RXC_O_B
23 GRN 14 TXC_O_A
16 WHT 13 TXC_O_B
20 RED 6 DSR_O
6 WHT 20 DTR_I
4 GRY 8 DCD_O
8 WHT 4 RTS_I
7 BLK 7 GND
1 SHIELD 1
MALE DB 25 CONNECTOR
2301430
24C1186 REV
COMP I/O
MALE DB 25 CONNECTOR
2301430
24C1186 REV
COMP I/O
NULL COMPOSITE I/O CABLE
(MD1187–A)

Figure B-3

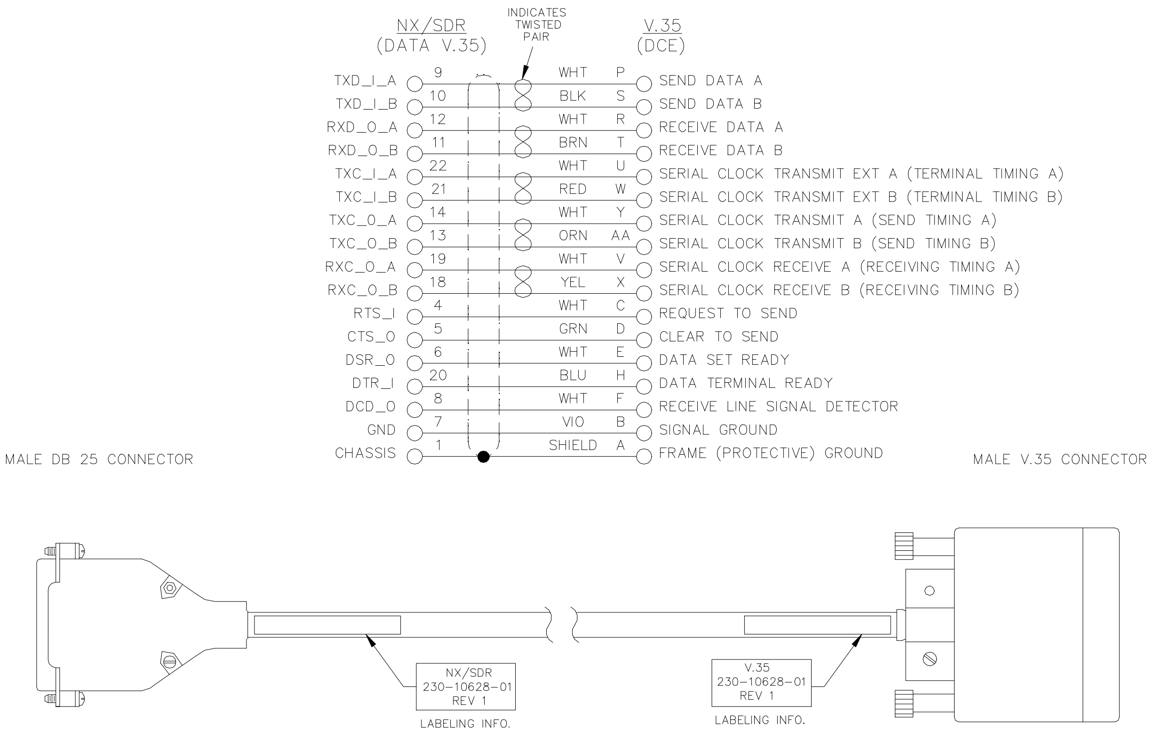
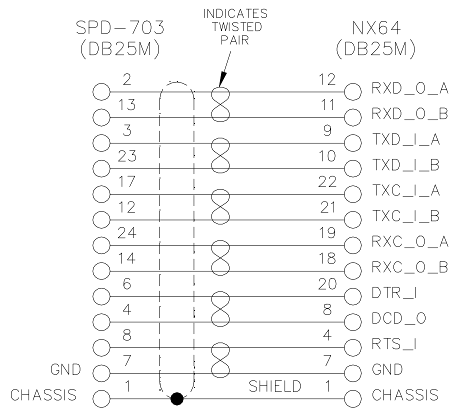


Figure B-4
NX64A/SDR-xx to RAD Kilomux Interface Cable



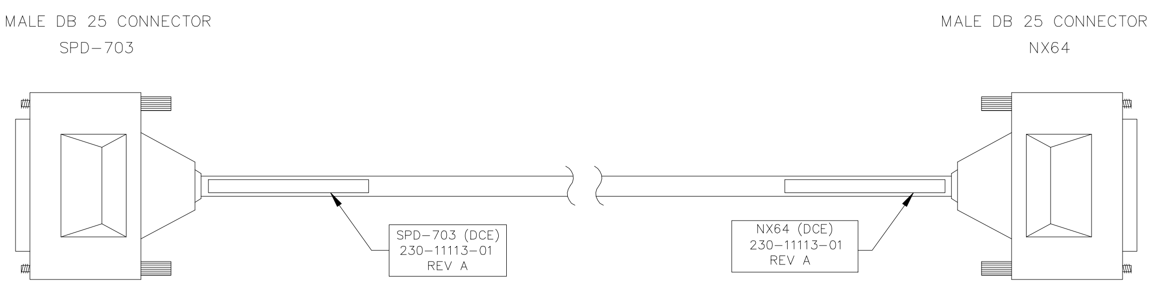


Figure B-5
NX64 to SPD-703 Interface Cable (DCE–DCE)
230-11113-01 R: A

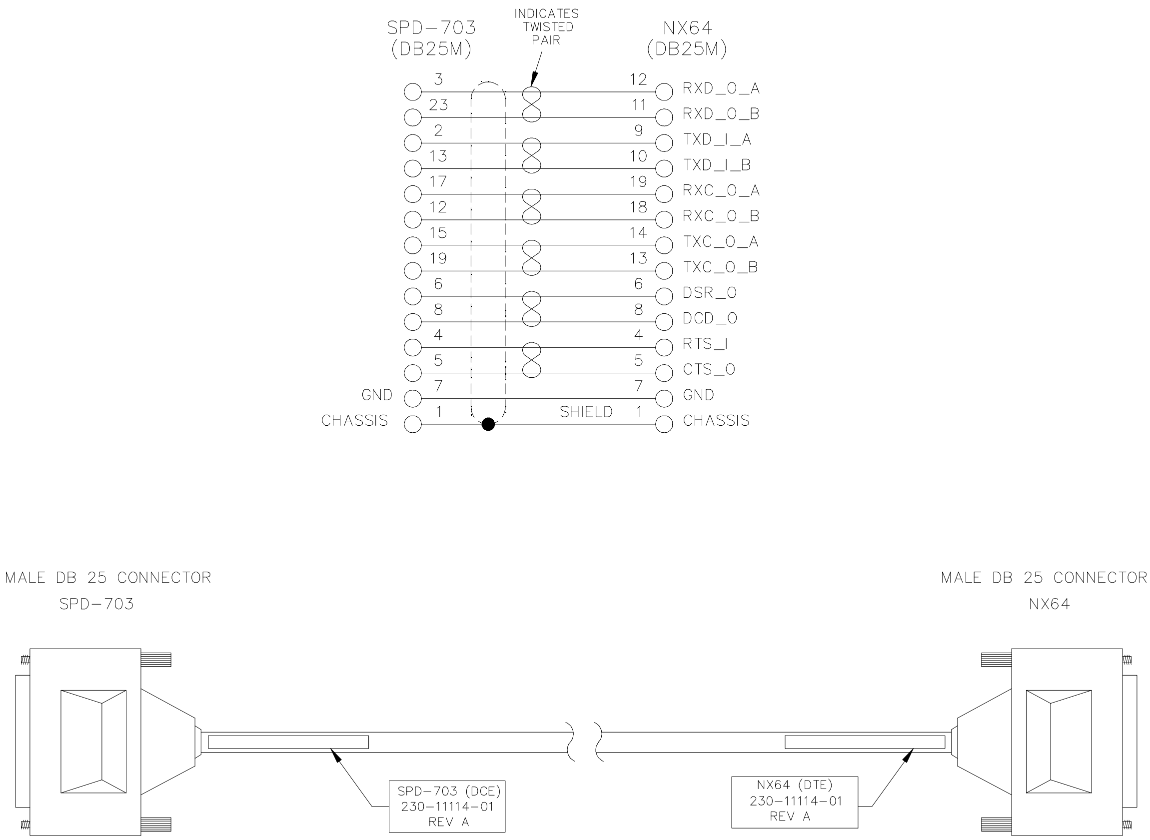


Figure B-6
NX64 to SPD-703 Interface Cable (DCE–DTE)
230-11114-01 R: A

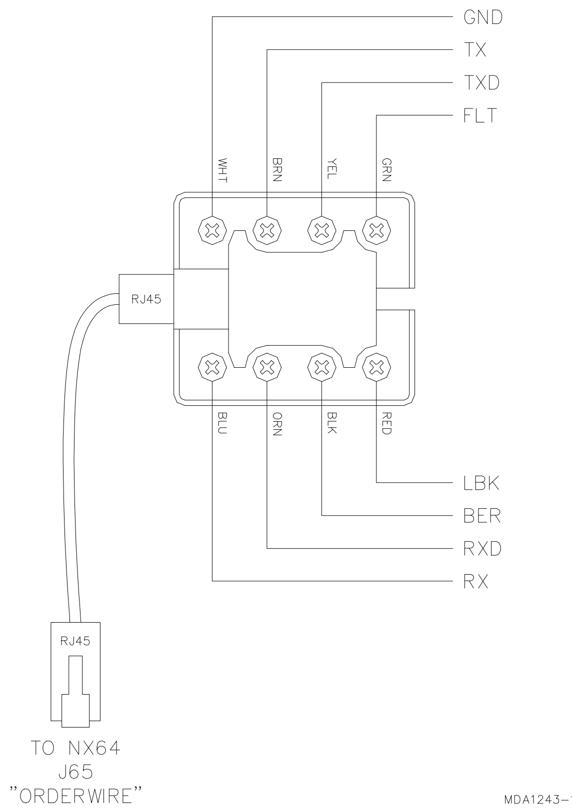
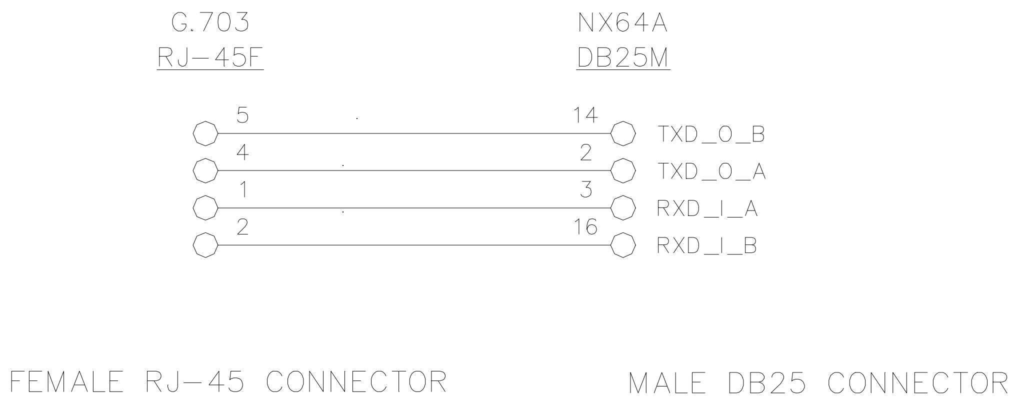


Figure B-7
Remote Metering Option Terminal Block
RJ45-8



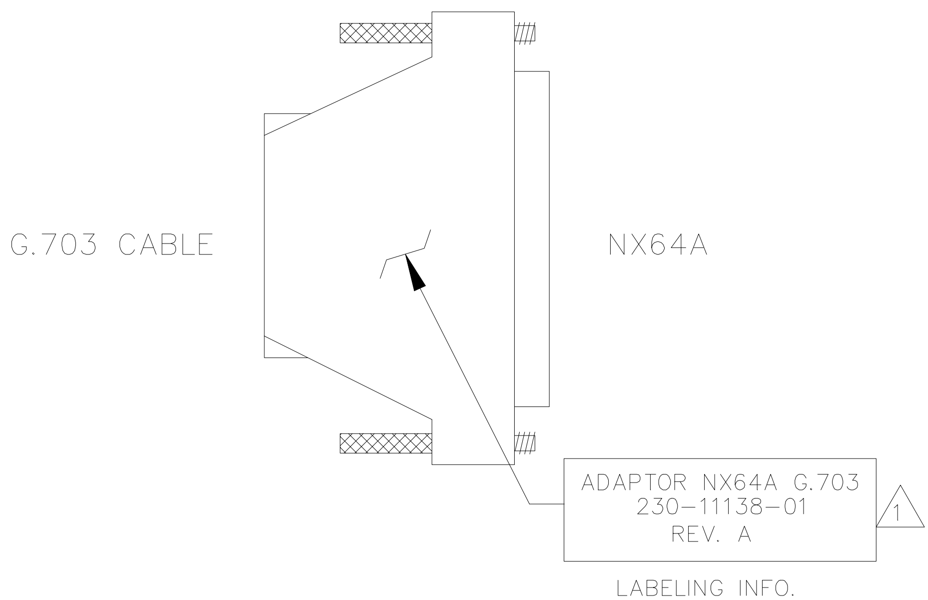


Figure B-8
G.703 Adaptor
230-11138-01 R:A

C. Connector Pin Assignments

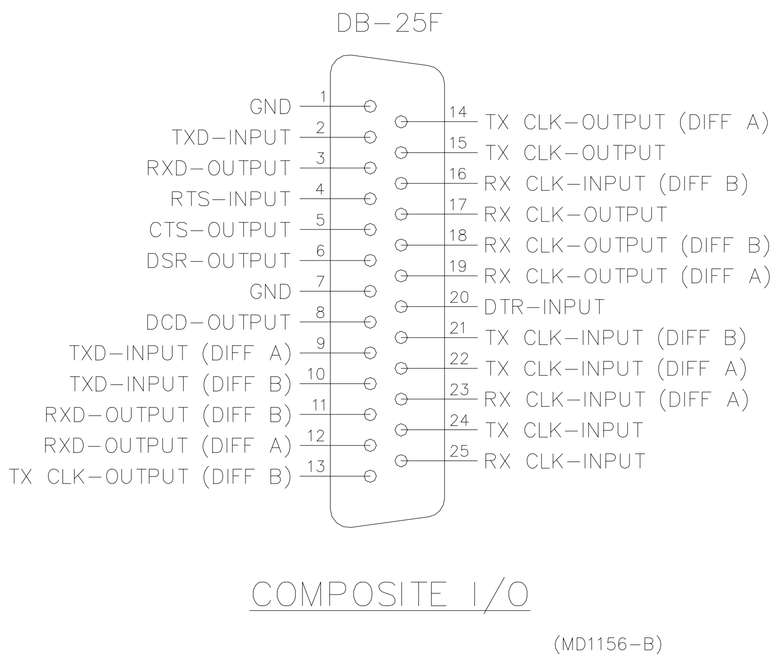


Figure C-1
(See Tables C-1 through C-5 for valid Connections)

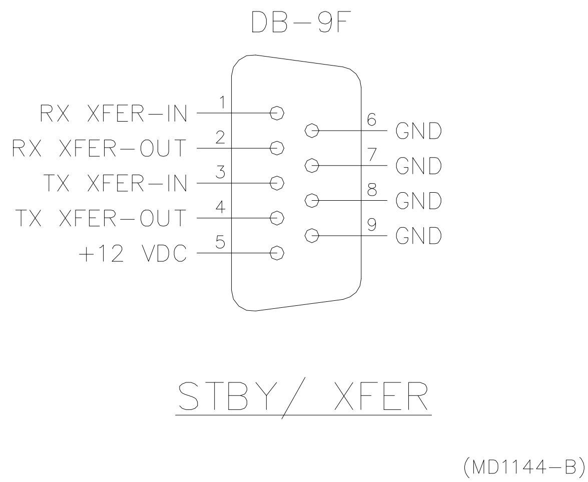


Figure C-2

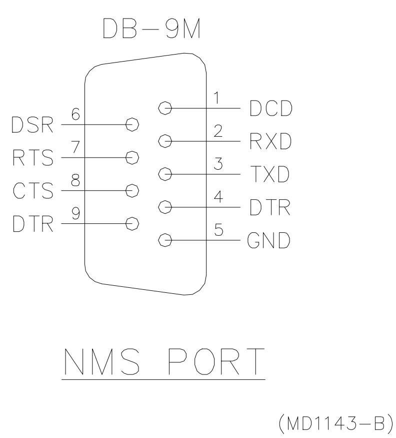


Figure C-3

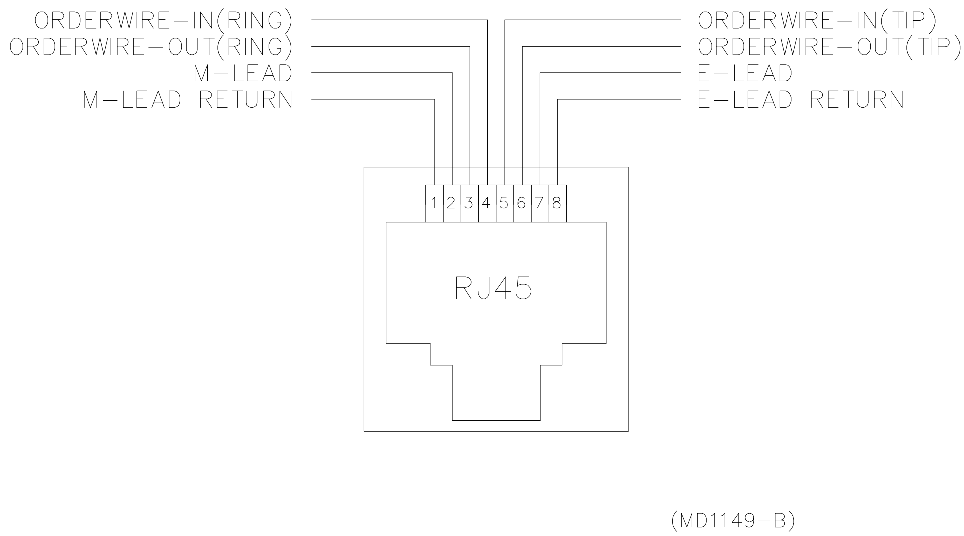


Figure C-4a
Orderwire

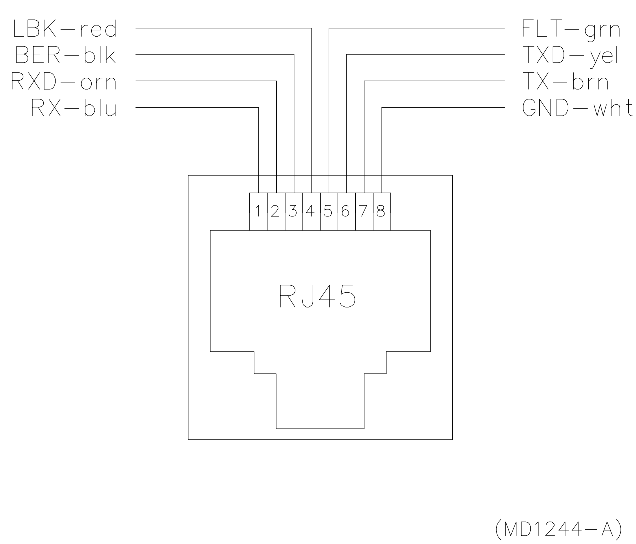


Figure C-4b
Remote Metering Option
(uses orderwire port)

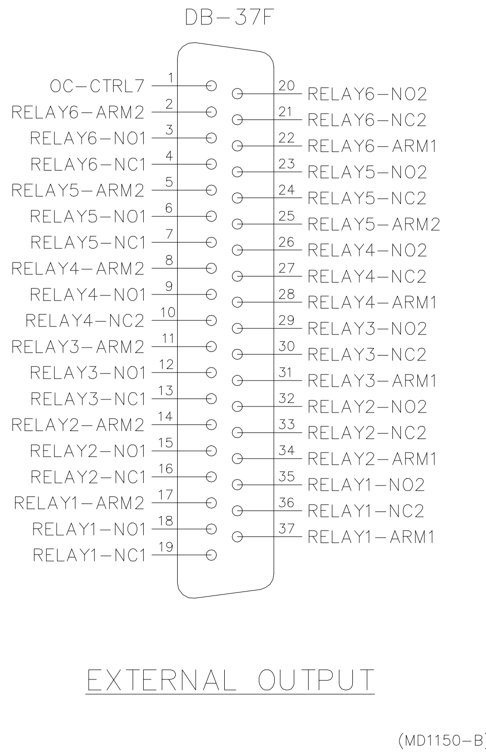


Figure C-5
Remote I/O

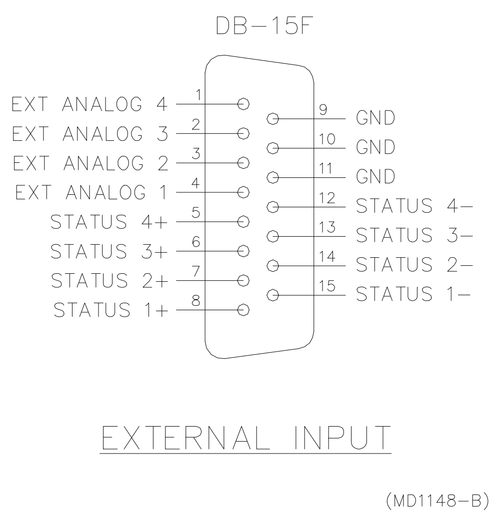


Figure C-6
Remote I/O

Table C-1
RS-449 NX64A I/O Connections

NAME	DIR	TYPE	NX64A (DCE) D25-F	RS449 (DCE) D37-F	FUNCTION
chassis gnd	-	-	1	1	Shield
rts_i	I	S	4	7	Request To Send A
cts_o	O	S	5	9	Clear To Send A
dsr_o	O	S	6	11	Data Mode A
signal gnd	-	-	7	19	Signal Gnd
signal gnd	-	-	7	20	Receive Common
signal gnd	-	-	7	27	Clear To Send B
signal gnd	-	-	7	29	Data Mode B
signal gnd	-	-	7	31	Receiver Ready B
signal gnd	-	-	7	37	Send Common
dcd_o	O	S	8	13	Receiver Ready A
txd_i_a	I	D	9	4	Send Data A
txd_i_b	I	D	10	22	Send Data B
rxd_o_b	O	D	11	24	Receive Data B
rxd_o_a	O	D	12	6	Receive Data A
txc_o_b	O	D	13	23	Send Timing B
txc_o_a	O	D	14	5	Send Timing A
rxc_o_b	O	D	18	26	Receive Timing B
rxc_o_a	O	D	19	8	Receive Timing A
dtr_i	I	S	20	12	Terminal Ready A
txc_i_b	I	D	21	35	Terminal Timing B
txc_i_a	I	D	22	17	Terminal Timing A

NOTES:
I=input
O=output
S=single-ended
D=differential

Table C-2
V.35 NX64A I/O Connections

NAME	DIR	TYPE	NX64A (DCE) D25-F	V.35 (DCE) WIN-F*	FUNCTION
chassis gnd	-	-	1	A	Frame (protective) Gnd
rts_i	I	S	4	C	Request To Send
cts_o	O	S	5	D	Clear To Send
dsr_o	O	S	6	E	Data Set Ready
signal gnd	-	-	7	B	Signal Gnd
dcd_o	O	S	8	F	Receive Line Signal Detector
txd_i_a	I	D	9	P	Send Data A
txd_i_b	I	D	10	S	Send Data B
rxd_o_b	O	D	11	T	Receive Data B
rxd_o_a	O	D	12	R	Receive Data A
txc_o_b	O	D	13	AA	Serial Clock Transmit B
txc_o_a	O	D	14	Y	Serial Clock Transmit A
rxc_o_b	O	D	18	X	Serial Clock Receive B
rxc_o_a	O	D	19	V	Serial Clock Receive A
dtr_i	I	S	20	H	Data Terminal Ready
txc_i_b	I	D	21	W	Serial Clock Transmit Ext A
txc_i_a	I	D	22	U	Serial Clock Transmit Ext B

NOTES:
I=input
O=output
S=single-ended
D=differential
* WIN-M required for RAD interface

Table C-3
EIA530 I/O Connections

NAME	DIR	TYPE	NX64A (DCE) D25-F	EIA530 (DCE) D25-F	FUNCTION
chassis gnd	-	-	1	1	Shield
txd_i_a	I	D	2	2	Transmitted Data A
rxd_o_a	O	D	3	3	Received Data A
rts_i_a	I	D	4	4	Request To Send A
cts_o_a	O	D	5	5	Clear To Send A
dsr_o_a	O	D	6	6	DCE Ready A
signal gnd	-	-	7	7	Signal Gnd
dcd_o_a	O	D	8	8	Receive Line Signal Detector A
rxc_o_b	O	D	9	9	Receiver Signal Element Timing B (DCE)
dcd_o_b	O	D	10	10	Receive Line Signal Detector B
txc_i_c	I	D	11	11	Transmit Signal Element Timing B (DTE)
txc_o_b	O	D	12	12	Transmit Signal Element Timing A (DCE)
cts_o_b	O	D	13	13	Clear To Send B
txd_i_b	I	D	14	14	Transmitted Data B
txc_o_a	O	D	15	15	Transmit Signal Element Timing A (DCE)
rxd_o_b	O	D	16	16	Received Data B
rxc_o_a	O	D	17	17	Receiver Signal Element Timing B (DCE)
rts_i_b	I	D	19	19	Request To Send B
dtr_i_a	I	D	20	20	DTE Ready A
dsr_o_b	O	D	22	22	DCE Ready B
dtr_i_b	I	D	23	23	DTE Ready B
tcx_i_a	I	D	24	24	Transmit Signal Element Timing A (DTE)

NOTES:
I=input
O=output
S=single-ended
D=differential

Table C-4
RS-232 I/O Connections

NAME	DIR	TYPE	NX64A (DCE) D25-F	RS-232 (DCE) D25-F	Function
chassis gnd	-	-	1	1	Chassis Gnd
txd_i	I	S	2	2	Transmit Data
rxd_o	O	S	3	3	Receive Data
rts_i	I	S	4	4	Request To Send
cts_o	O	S	5	5	Clear To Send
dsr_o	O	S	6	6	Data Set Ready
signal gnd	-	-	7	7	Signal Gnd
dcd_o	O	S	8	8	Data Carrier Detect
txc_o	O	S	15	15	Transmit Clock Out
rxc_o	O	S	17	17	Receive Clock Out
dtr_i	I	S	20	20	Data Terminal Ready
txc_i	I	S	24	24	Transmit Clock In
rxc_i	I	S	25	25	Receive Clock In

NOTES:
I=input
O=output
S=single-ended
D=differential

Table C-5
G.703 I/O Connections

NAME	DIR	TYPE	NX64A (DCE) D25-F	Function
chassis gnd	-	-	1	Chassis Gnd
txd_o_a	O	D	2	Transmit Data a
rxd_i_a	I	D	3	Receive Data a
txd_o_b	O	D	14	Transmit Data b
rxd_i_b	I	D	16	Receive Data b

NOTES:
I=input
O=output
S=single-ended
D=differential

Table C-6A
FEC Switch Settings

Switch Position	V.35	RS-449
1	ON	ON
2	OFF	ON
3	OFF	OFF
4	OFF	OFF

Table C-6B
FEC Switch Settings

Switch Position	Function	Setting
5	Reserved	Must be “OFF”
6	Reserved	Must be “ON”
7	RX Clock Phase	OFF: Normal ON: Invert
8	Reserved	Must be “OFF”

D. Manufacturer's Data Sheets

The following pages contain example data sheets of some common antenna and cabling equipment. Inclusion herein does not constitute an endorsement by Moseley Associates, Inc. Moseley does not guarantee the content of these sheets.