# User Manual
# NXE1-20
# Digital Radio

Doc. 602-95555-01

January 10, 2002

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| Section | Drawing No: | REV | Revised / Released | Reason |
|---|---|---|---|---|
| NXE1-20 | 602-95555-01 | A | SN | NEW |
| | | | | |

# Table of Contents

# 1 System Description

# 1.1 Introduction

The NXE1-20 is a spectrum-scalable point-to-point digital radio that can deliver 8Mbps of data. Advanced modulation and digital processing techniques allow one radio to deliver user-defined rates from 512 kbps to 8Mbps

The product is an all-digital, open-architecture, modular system (see Figure 1-1 below). The versatility and power of the product comes from a complete range of "plug and play" personality modules.

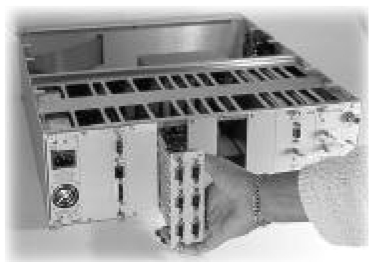

**Figure 1-1. NXE1-20 Modular Open Architecture**

The high spectral efficiency of the NXE1-20 is achieved by user-selectable QPSK, or 16 QAM. Powerful Reed-Solomon error correction, coupled with a 20-tap adaptive equalizer, provides unsurpassed signal robustness in hostile RF environments. .

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# 1.2 System Features

- Selectable Rates: 512 kbps to 8.448 Mbps
- Selectable Spectral Efficiency of 1.6 or 3.2 bps/Hz
- QPSK & 16 QAM Modulation
- Powerful Reed-Solomon Error Correction with up to 12 level interleaver
- Built-in Adaptive Equalizer
- Internal Duplexer or external for hot standby system
- Independent Synthesized Tx & Rx units
- Auto / Manual Power Control of up to 20 dB
- Built-in Auto Pin Diode Attenuator for powerful signals
- Accurate Digital Filtering for adjacent channel rejection
- 386 Processor-based controller
- Extensive LCD screen status monitoring

- Built-in BER Meter
- Built-in NMS
- Monitoring & Time Stamping
- Monitor up to 4 external Analog & Digital I/O
- Readout of RSL in dBm
- Completely modular

# 1.3 Typical Configurations

### 1.3.1 Data Rate and Interface

Table 1-1 provides basic data channel capabilities for the NXE1-20. See Section 2 (Installation) for more detailed information.

**Table 1-1.NXE1-20 Data Channel Configurations**

| Data Rate | MUX Hardware | Channels | Interface(s) |
|---|---|---|---|
| 1.5 Mbps-8 Mbps | 2 or 4 x E1/T1 | 2 or 4 | G.703, E1/T1 |
| 512 kbps-2 Mbps | QAM Modem | 1 | Fractional E1/T1 |
| 512 kbps-2 Mbps | QAM Modem | 1 | V35, RS449 |

### 1.3.2 Standalone Operation

The NXE1-20 may be used as a standalone digital radio with an interface in the modem or with a Multiplexer with 2 or 4 E1/T1 interfaces. The Multiplexer has an overhead channel which can be utilized by the customer

### 1.3.3 Hot Standby (Protected) Operation

The product in a hot standby configuration as depicted in Fig.1-3, using two NXE1-20 radios and a TP64 transfer panel.

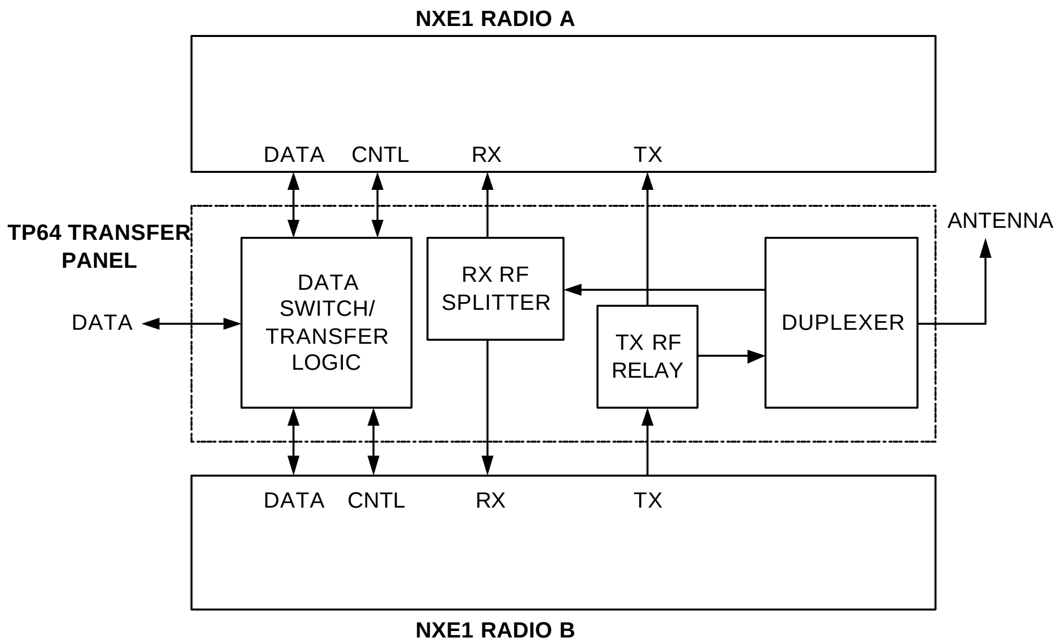


**Figure 1-3. NXE1-20 Hot Standby – Two Discrete Radios with Transfer Panel**

# 1.4 Regulatory Notices

**FCC Part 15 Notice**

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his expense. Any external data or audio connection to this equipment must use shielded cables.

**EC Declaration of Conformity**

# 1.5 System Description (QAM)

## 1.5.1 Introduction

The product is a full-duplex digital radio. The following sections describe the TX system, RX system, followed by sub-system components. Please reference the accompanying block diagrams for clarification.

We will follow the typical end-to-end progression of a radio system starting with the TX baseband inputs, to the QAM modulator, followed by the upconversion process and the power amplifier. We then proceed to the RX preamplifier input, the downconversion process, followed by the QAM demodulator and baseband outputs.

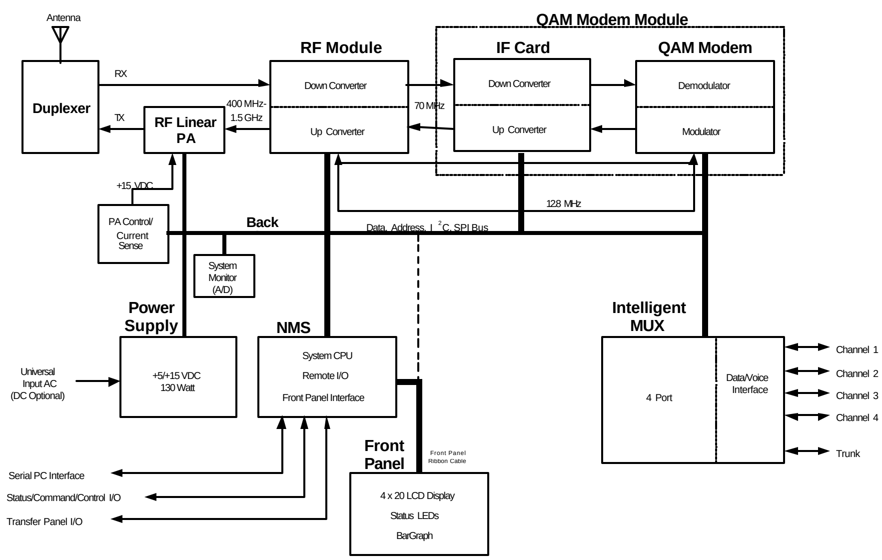

**Figure 1-12. NXE1-20 System Block Diagram**

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All modules (excluding the Front Panel and Power Amplifier) are interconnected via the backplane that traverses the entire width of the unit. The backplane contains the various communication buses as well as the PA (Power Amplifier) control and redundant transfer circuitry. See Figure 1-13 below for locations of the Backplane and the Power Amplifier. The power supply levels and status are monitored on the backplane and the NMS/CPU card processes the data.

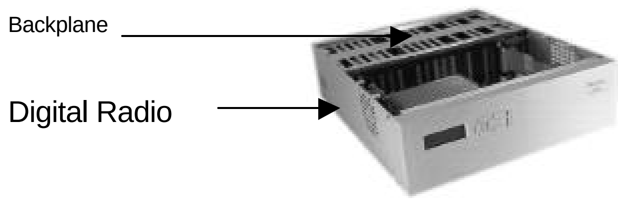



**Figure 1-13. Location of theNXE1-20Backplane and Power Amplifier**

The NMS/CPU card incorporates microprocessor and FPGA logic to configure and monitor the overall operation of the system via front panel controls, LCD screen menus, status LEDs and the bar graph display. Module settings are loaded into the installed cards and power-up default settings are stored in non-volatile memory. LCD screen menu software is uploaded into memory, providing field upgrade capability. A Windows-based PC interface is available for connection at the rear panel DATA port.

## 1.5.2 QAM Modulator/IF Upconverter

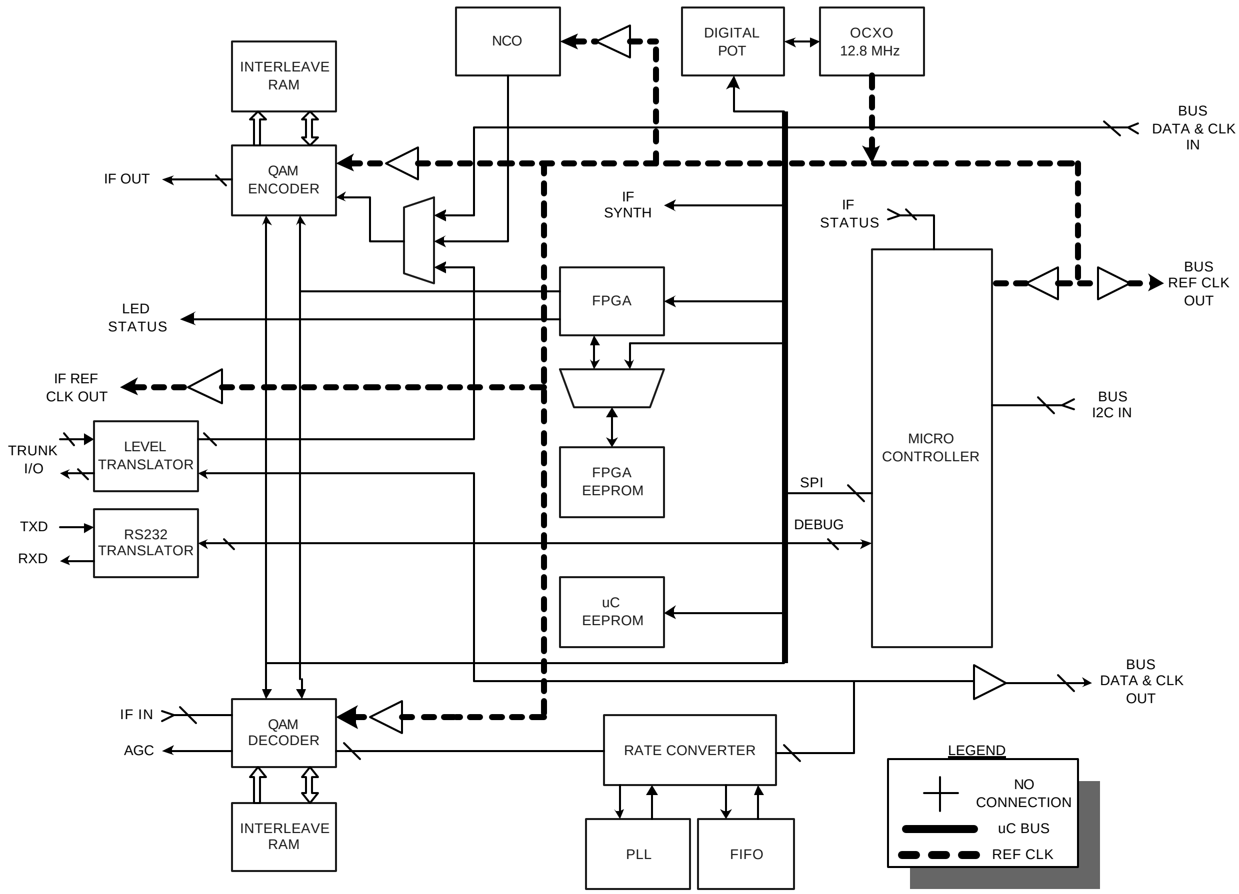



**Figure 1-14. QAM Modem Block Diagram**

The QAM (Quadrature Amplitude Modulation) Modulator is the transmit portion of the QAM Modem card. The QAM Modem also houses the IF Up/Down Converter. The QAM Modulator utilizes the upconverter portion of the IF daughter card.

The QAM Modulator accepts the aggregate data stream via the backplane (see Figure 1-14 above). The module performs modulation at a carrier frequency of 6.4 MHz, adding FEC (Forward Error Correction) bits while interleaving the blocks of data. The result is a very spectrally efficient, yet robust linear modulation scheme. This process requires an ultra-stable master clock provided by an OCXO (oven controlled crystal oscillator) that is accurate to within 0.1 ppm.

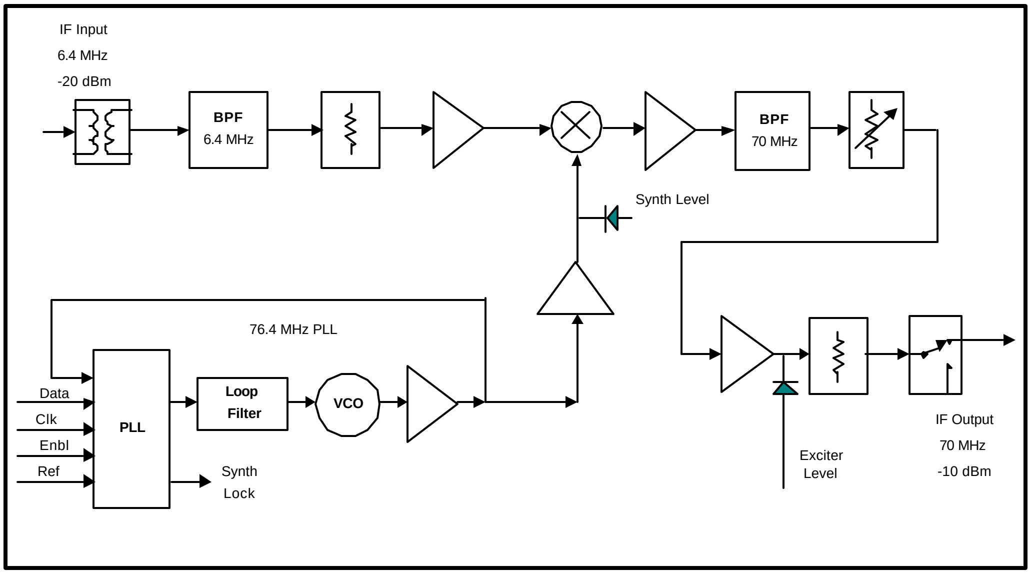



**Figure 1-15. IF Upconverter Block Diagram**

The resultant carrier is translated up to 70 MHz by the IF Upconverter (see Figure 1-15). This is accomplished by a standard mixing of the carrier with a phase-locked LO. A 70 MHz SAW filter provides an exceptional, spectrally-clean output signal.

## 1.5.3 RF Upconverter

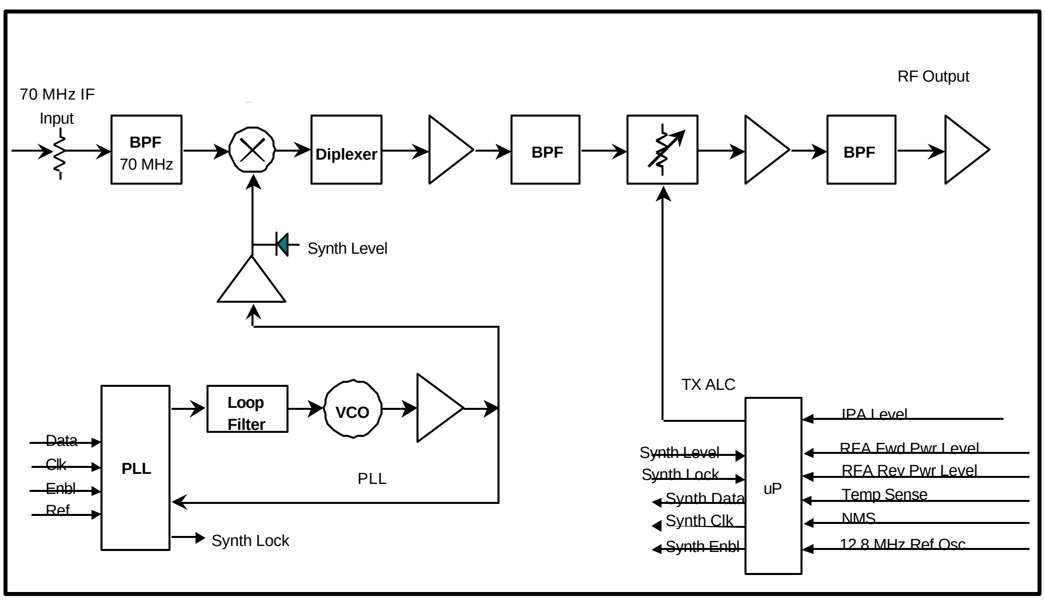



**Figure 1-16. RF Upconverter Block Diagram**

The IF output carrier of the IF Upconverter daughter card is fed to the transmit portion of the RF Module via an external (rear panel) semi-rigid SMA cable. This module performs the necessary upconversion to the RF carrier (see Figure 1-16). There is an on-board CPU for independent control of the critical RF parameters of the system.

Since this is a linear RF processing chain, an automatic leveling control loop (ALC) is implemented here to maintain maximum available power output (and therefore maximum system gain). The ALC monitors the PA forward power (FWD) output sample, and controls the upconverter gain per an algorithm programmed in the CPU. The ALC also controls the power-up RF conditions of the transmitter output.

### 1.5.4 Power Amplifier (PA)

The Power Amplifier (PA) is a separate module that is mounted to a heat sink and is fan-cooled for reliable operation (see Figure 1-17). The PA is a design for maximum linearity in an amplitude modulation-based system.

### 1.5.5 RF Downconverter

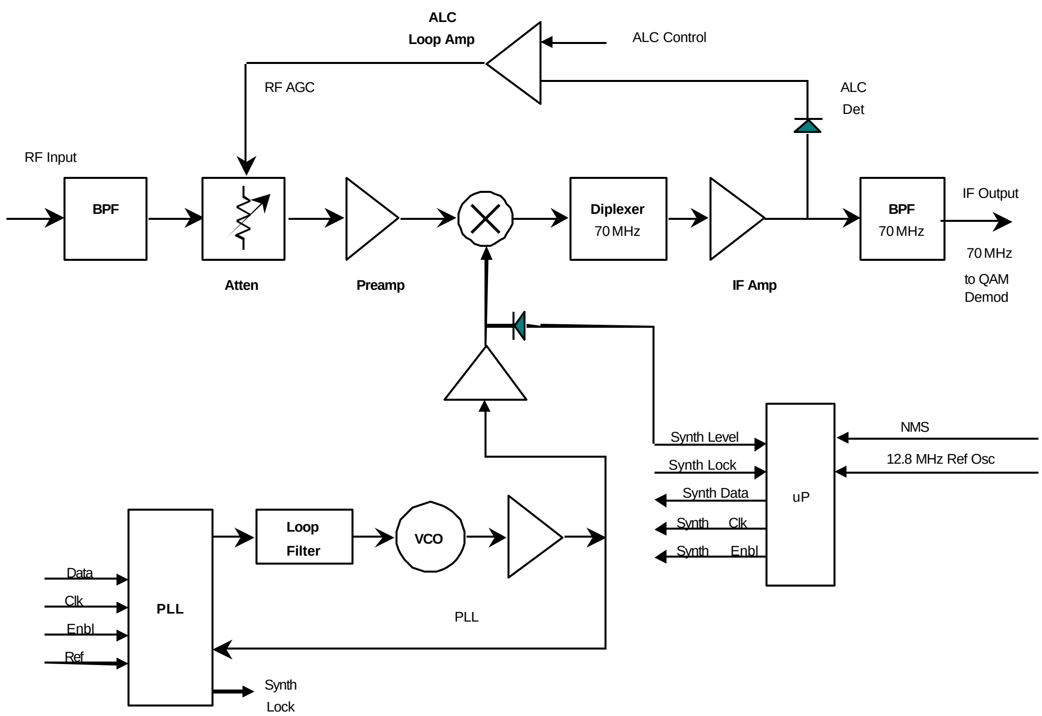



**Figure 1-18. RF Downconverter Block Diagram**

The receiver handles the traditional RF to IF conversion from the carrier to 70 MHz (see Figure 1-18). Considerations are given to image rejection, intermodulation performance, dynamic range, agility, and survivability. A separate AGC loop was assigned to the RF front end to prevent intermodulation and saturation problems associated with reception of high level undesirable interfering RF signals resulting from RF bandwidth that is much wider than the IF bandwidth. The linear QAM scheme is fairly intolerant of amplifier overload.

### 1.5.6 QAM Demodulator/IF Downconverter

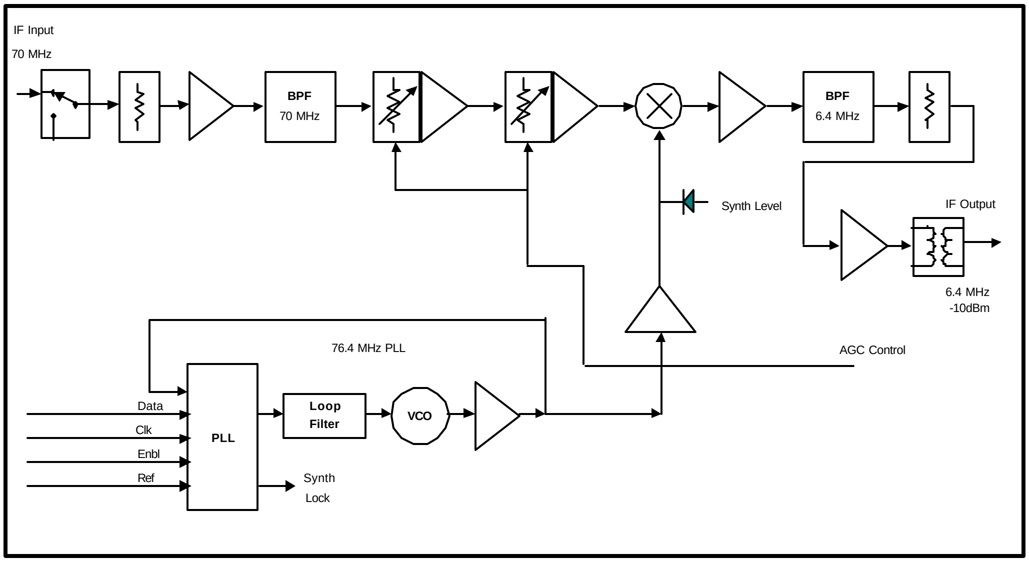



**Figure 1-19. IF Downconverter Block Diagram**

The QAM (Quadrature Amplitude Modulation) Demodulator is the receive portion of the QAM Modem card. The QAM Modem also houses the IF Up/Down Converter. The QAM Demod utilizes the downconverter portion of the IF daughter card.

The IF Downconverter receives the 70 MHz carrier from the receiver portion of the RF Module via an external semi-rigid cable and directly converts the carrier to 6.4 MHz by mixing with a low-noise phase-locked LO (see Figure 1-19). System selectivity is achieved through the use of a 70 MHz SAW filter.

The QAM Demod receives and demodulates the 6.4 MHz carrier (see Figure 1-16). The demodulation process includes the FEC implementation and de-interleaving that matches the QAM modulator in the transmitter, and the critical “data assisted recovery” of the clock. This process requires an ultra-stable master clock provided by an OCXO (oven controlled crystal oscillator).

The output is an aggregate data stream that is distributed to the trunk port for if the data input/output is out of the Modem, or to the backplane for connection to the multiplexer connected on the backplane.

# 2 Installation

## 2.1 Unpacking

The following is a list of all included items.

| Description | Quantity |
|---|---|
| Digital Radio (3RU chassis) | 1 |
| Rack Ears (with hardware) | 4 |
| Extender Card (Universal QAM) — optional | 1 |
| Power Cord (IEC 3 conductor for AC, 2-wire for DC) | 2 |
| Manual ( or Soft copy on a CD) | 1 |
| Test Data Sheet (customer documentation) | 1 |

Be sure to retain the original boxes and packing material in case of return shipping. Inspect all items for damage and/or loose parts. Contact the shipping company immediately if anything appears damaged. If any of the listed parts are missing, call the distributor or the factory immediately to resolve the problem.

## 2.2 Notices

***CAUTION***

*DO NOT OPERATE UNITS WITHOUT AN ANTENNA, ATTENUATOR, OR LOAD CONNECTED TO THE ANTENNA PORT. DAMAGE MAY OCCUR TO THE TRANSMITTER DUE TO EXCESSIVE REFLECTED RF ENERGY.*

*ALWAYS ATTENUATE THE SIGNAL INTO THE RECEIVER ANTENNA PORT TO LESS THAN 3000 MICROVOLTS. THIS WILL PREVENT OVERLOAD AND POSSIBLE DAMAGE TO THE RECEIVER MODULE*

**WARNING**

**HIGH VOLTAGE IS PRESENT INSIDE THE POWER SUPPLY MODULE WHEN THE UNIT IS PLUGGED IN. REMOVAL OF THE POWER SUPPLY CAGE WILL EXPOSE THIS POTENTIAL TO SERVICE PERSONNEL. TO PREVENT ELECTRICAL SHOCK, UNPLUG THE POWER CABLE BEFORE SERVICING. UNIT SHOULD BE SERVICED BY QUALIFIED PERSONNEL ONLY.**

**PRE-INSTALLATION NOTES**

Always pre-test the system on the bench in its intended configuration prior to installation at a remote site. Avoid cable interconnection length in excess of 1 meter in strong RF environments. We highly recommend installation of lightning protectors to prevent line surges from damaging expensive components.

# 2.3 Rack Mount

The product is normally rack-mounted in a standard 19” cabinet. Leave space clear above (or below) the unit for proper air ventilation of the card cage. The rack ears are typically mounted as shown in Figure 2-1. Other mounting methods are possible by changing the orientation of the rack ears.

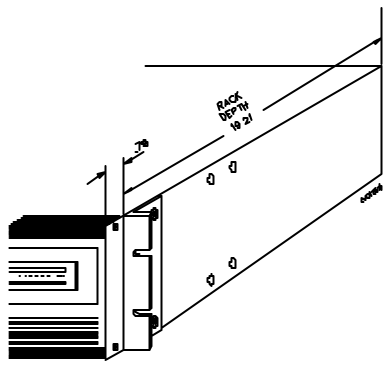



**Figure 2-1.NXE1-20 Typical Rack Mount Bracket Installation**

# 2.4 Duplexer: Internal/External

Various duplexers, both internal and external, can be utilized. For current duplexers utilized with the radios, please see the Appendix.

# 2.5 Rear Panel Connections & Indicators

Please refer to the Figure 2-2 for a pictorial of a typical product rear panel (internal duplexer). Following is a descriptive text of the connections and LED indicators.

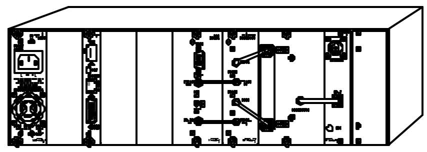


**Figure 2-2.NXE1-20 Rear Panel Connections**

**Power Supply:**

| | | |
|---|---|---|
| **Inputs:** | AC: | Universal Input, 100-240V, 50/60 Hz; IEC 3 conductor |
| | DC: | 24v/48v (Isolated Input); 2 pin socket (custom) |
| **Status LED:** | +12V: | Green LED indicates +12 volt supply OK |
| | +5V: | Green LED indicates +5 volt supply OK |

**NMS Card**

| | |
|---|---|
| **I/O Port:** | RS232 PC access; 9 pin D-sub (female) |
| **Reset Switch:** | Activates hard system reset |
| **Status LED:** | Green LED Indicates CPU OK |

**QAM Modem**

| | | |
|---|---|---|
| **I/O Ports:** | TRUNK: | Data I/O 15pin D-sub (female) HD |
| **RF Connectors:** | 70 MHz OUT: | SMA (female); Modulator output |
| | 70 MHz IN: | SMA (female); Demod input |
| **Status LED:** | MOD: | GREEN indicates Modulator Lock |
| | DEMOD: | GREEN indicates Demod Lock |

**Up/Down Converter Module**

| | | |
|---|---|---|
| **RF Connectors:** | TO PA: | SMA (female), Upconverter output to be applied to linear Power Amplifier module (internal to radio). |

| | | |
|---|---|---|
| | 70 MHz IN: | SMA (female), Modulated IF input from QAM Modulator. |
| | RF IN: | SMA (female), Receiver input. |
| | 70 MHz OUT: | SMA (female); Downconverter output to Modulator input |
| **Status LED:** | TX LOCK: | GREEN indicates TX AFC LOCK<br>Flashing RED indicates LOSS OF TX LOCK |
| | RX LOCK: | GREEN indicates RX AFC LOCK and strong RX signal<br>YELLOW indicates RX AFC LOCK and nominal RX signal<br>RED (continuous) indicates RX AFC LOCK and weak RX signal<br>RED (flashing) indicates LOSS OF RX LOCK |

**RF I/O Panel**

| | | |
|---|---|---|
| **RF Connectors:** | ANTENNA: | Type N (female), RF cabling from internal PA module. |
| | PA IN: | SMA (female), RF cabling to internal PA module. |
| | RX OUT: | SMA (female), RF cabling from internal duplexer. |

**SEMI-RIGID CABLE**

Ensure that the cables are secure and tightly attached.

Check for any damage (kinks or breaks in the copper sheath).

# 2.6 Power Requirements

### 2.6.1 Power Supply Card Slot Details

The leftmost slot in the NXE1-20 card cage (as viewed from the rear of the unit) is designated as the “PRIMARY A” power supply. The main bus voltages (+5 and +/-12) are summed in the backplane and provide the supply the plug-in modules.

**NOTE:** The front panel LCD screen displays the system supply voltages and the nomenclature follows the physical location of the power supply modules.

### 2.6.2 AC Line Voltage

The NXE1-20 uses a high reliability, universal input switching power supply capable of operating within an input range of:

100 - 240 VAC; 50/60 Hz

The power supply module is removable from the unit and a perforated cage protects service personnel from high voltage. The power supply is fan cooled due to high power consumption by the PA.

**CAUTION**

High voltage is present when the unit is plugged in. To prevent electrical shock, unplug the power cable before servicing. Power supply module should be serviced by qualified personnel only.

### 2.6.3 DC Input Option

An optional DC input power supply is available for the NXE1-20; using high reliability, DC-DC converter(s) capable of operation within the following input ranges (dependent upon nominal input rating):

| Nominal DC Input | Operating Input Range |
|---|---|
| 24 Volt: | 20 – 28 VDC |
| 48 Volt: | 32 – 64 VDC |

The DC input is isolated from chassis ground and can be operated in a positive or negative ground configuration. The power supply module is removable from the unit and no high voltages are accessible.

### 2.6.4 Fusing

For AC modules, the main input fuse is located on the switching power supply mounted to the carrier PC board and the protective cage may be removed for access to the fuse.

For DC modules, all fusing is located on the carrier PC board.

Always replace any fuse with same type and rating. Other fuses are present on the board, and are designed for output fail-safe protection of the system. All output fuse values are printed on the backside of the PC board to aid in replacement.

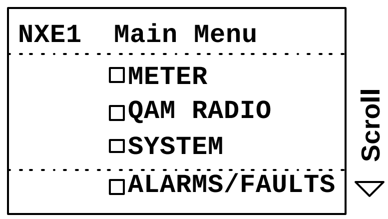
NOTE: If a fuse does blow in operation, investigate the possible cause of the failure prior to replacing the fuse, as there is adequate built-in protection margin.

# 2.7 Power-Up Setting

As shipped, the NXE1-20 will radiate into the antenna upon power-up, THIS ASSUMES THAT THE ANTENNA LOAD IS GOOD (LOW VSWR). If the VSWR of the load causes a high reverse power indication at the PA, the red VSWR LED will light and the transmitter will cease radiating. This is called the "AUTO" setting in the QAM RADIO CONTROL screen (see below).

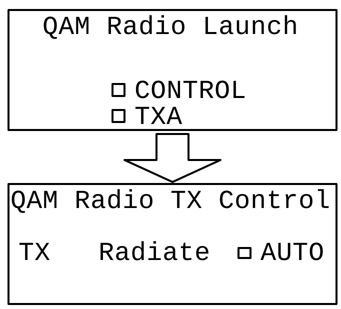
The LCD screen ("QAM RADIO TX CONTROL") selects the power-up state and controls the radiate function of the TX unit.

Go to the MAIN MENU:




Scroll to QAM Radio, press ENTER.

Select Launch Screen for CONTROL TX, press ENTER:




Verify the AUTO setting.

| | |
|---|---|
| AUTO: | Transmitter will protect its PA by "folding back" the ALC under bad load VSWR condition *(default setting)* |
| ON: | Transmitter will remain in radiate at full power under all antenna port conditions *(not recommended).* |
| OFF: | Transmitter in standby mode. |

# 2.8 Data Interface

## 2.8.1 4xE1/T1 MUX Channel Configurations

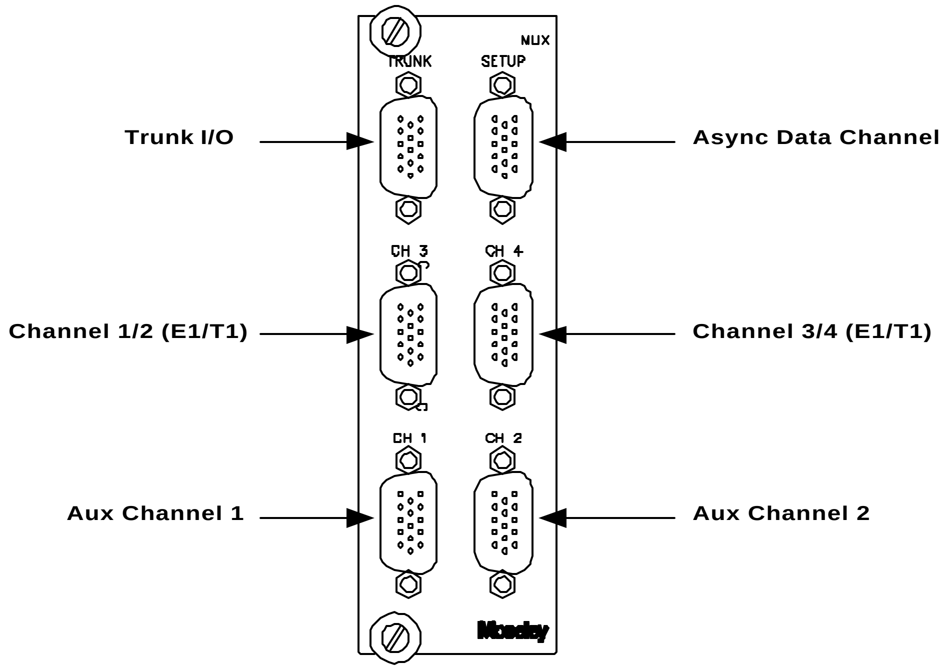



**Figure 2-3. 4XE1/T1 MUX Panel**

The 4xE1/T1 MUX is a high speed card (up to 8 MBPS) that has a total of 7 ports. Table 2-1 summarizes the capabilities.

**Table 2-1.NXE1-20 4xE1/T1 MUX Data Channel Configurations**

| Chnl | Data Rate 4xE1 (BPS) | Data Rate 4xT1 (BPS) | Data Rate 2xE1 (BPS) | Data Rate 2xT1 (BPS) | Data Rate 1xE1 (BPS) | Data Rate 1xT1 (BPS) | Inter-face |
|---|---|---|---|---|---|---|---|
| 1 | 2.048 K | 1.544 K | 2.048 K | 1.544 K | 2.048 K | 1.544 K | G.703, DSX-1 |
| 2 | 2.048 K | 1.544 K | 2.048 K | 1.544 K | --- | --- | G.703, DSX-1 |
| 3 | 2.048 K | 1.544 K | --- | --- | --- | --- | G.703, DSX-1 |
| 4 | 2.048 K | 1.544 K | --- | --- | --- | --- | G.703, DSX-1 |
| * Aux1 | 128 K | 96 K | 64 K | 48 K | 32 K | 24 K | V.35, RS449 |
| * Aux2 | 128 K | 96 K | 64 K | 48 K | 32 K | 24 K | V.35, RS449 |
| ASYNC Data | 9600 | 7200 | 4800 | 3600 | 2400 | 1800 | RS232 |

* AUX Channels 1-2 can be combined to form 2xCh.1 or 2xCh.2 (i.e., in 4xE1 mode, AUX could be a single channel of 256 KBPS)

**Table 2-2.NXE1-20 Voice/Data MUX Channel Configurations**

# 2.9 Hot Standby (Protected) Configuration

The NXE1-20 may be installed in a hot standby (protected) configuration. This consists of twoNXE1-20 chassis with a TP64 transfer panel (Figure 2-5)

### Transfer Panel Connection

The usual hot 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 2-5 for installation details.

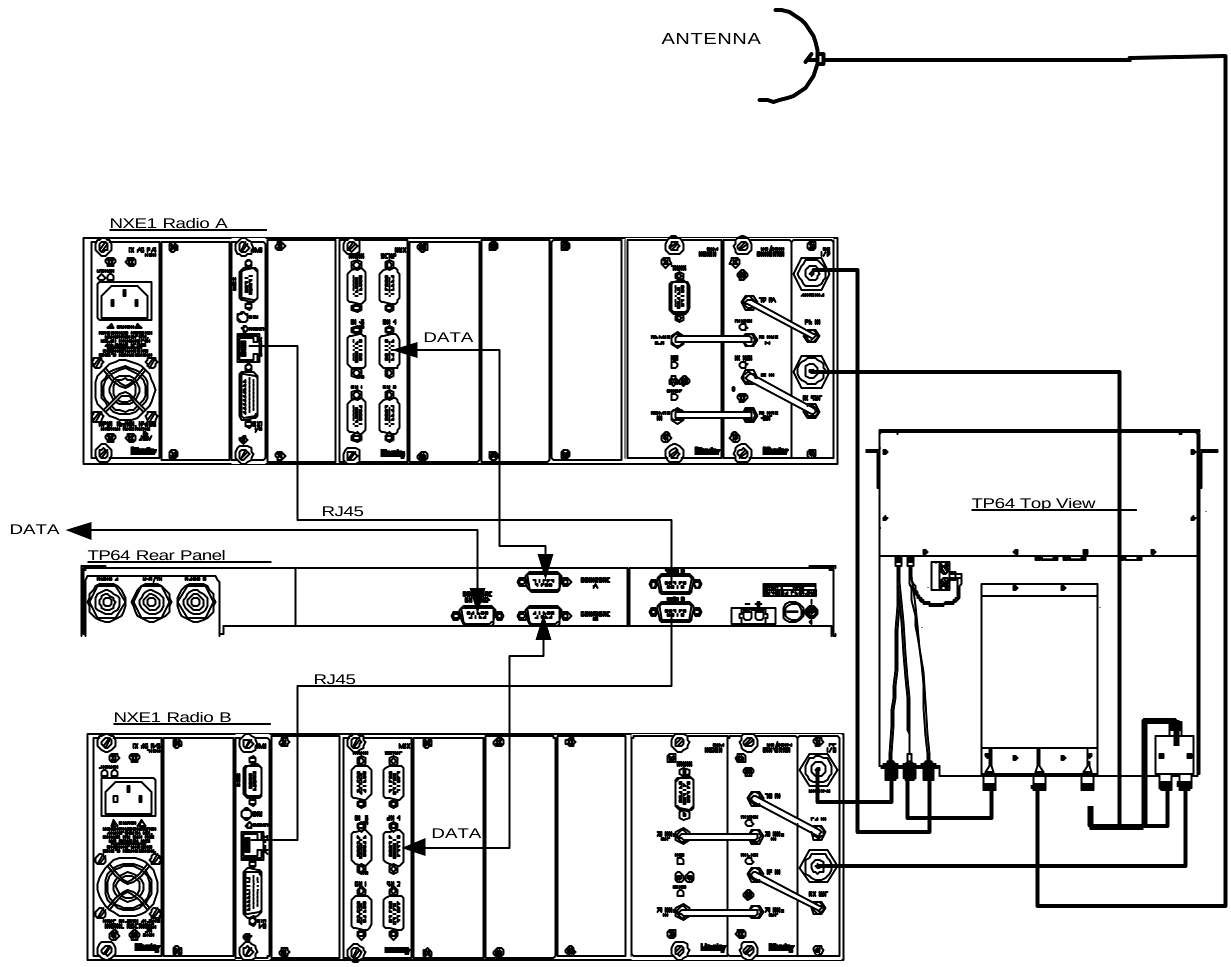



**Figure 2-5.NXE1-20 Hot Standby – with Transfer Panel**

## 2.9.1 Hot/Cold Standby Modes

### Hot Standby ( *preferred)

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

### Cold Standby

Cold standby can be used in situations where lower power consumption is a priority. In this mode, the transfer logic 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.

## 2.9.2 Hot Standby Control using the Moseley TP64

### 2.9.2.1 TP64 Front Panel Controls and Indicators

**Note:** See the following section for a detailed description of the Master/Slave logic implemented in the TP64.

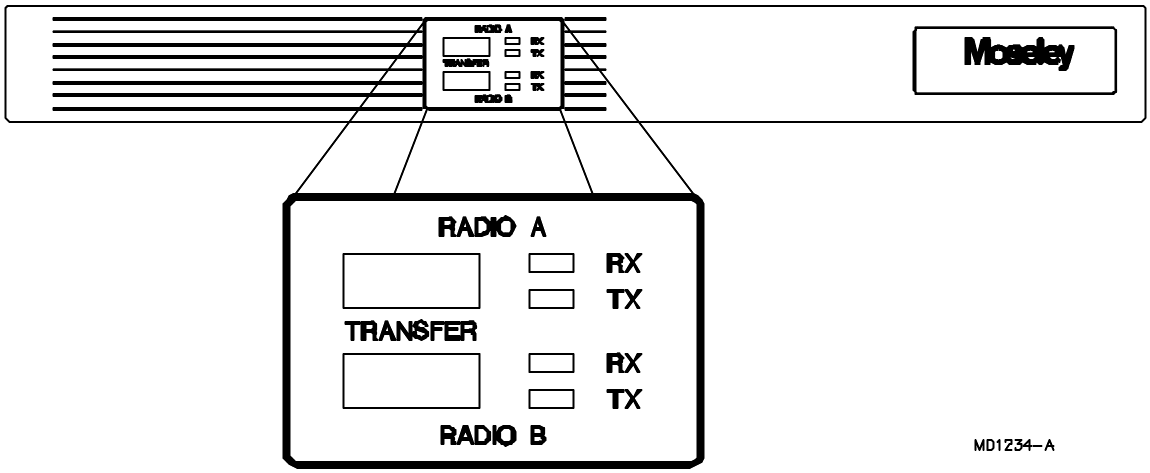



**Figure 2-7. TP64 Front Panel**

**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.

**TRANSFER Switches**

The RADIO A and RADIO B transfer switches cause the selected radio to become *active*, and the *Master*. See Section 3.4 (following) for further details.

### 2.9.2.2 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.

### Table 2-3. 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 2-4. 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 2-3 and 2-4.

**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 Cold Standby, the “burn time“ is more significant, since the RF power amplifier device operating life becomes a factor.

### 2.9.2.3 NXE1-20 Software Settings

The full array of available settings for the Control and Configuration menus are located in Section 3—Operation of the Front Panel. Shown here are the applicable settings for redundant standby systems.

**Clock Settings**

For proper operation, the clock settings (located in the QAM Radio/Config/Modem Menu) must be set as follows:

```
QAM Interface

Intfc        TRUNK
```

↓

```
    Tx In Clock

Clk Phase  INVERTED
```

↓

```
    Rx Clock Out

Clk Phase  NORMAL
```

↓

```
      Trunk Out

Clk Source EXTERNAL
Clk Phase  NORMAL
```

**Control Settings**

These settings configure the transmitter for hot (or cold) standby.

It is important that each NXE1-20 radio in the redundant pair is configured identically for proper operation.

*In the SYSTEM TRANSFER menu:*

```
   Transfer

Tx Transfer ______
Rx Transfer ______
```

**Tx Transfer:**

**OFF:** Turns Transmitter Transfer Mode OFF.

**Rx Transfer:**

**OFF:** Indicates the receivers are not switched.

*In the QAM Radio TX Control menu:*

```
QAM Radio Tx Control

TX   Radiate______
```

**Tx Radiate:**

**ON:** Configures the Transmitter to always RADIATE.

#### 2.9.2.4 TP64 Settings

The TP64 software settings are contained in the internal firmware. Aside from the front panel RADIO A/B Master Select (as described above), there are no user-configurable settings in the TP64 unit.

### 2.9.3 Hot Standby Control with Single Unit

#### 2.9.3.1 NXE1-20 Software Settings

The full array of available settings for the Control and Configuration menus are located in Section 3—Operations. Shown here are the applicable settings for single systems.

**Clock Settings**

All controls and indications can be found on the NXE1-20 front panel LCD display (located in the QAM Radio/Config/ModA or ModB Menu).

```
  QAM Interface

Intfc  RADIO(BKPLN)
```

```
   Tx In Clock

Clk Phase   NORMAL
```

**Control Settings**

These settings configure the transmitter for hot (or cold) standby.

It is important that each NXE1-20 radio in the redundant pair is configured identically for proper operation.

*In the SYSTEM TRANSFER menu:*

```
   Transfer

Tx Transfer  ______
Rx Transfer  ______
```

**Tx Transfer:**

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

**COLD:** Configures the Transmitter for COLD STANDBY operation.

**Rx Transfer:**

**ON:** Places the receivers in both active and transfer mode.

*In the QAM Radio TX Control menu:*

```
QAM Radio Tx Control
TX   Radiate______
```

**Tx Radiate:**

**AUTO:** Software controls the RADIATE function.

# 2.10 Site Installation

The installation of the NXE1-20 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 2-8 for Site Installation Details).

Before taking the product to the installation site verify that the interface connections are compatible with the equipment to be connected. Also, locate the information provided by the path analysis that should have been performed before ordering the equipment. At the installation site, particular care should be taken in locating the product 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.

**The Installations should only be performed by qualified technical personnel only.**

# 2.11 Antenna/Feed System

## 2.11.1 Antenna Installation

**For compliance with FCC RF Exposure requirements the following has to be adhered to:-**

1. All antenna installation and servicing is to be performed by qualified technical personnel only. When servicing the antenna, or working at distances closer than those noted below, ensure the transmitter has be disabled.
2. Typically, the antenna connected to the transmitter is a directional (high gain) antenna, fixed-mounted on the side or top of a building, or on a tower. Depending upon the application and the gain of the antenna, the total composite power could exceed 20 to 61watts EIRP. The antenna location should be such that only qualified technical personnel can access it, and that under normal operating conditions the antenna separation from the user is required to be located at the distance of 3.5meters or more.

EIRP at the antenna is calculated as follows:-

Transmit power – Cable loss + Antenna Gain = EIRP

Eg.

+31.1dBm – 6dB(for 100m LDF5-50A) +36dBi = 61.1Bmi

# 3 Front Panel Operation

## 3.1 Introduction

This section describes the front panel operation of the NXE1-20 digital radio/modem. This includes:

- LCD display (including all screen menus)
- Cursor and screen control buttons
- LED status indicators

## 3.2 Front Panel Operation

A picture of the NXE1-20 front panel is depicted in Figure 3-1 below.

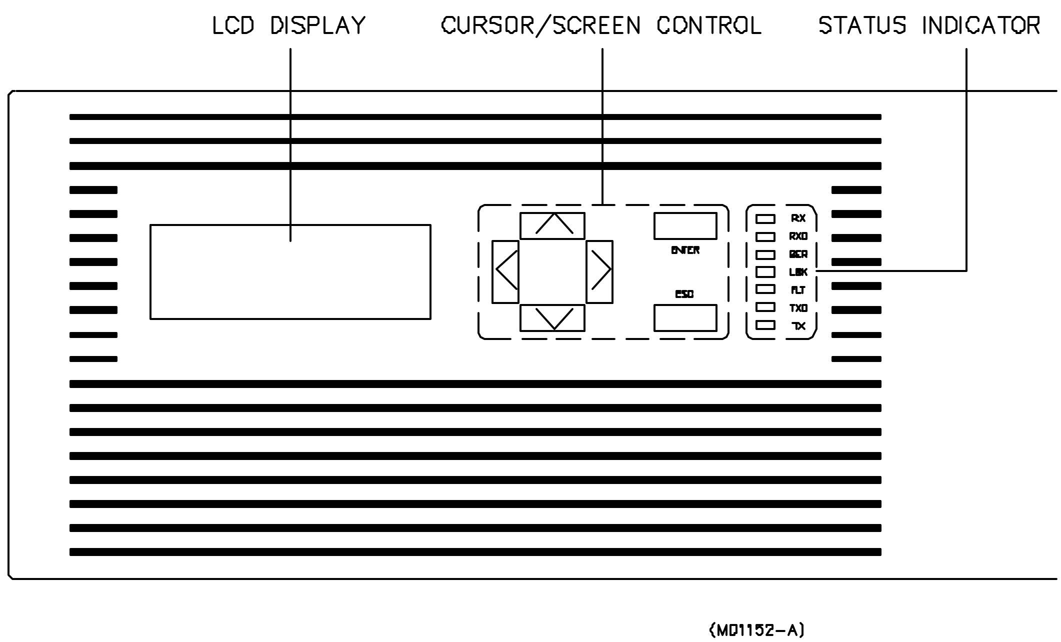



**Figure 3-1.NXE1-20 Front Panel**

### 3.2.1 LCD Display

The Liquid Crystal Display (LCD) on the NXE1-20 front panel is the primary user interface and provides status, control, configuration, and calibration functionality. The menu navigation and various screens are explained in detail later in this section.

<u>Backlight:</u>

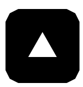
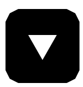
An automatic backlight is built-in to the LCD for better clarity under low-light conditions. This backlight is enabled on power-up and will automatically turn off if there is no button activity by the user. The backlight will automatically turn on as soon as any button is pressed.

<u>Contrast Adjustment:</u>

Internal adjustment on board (in back of front panel button PCB).

### 3.2.2 Cursor and Screen Control Buttons

The buttons on theNXE1-20 front panel are used for LCD screen 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 LED Status Indicators

**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. |

### 3.2.4 Screen Menu Tree Structure

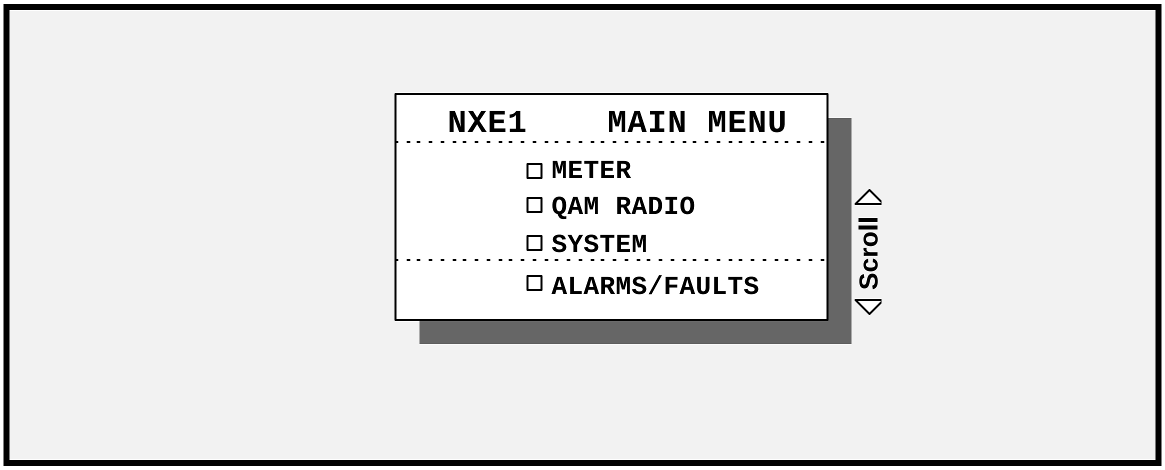
Figures 3-2a, b and c, located on pages 3-7, 3-8, 3-9 and 3-10, show the tree structure of the screen menu system. The figures group the screens into functional sets. There may be minor differences in the purchased unit, due to software enhancements and revisions. The current software revision may be noted in the **SYSTEM** sub-menu (under **INFO**).

In general, <**ENTER**> will take you to the next screen from a menu choice, <**UP**> or <**DOWN**> will scroll through screens within a menu choice, and <**ESC**> will take you back up one menu level. Certain configuration screens have exceptions to this rule, and are noted later in this section.

## <u>CAUTION</u>

**DO NOT change any settings in the CONFIGURE or CALIBRATE screens. The security lock-out features of the software may not be fully implemented, and changing a setting will most likely render the system non-operational!**

# 3.3 Main Menu




The main menu appears on system boot-up, and is the starting point for all screen navigation. Unlike most other screens in the software, the main menu scrolls up or down, one line item at a time.

## 3.3.1 Launch Screens

The **LAUNCH** screen allows the user to quickly get to a particular screen within a functional grouping in the unit. The logic is slightly different than other screens. Figure 3-3 below contains a "Launch Screen Navigation Guide" to assist the user in locating the desired Radio screen.

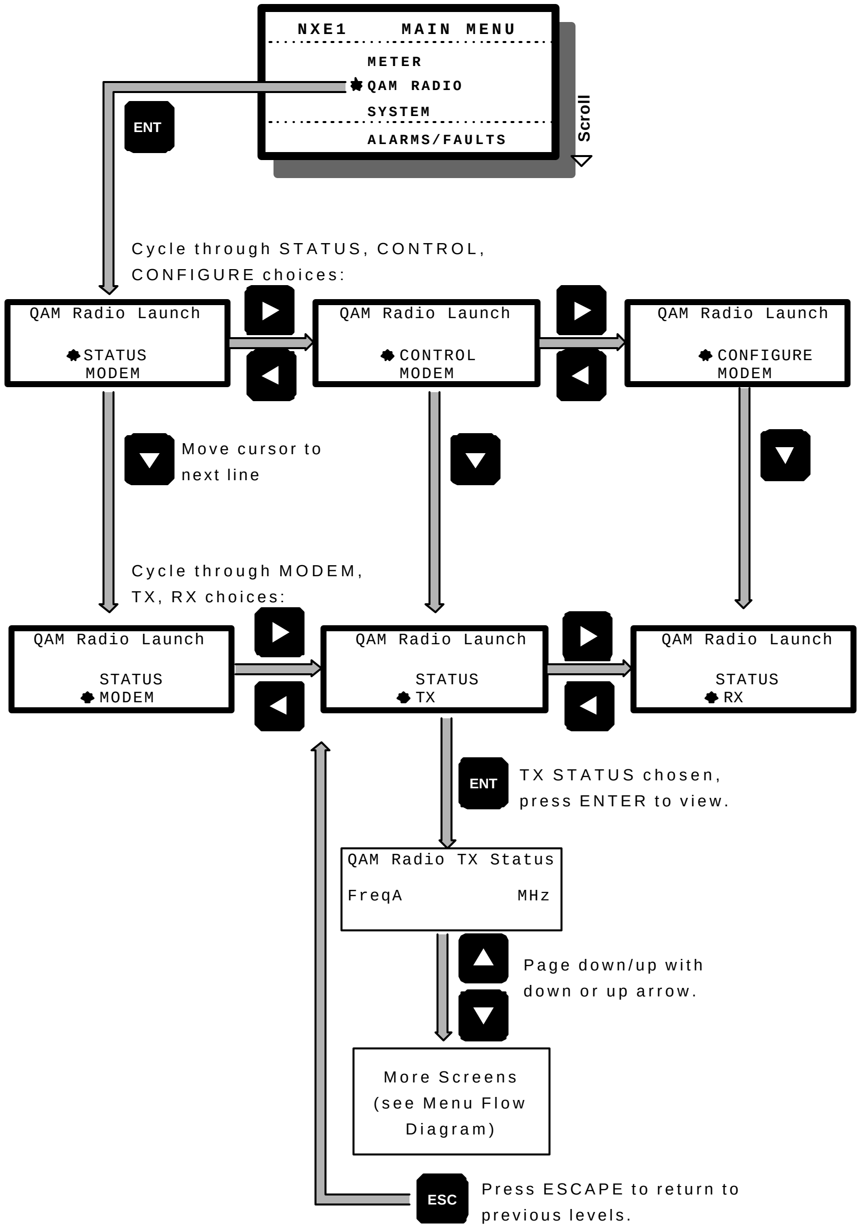
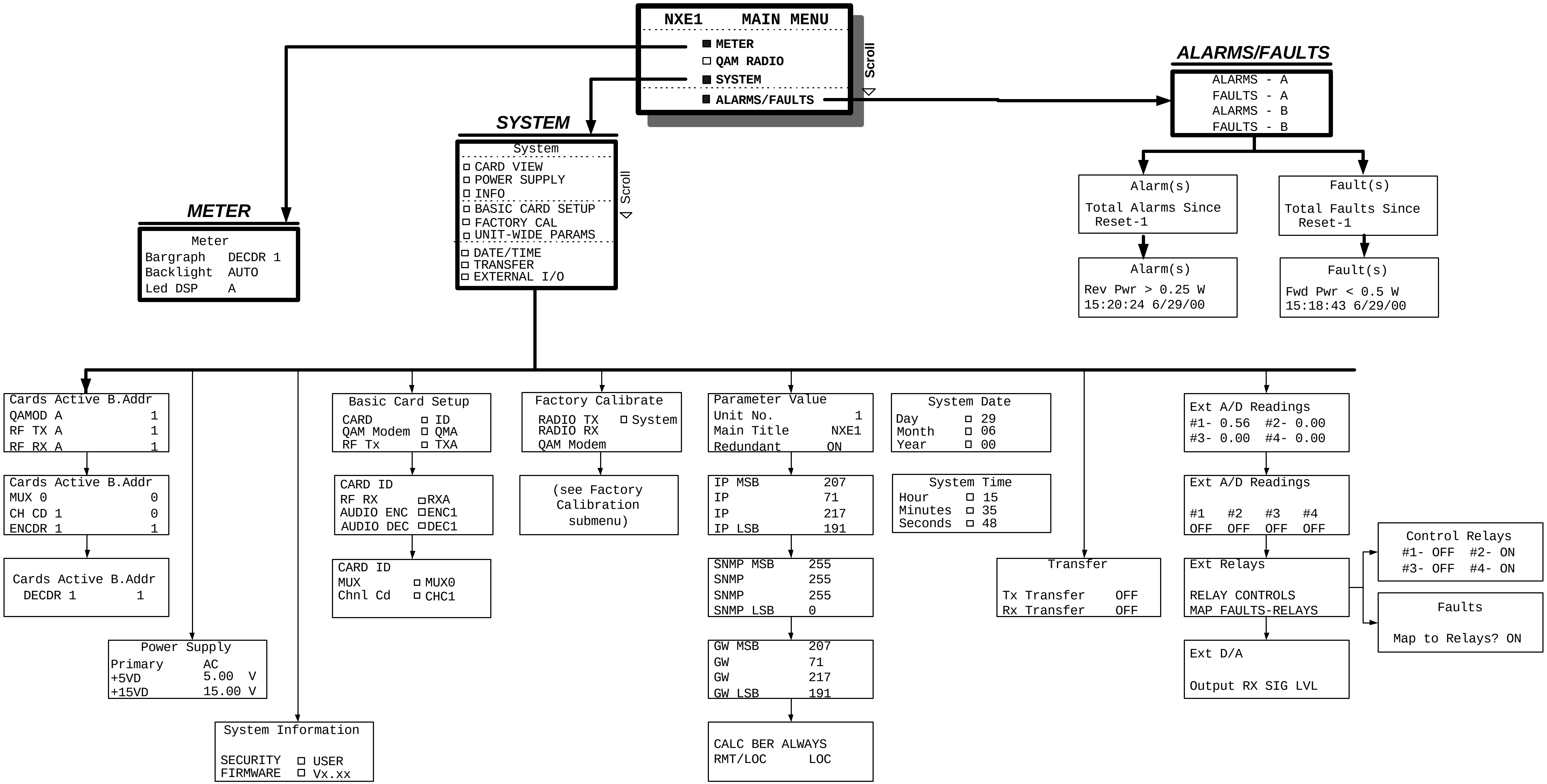



**Figure 3-3. Launch Screen Navigation Guide**

**This page is intentionally blank.**




**Note:** "A" module and "Primary" screens are the default.

"B" module and "Secondary" calibrations are available only when redundant systems are configured.

***Meter, System, Alarms/Faults***

**Figure 3-2a**
**LCD SCREEN MENU TREE**

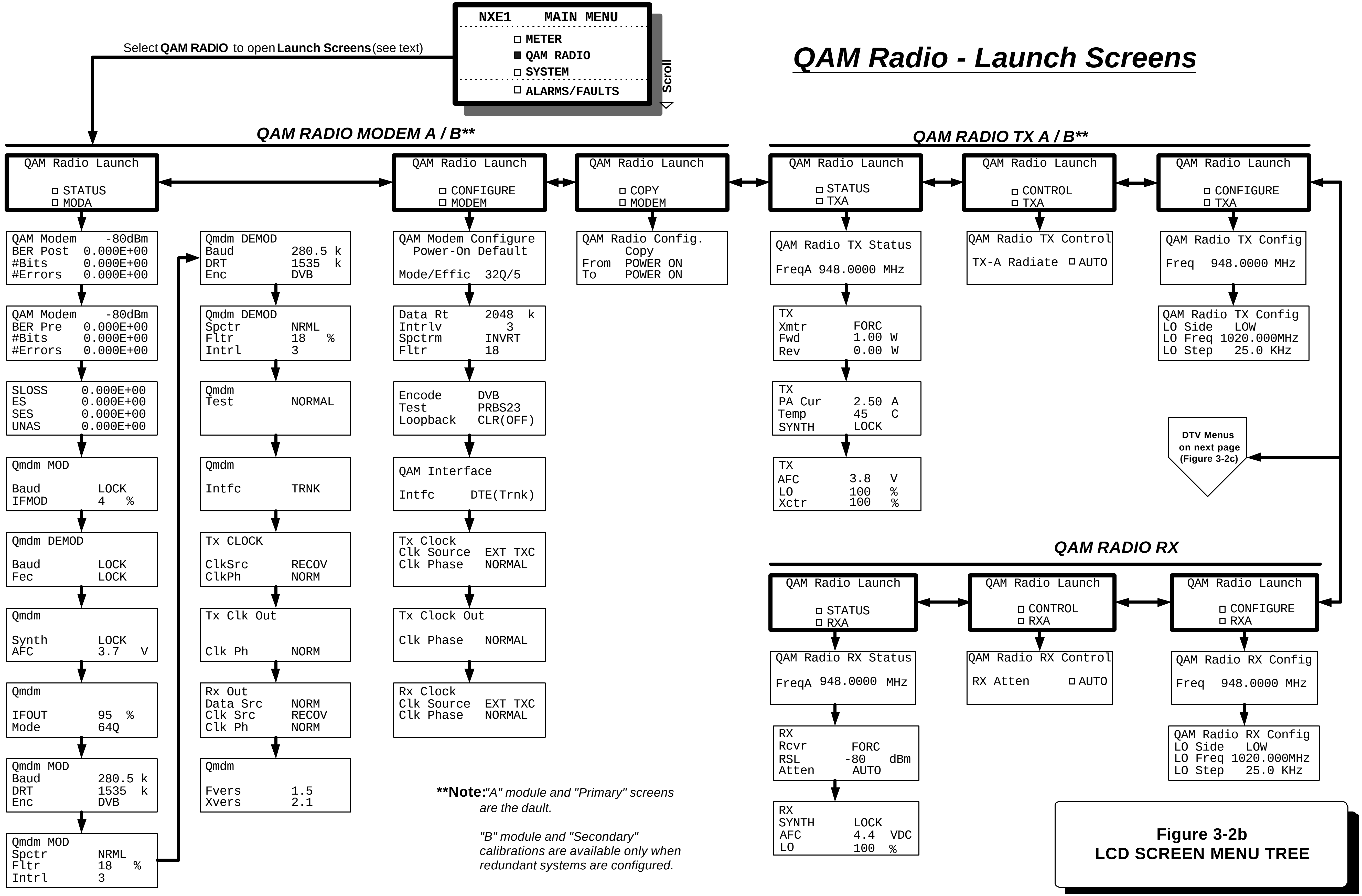
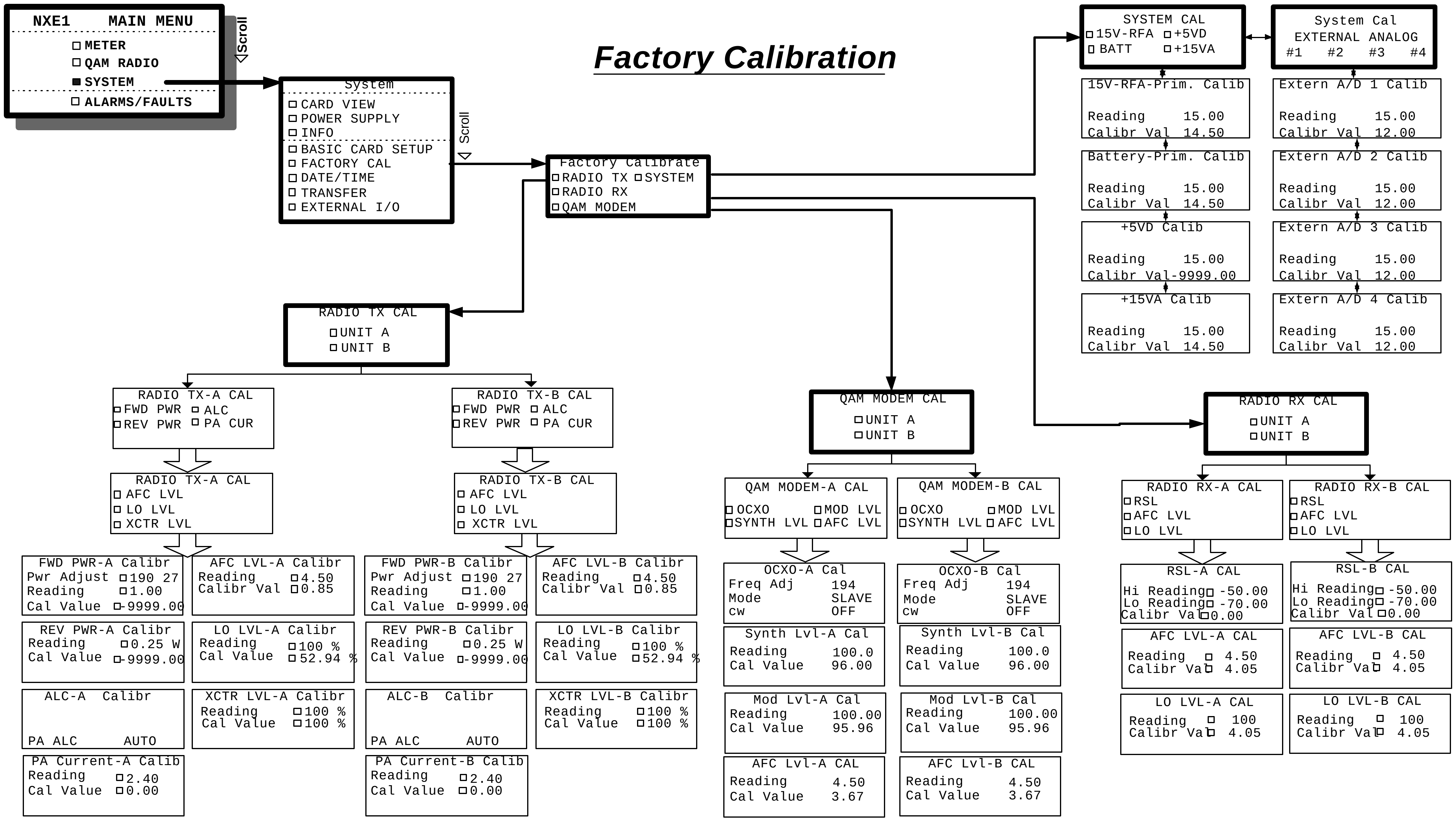



**Figure 3-2b**
**LCD SCREEN MENU TREE**




Note: "B" Module and "Secondary" calibrations are available only when redundant systems are configured.
"A" module and "Primary" screens are the default.

Figure 3-2d
LCD SCREEN MENU TREE

# 3.4 Screen Menu Summaries

The following tables and text provide a screen view for that topic as well as the functions and settings of that screen. The order follows the Screen Menu Tree (Figures 3-2a, b, and c) with the exception of the QAM Radio screens, which are grouped in the STATUS, CONTROL and CONFIGURE categories.

Outline of Section 3.4 (Screen Menu Summaries)

A summary of each function is also provided.

### 3.4.1 Meter

```
      Meter
Bargraph  DECDR 1
Led Dsp     A
```

| Function | Settings | Summary |
|---|---|---|
| Bargraph | ENCDR1, 2, etc… | Selects the desired audio source for display on the audio |
| | DECDR1, 2, etc… | level bargraph |
| | NONE | Turns off the bargraph |
| Led Dsp | A | The status of Radio A or Radio B is displayed on the |
| | B | LEDs on the front panel. |

### 3.4.2 System: Card View

```
Cards Active B.Addr
 QAMOD A          1
 RF TX A          1
 RF RX A          1
```

```
Cards Active B.Addr
 MUX 0            0
 CH CD 1          0
 ENCDR 1          1
```

```
Cards Active B.Addr
 DECDR 1          1
```

| Function | Settings | Summary |
|---|---|---|

| | | |
|---|---|---|
| Cards Active | RF RX A | QAM Receiver RF Module installed in QAM Radio "A" slots (base address 0) |
| | DECDR 1 | Audio Decoder #1 installed (base address 1) |
| | ENCDR 1 | Audio Encoder #1 installed (base address 2) |
| | QAMOD A | QAM Modem Module installed in QAM Radio "A" slots (base address 3) |
| | RF TX A | QAM Transmitter RF Module installed in QAM "A" slots (base address 4) |
| | MUX 0 | Intelligent Multiplexer #0 installed (base address 5) |
| | CH CD 1 | |

*Note: The card view screen gives the user a list of all installed cards in the unit. The base address (B. Addr) is listed for diagnostic purposes only.*

### 3.4.3 System: Power Supply

```
Power Supply Status
Primary        AC
+5VD           5.00  V
+15VD          15.00 V
```

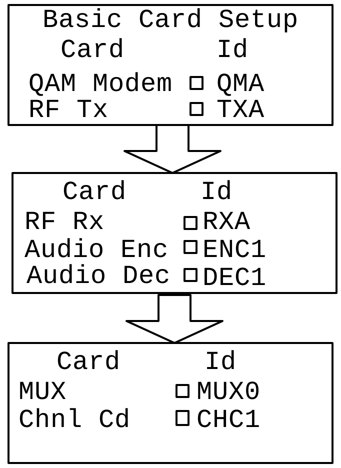
| **Function** | **Settings** | **Summary** |
|---|---|---|
| Primary | | Indicates type of supply in primary slot A: |
| | AC | Universal AC input |
| | DC | DC Option |
| +5 VD | 0-9.99 V<br>5.20 V nominal | Voltage level of the main +5 volt supply |
| +15 VD | 0-99.9 V<br>15.2 V nominal | Voltage level of the main +15 volt supply |

### 3.4.4 System: Info

```
 System Information
Unit No.     1
Security     USER
Firmware     V.2.04
```

| **Function** | **Settings** | **Summary** |
|---|---|---|
| Unit No. | 1,2,3,… | Identification for NMS system |
| SECURITY | | Indicates access level of security: |
| | Lockout | No control available |
| | User *(default)* | Limited control of parameters |
| | Factory | Full configure and calibration |
| FIRMWARE | V x.xx | Revision of front panel screen menu software |

### 3.4.5 System: Basic Card Setup




| **Function** | **Settings** | **Summary** |
|---|---|---|
| QAM Modem | QMA, QMB | QAM Modem installed in QAM Radio slots A or B |
| RF Tx | TXA, TXB | QAM Transmitter installed in QAM Radio slots A or B |
| RF Rx | RXA, RXB | QAM Receiver installed in QAM Radio slots A or B |
| Audio Enc | ENC1,2,… | Audio Encoder installed and identified (affects meter selection of bargraph) |
| Audio Dec | DEC1,2,… | Audio Decoder installed and identified (affects meter selection of bargraph) |
| MUX | MUX 0,1,… | Mux Module installed and identified |
| Chnl Cd | CHC 1,2,… | Channel Card installed and identified |

***Note:*** *These are factory settings of installed cards, used to control appropriate displays in the CARD VIEW screens.*

**Note:** Pressing **enter** at each ID type brings up another screen with the Card Function shown and the question: **In System?** Is displayed. Depending upon the card type, this screen also indicates the base address. These windows are shown below:

```
QAM Modem A

In system?  YES
```

```
Mux 0
In system?     YES
Chnl Base Addr   0
Hooked to Radio NO
```

```
Mux 0
Channel Types
1 NONE     3 NONE
2 NONE     4 NONE
```

```
Radio TX A

In system?  YES
```

```
Radio RX A

In system?  YES
```

```
Channel Card   1

In system?   YES
Base addr     0
```

```
Channel Card 1
Channel Types
1 NONE     3 NONE
2 NONE     4 NONE
```

```
Encoder   1

In system?   YES
Base addr     1
```

```
Decoder   1

In system?   YES
Base addr     1
```

### 3.4.6 System: Factory Calibration

```
Factory Calibrate
□ RADIO TX   □ System
□ RADIO RX
□ QAM Modem
```

The Factory Calibration Screens are documented in Figure 3-2 (Screen Menu Tree). The user may refer to this diagram when instructed to do so by customer service technicians.

### 3.4.7 System: Unit-Wide Parameters

```
 Parameter   Value
Unit No.   □ 1
Main Title □ NXE1
Redundant  □ ON
```

⇩

```
IP MSB       207
IP           71
IP           237
IP LSB       115
```

⇩

```
SNM MSB      255
SNM          255
SNM          255
SNM LSB      0
```

⇩

```
GW MSB       207
GW           71
GW           237
GW LSB       254
```

⇩

```
Calc BER always

RMT/LOC      LOC
```

| Function | Settings | Summary |
|---|---|---|
| Unit No. | 1,2,3,… | Identification for NMS system |
| Main Title | TRANSMITTER, RECEIVER, TRANSCEIVER T1 DTV Link NXE1 | Determines main menu display and affects screen menu selection of modules |
| Redundant | ON | Hot Standby Dual Radio operation. |
| | OFF | Single Radio operation. |
| IP | Integer (0-255) | Internet Protocol (IP) address of the device. These values must be set for the device to possess network capabilities. |
| SNM | Integer | Subnet Mask of the device. Only needs to be set if the device is to use its network capabilities. Subnetting allows network administrators additional flexibility in defining relationships among network hosts. |
| GW | Integer | The default Gateway of the device. The Gateway address is configured by the network administrator. This address informs each device where to send data if the target station does not reside on the same subnet as the source. |
| Calc BER always | RMT | (Remote) Use RMT only in SNMP mode. |
| | LOC | (Local) Put in local. |

### 3.4.8 System: Date/Time

```
    System Date
Day      □ 29
Month    □ 06
Year     □ 98
```

```
    System Time
Hour     □ 15
Minute   □ 35
Second   □ 48
```

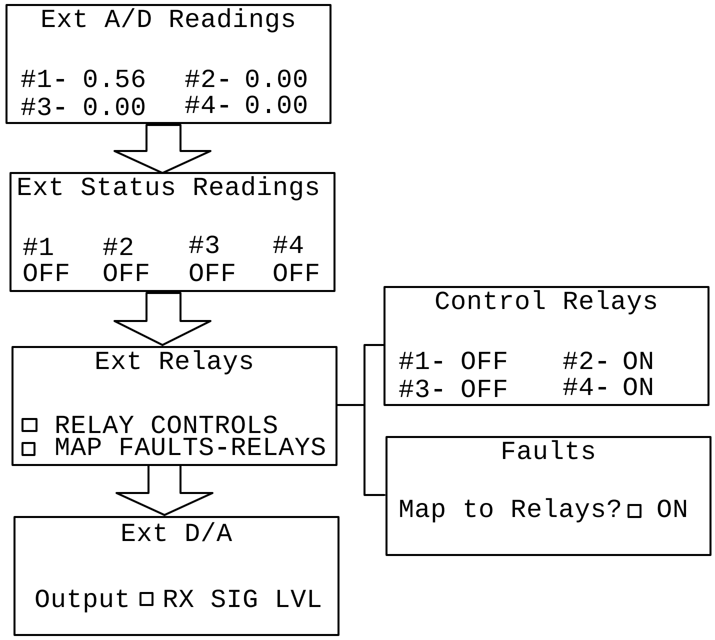
| Function | Settings | Summary |
|---|---|---|
| Day | 01-31 | Sets the system date used for NMS and Fault/Alarm logging |
| Month | 01-12 | |
| Year | 00-99 | After selection, press ENTER to save |
| Hour | 00-23 | Sets the system time used for NMS and Fault/Alarm logging |
| Minute | 00-59 | |
| Second | 00-59 | After selection, press ENTER to save |

### 3.4.9 System: Transfer

```
      Transfer

Tx Transfer   □ OFF
Rx Transfer   □ OFF
```

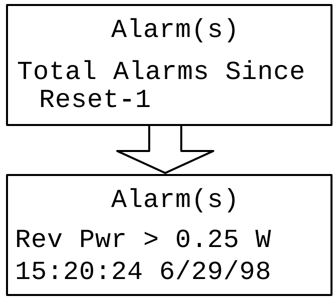
| Function | Settings | Summary |
|---|---|---|
| TX Transfer | OFF<br>HOT<br>COLD | Configures the internal logic for transfer panel (TP64) TX control |
| RX Transfer | OFF<br>ON | Configures the internal logic for transfer panel (TP64) RX control |

### 3.4.10 External I/O




| Function | Settings | Summary |
|---|---|---|
| Ext A/D Readings | #1, #2, #3, #4 | Voltage readings via the NMS I/O card |
| Ext Status Readings | #1, #2, #3, #4 | Logic Level readings via the NMS I/O card |
| Ext Relays | #1, #2, #3, #4 | Control of relays at the NMS I/O card |
| Map Faults-Relays | ON<br>OFF | Maps pre-determined fault conditions to trigger relays at the NMS I/O card |
| Ext D/A Output | RX SIG LVL<br>NOTHING<br>TX FWD PWR | External output follows Receive Signal Level.<br>External output follows nothing.<br>External output follows Transmit Forward Power. |

### 3.4.11 Alarms




| **Module** | **Parameter** | **Nominal** | **Trip Value** |
|---|---|---|---|
| **QAM RF TX** | Reverse Power | 0.05 Watt | > 0.25 Watt |
| | PA Current | 2.5 Amp | > 3.0 Amp |
| | LO Level | 100% | < 50% |
| | Exciter Level | 100% | < 50% |
| **QAM RF RX** | RSL | -30 to –90 dBm | |
| | LO Level | 100% | < 50% |
| **QAM MODEM** | BER | - | >1.00E-04 |
| | Synth Level | 100% | < 50% |
| Modulator only | Modem Level | 100% | < 50% |

***Alarm definition:*** *A specific parameter is out of tolerance, but is NOT crucial for proper system operation. ALARMS are cautionary only, and indicates a degradation in a system parameter.*

***Logging:*** *All fault and alarm events are logged with the date and time.*

***Alarm screen reset:*** *After viewing the screen, press ENTER to clear all logs entries. If the alarm has been corrected, no new logs will be generated.*

### 3.4.12 Faults

```
      Fault(s)

Total Faults Since
  Reset-1
```

```
      Fault(s)

Fwd Pwr < 0.5 W
15:18:43 6/29/98
```

| **Module** | **Parameter** | **Nominal** | **Trip Value** |
|---|---|---|---|
| **QAM RF TX** | Forward Power | 1.0 Watt | < 0.5 Watt |
| | AFC Lock | Lock | Unlock |
| | PA Temp | 40 deg C | >80 deg C |
| **QAM RF RX** | AFC Lock | Lock | Unlock |
| **QAM MODEM** | AFC Lock | Lock | Unlock |
| | Mbaud | Lock | Unlock |
| | Dbaud | Lock | Unlock |
| | Dfec | Lock | Unlock |

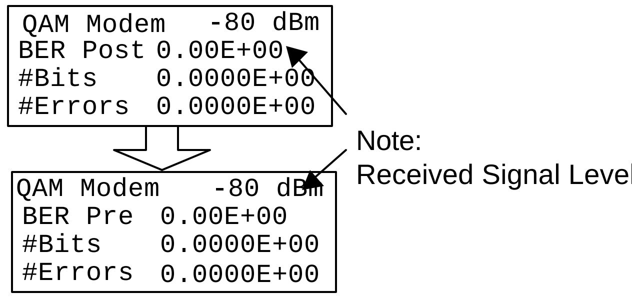
***Fault definition:*** *A specific parameter is out of tolerance and is crucial for proper system operation.*
***Logging:*** *All fault and alarm events are logged with the date and time.*
***Fault screen reset:*** *After viewing the screen, press ENTER to clear all logs entries. If the fault has been corrected, no new logs will be generated.*

### 3.4.13 G821 Parameters

```
SLOSS   0.000E +00
ES      0.000E +00
SES     0.000E +00
UNAS    0.000E +00
```

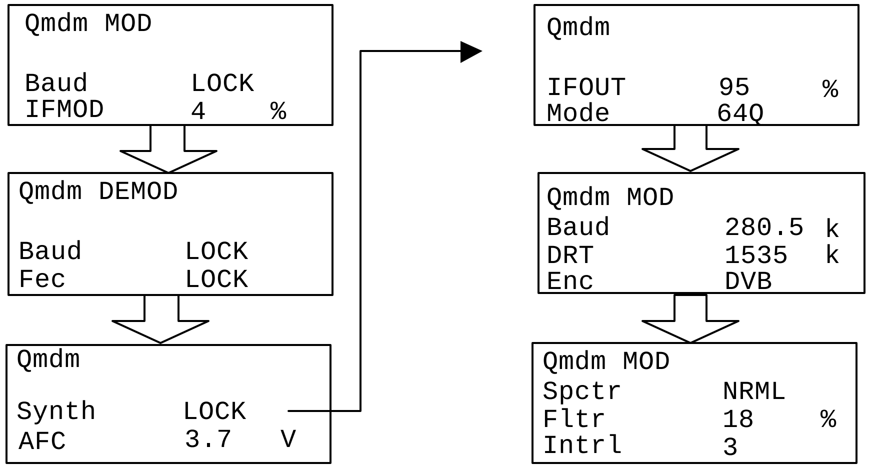
| **Function** | **Settings** | **Summary** |
|---|---|---|
| SLOSS | 0.000E +00 | Number of times the signal has been lost for more than 10 seconds |
| ES | 0.000E +00 | Errored seconds |
| SES | 0.000E +00 | Severely errored seconds |
| UNAS | 0.000E +00 | Unavailable seconds |

### 3.4.14 QAM Modem Status




| Function | Settings | Summary |
|---|---|---|
| BER Post | 0.00E-00 | Post-FEC (Forward Error Correction) Bit Error Rate since last “ENTER” reset |
| BER Pre | 0.00E-00 | Pre-FEC (Forward Error Correction) Bit Error Rate since last “ENTER” reset |
| # Bits | 0.0000E+00 | # of Bits counted since last “ENTER” reset |
| # Errors | 0.0000E+00 | # of Errors counted since last “ENTER” reset |

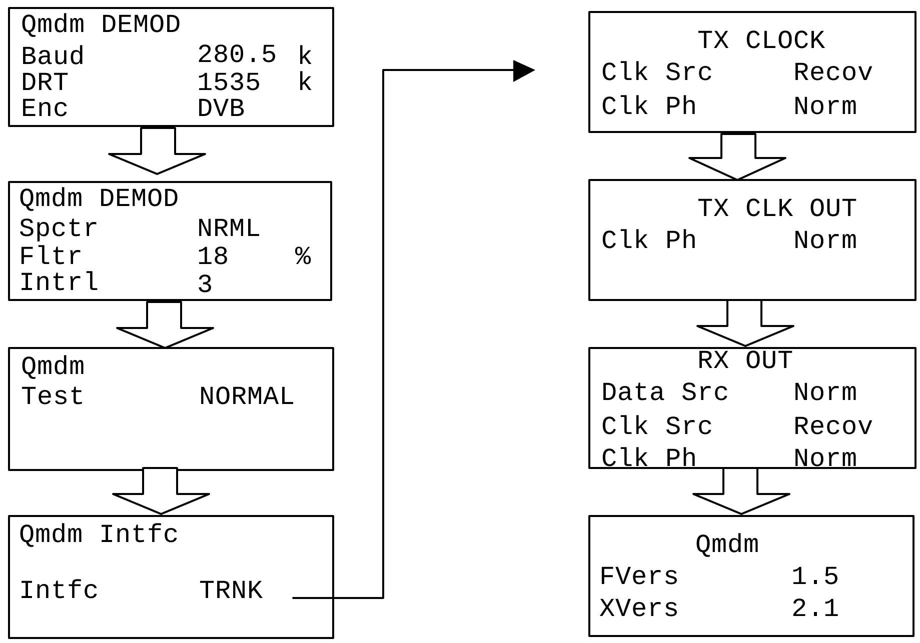
### QAM Modem Status (continued)




| Function | Settings | Summary |
|---|---|---|
| BAUD | LOCK *(default)*<br>UNLOCK | Indicates modulator PLL is locked to incoming data clock |
| IFMOD | 0 – 100%<br>100% NOM | |
| BAUD | LOCK *(default)*<br>UNLOCK | Indicates demodulator PLL is locked to incoming data clock |
| FEC | LOCK *(default)*<br>UNLOCK | Indicates FEC decoder is synchronized |
| SYNTH | LOCK *(default)*<br>UNLOCK | Confirms 70 MHz IF synthesizer is phase locked |
| AFC | 0 – 9.9 VDC<br>3.7 VDC *(nominal)* | 70 MHz IF synthesizer AFC voltage |
| IFOUT | 0 – 100%<br>100% *(nominal)* | Modulator level |
| Mode | 16-64Q | Modulation mode:16QAM, 32QAM, 64QAM |
| BAUD | 280.5 K | Symbol rate |
| DRT | 1535 K | Data rate |
| ENC | DVB | Encoding mode |
| SPCTR | NRML | Spectrum Normal or Invert |
| FLTR | 18 % | Nyquist filter |
| INTRL | 3 | Interleave Depth |

*Continued on next page.*

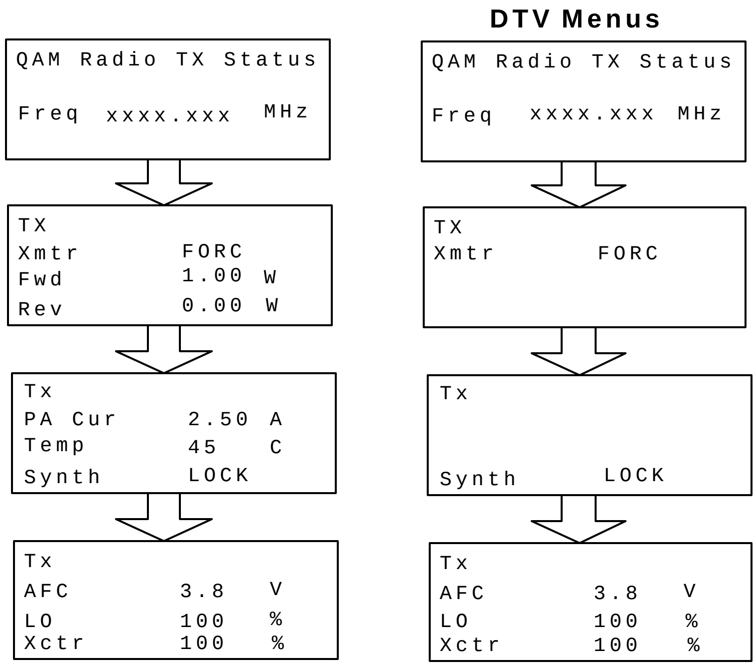
## QAM Modem Status (continued)




| Function | Settings | Summary |
|---|---|---|
| BAUD | 280.5 K | Symbol rate |
| DRT0 | 1535 K | Data rate |
| ENC | DVB | Encoding mode |
| SPCTR | NRML | Spectrum Normal or Invert |
| FLTR | 18 % | Nyquist filter |
| INTRL | 3 | Interleave Depth |
| TEST | NORMAL | Internal Test Pattern Generator |
| Interface | Trunk | Active Interface |
| Clk Src (Tx Clock) | Internal, EXT TXC, EXT RXC, Recovered | Clock source of the Transmitter. |
| Clk Ph (Tx Clock) | Inverted, Normal | Clock Phase of the Transmitter. |
| Clk Ph (Tx Clock Out) | Inverted, Normal | Clock Phase of the Transmitter Clock Out. |
| Data Src (Rx Out) | Norm, RPT, Loop | Data Source of the Receiver Out. Normal means the source is either BKPLN or TRNK; RPT sets the radio to Repeater; Loop sets the radio to loopback mode. |
| Clk Src (Rx Out) | Internal, EXT TXC, EXT RXC, Recov | Clock Source of the Receiver Out. |
| Clk Ph (Rx Out) | Norm, Inverted | Clock Phase of the Receiver Out. |
| Fvers | | |
| Xvers | | |

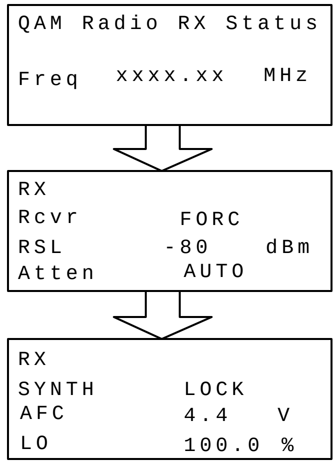
*Internal is the internal clock of the NXE1; EXT TXC is the External Transmit Clock; EXT RXC is the External Receive Clock; Recovered is the recovered clock from the receiving RF.*

### 3.4.15 QAM Radio TX Status



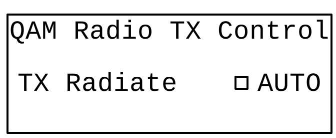

| **Function** | **Settings** | **Summary** |
|---|---|---|
| Freq A | 2300.00MHz | Displays the transmitter output carrier frequency |
| XMTR | | Status of transmitter: |
| | TRAFFIC | ON in a hot standby mode |
| | FORCED *(default)* | Forced ON |
| FWD | 0 – 9.99 Watt<br>1.00 Watt *(nominal)* | Output Power of TX. This menu item does not appear when the unit is configured for DTV. |
| REV | 0 – 9.99 Watt<br>0.07 Watt *(nominal)* | Reverse (or reflected) power at antenna port. This menu item does not appear when the unit is configured for DTV. |
| PA CUR | 0.00– 9.99 Amp<br>2.40 Amp *(nominal)* | Power amplifier current consumption. This menu item does not appear when the unit is configured for DTV. |
| TEMP | 0– 99.9 deg C<br>45.0 deg C *(nominal)* | Power amplifier temperature. This menu item does not appear when the unit is configured for DTV. |
| SYNTH | LOCK *(default)*<br>UNLOCK | Indicates phase lock of the 1$^{st}$ LO |
| AFC | 0 – 9.9 VDC<br>3.8 VDC *(nominal)* | 1$^{st}$ LO PLL AFC Voltage |
| LO | 0 – 99.9%<br>100% *(nominal)* | 1$^{st}$ LO relative power level |
| XCTR | 0 – 99.9%<br>100% *(nominal)* | Transmit module’s relative output power level |

## 3.4.16 QAM Radio RX Status




| Function | Settings | Summary |
|---|---|---|
| Freq A | 2300.00 MHz | Displays the receiver operating frequency |
| XMTR | | Transfer status of receiver: |
| | TRAFFIC | Is operating, ready for transfer |
| | FORCED *(default)* | Is operating, will not transfer (forced ON) |
| RSL | -30.0 to -90.0 dBm | Received signal level (signal strength)<br>Nominal level dependent upon customer path/system gain |
| ATTEN | | Receiver PIN attenuator setting: |
| | AUTO *(default)* | Controlled by internal software |
| | ON | Forced ON |
| | OFF | Forced Off |
| SYNTH | LOCK *(default)*<br>UNLOCK | Indicates phase lock of the 1st LO |
| AFC | 0 – 9.9 VDC<br>3.5 VDC *(nominal)* | 1st LO PLL AFC Voltage |
| LO | 0 – 99.9%<br>100% *(nominal)* | 1st LO relative power level |

## 3.4.17 QAM Radio TX Control




| Function | Settings | Summary |
|---|---|---|
| TX-A Radiate | AUTO *(default)* | Transmitter radiating, but folds back output power on high antenna VSWR (REV PWR) |
| | ON | Transmitter radiating |
| | OFF | Transmitter not radiating |

## 3.4.18 QAM Radio RX Control

```
QAM Radio RX Control
RX Atten      □ AUTO
```

| **Function** | **Settings** | **Summary** |
|---|---|---|
| RX-A ATTEN | AUTO *(default)* | ON, and is activated on high signal level |
| | ON | ON *always* |
| | OFF | OFF |

## 3.4.19 QAM Modem Configure

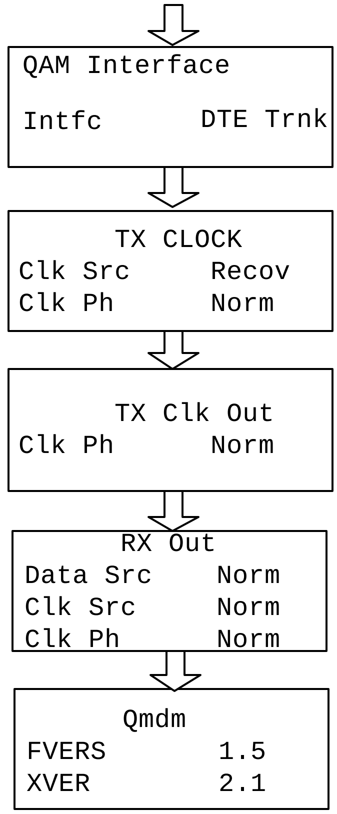
```
QAM Modem Configure
 Power-On Default

Mode/Effic  □ 32Q/5
```

```
Data Rt   □  2048  k
Intrlv    □      3
Spctrm    □  INVRT
Fltr      □  18
```

```
Encode    □ DVB
Test      □ PRBS23
Loopback  □ CLR(OFF)
```

| Function | Settings | Summary |
|---|---|---|
| Interface | QPSK/2, 16Q/4, 32Q/5, 64Q/6, 128Q/7, 256Q/8 | Default is 64QAM |
| DATA RATE | N x 64 kbps, | Valid range depends upon configuration. |
| INTERLEAVE | 1 | Interleave depth. |
| | 2 | 1 to 204 |
| | 3 *(default)* | |
| | 4 | |
| | 6 | |
| | 12 | |
| | 2,17 | |
| | 2,34 | |
| | 2,51 | |
| | 2,68 | |
| | 2,102 | |
| | 2,204 | |
| SPECTRUM | INVERT *(default)* | |
| FILTER | 18 | Nyquist roll-off factor |
| | 15 *(default)* | |
| | 12 | |
| ENCODING | DVB *(default)* | Raw data format |
| TEST | NORMAL *(default)* | Test pattern length |
| | PRBS15, PRBS23 | |
| Loopback | CLR (Off) | Loopback mode |
| | RMT+LOC | |
| | RPTR | |

**QAM Modem Configure (continued)**



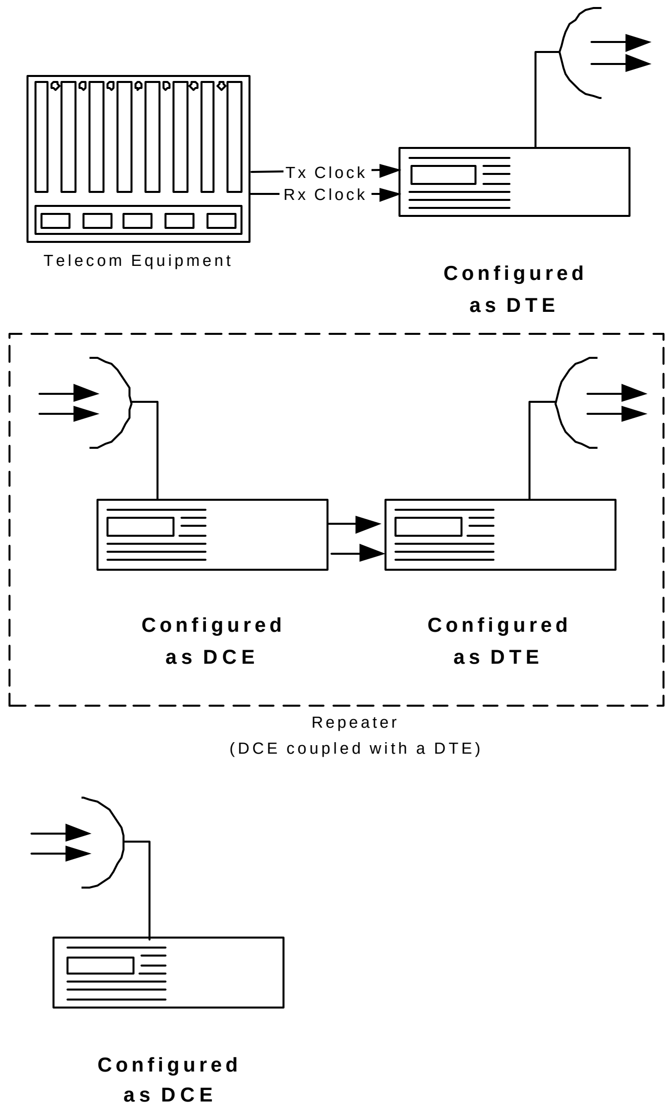

| Function | Settings | Summarys |
|---|---|---|
| Interface | Trunk | Uses Trunk for I/O. |
| | Radio (bkpln) | Uses Backplane for I/O. |
| Clk Src (Tx Clock) | Internal, EXT TXC, EXT RXC, Recovered | Clock source of the Transmitter. |
| Clk Ph (Tx Clock) | Inverted, Normal | Clock Phase of the Transmitter. |
| Clk Ph (Tx Clock Out) | Inverted, Normal | Clock Phase of the Transmitter Clock Out. |
| Data Src (Rx Out) | Norm, RPT, Loop | Data Source of the Receiver Out. Normal means the source is either BKPLN or TRNK; RPT sets the radio to Repeater; Loop sets the radio to loopback mode. |
| Clk Src (Rx Out) | Internal, EXT TXC, EXT RXC, Recov | Clock Source of the Receiver Out. |
| Clk Ph (Rx Out) | Norm, Inverted | Clock Phase of the Receiver Out. |
| Fvers | | |
| Xvers | | |

*Internal is the internal clock of the NXE1-20; EXT TXC is the External Transmit Clock; EXT RXC is the External Receive Clock; Recovered is the recovered clock from the receiving RF.*

NOTE: See the User Clock Options Conceptual Diagram in Figure 3-4 below for clarification.

### 3.4.19.1 Typical Configuration

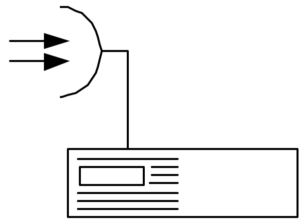
A typical installation of NXE1-20 Digital Radios involves configuring each NXE1-20 as either Data Communications Equipment (DCE) or as Data Terminal Equipment (DCE), as illustrated below:




A DCE coupled together with a DTE enables the signal to be relayed to another DCE. This configuration is called a Repeater.  A network can consist of as many Repeaters as necessary. The following sub-sections describe how to configure the NXE1-20 a DCE or as a DTE.

### 3.4.19.2 NXE1-20 as Data Communications Equipment (DCE)

By default, the NXE1-20 is configured as Data Communications Equipment (DCE).  In the mode, the device recovers the transmitted clocks and effectively performs as a modem.



**Configured as DCE**

To configure the NXE1-20 as a DCE, select the following clock settings in the System menu:

```
      QAM Inerface

Intfc    DCE Trunk
```

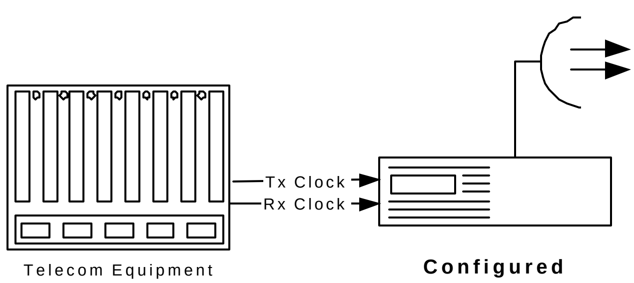
```
      TX CLOCK
Clk Src     Recov
Clk Ph      Norm
```

```
      TX CLK OUT

Clk Ph      Norm
```

```
      RX CLOCK
Clk Src     Recov
Clk Ph      Norm
```

### 3.4.19.3 NXE1-20 as Data Terminal Equipment (DTE)

When configured as Data Terminal Equipment (DTE), the NXE1-20 gets its clock from an external source, such as a telecommunications device.




**Configured as DTE**

To configure the NXE1-20 as a DTE, make the following clock selections in the System menu:

```
   QAM Interface

Intfc    DTE Trunk
```

```
      TX CLOCK
Clk Src   EXT TXC
Clk Ph    Norm
```

```
      TX CLK OUT

Clk Ph      Norm
```

```
      RX CLOCK
Clk Src    EXT TXC
Clk Ph     Norm
```

### 3.4.19.4 User Clock Options Conceptual Diagram

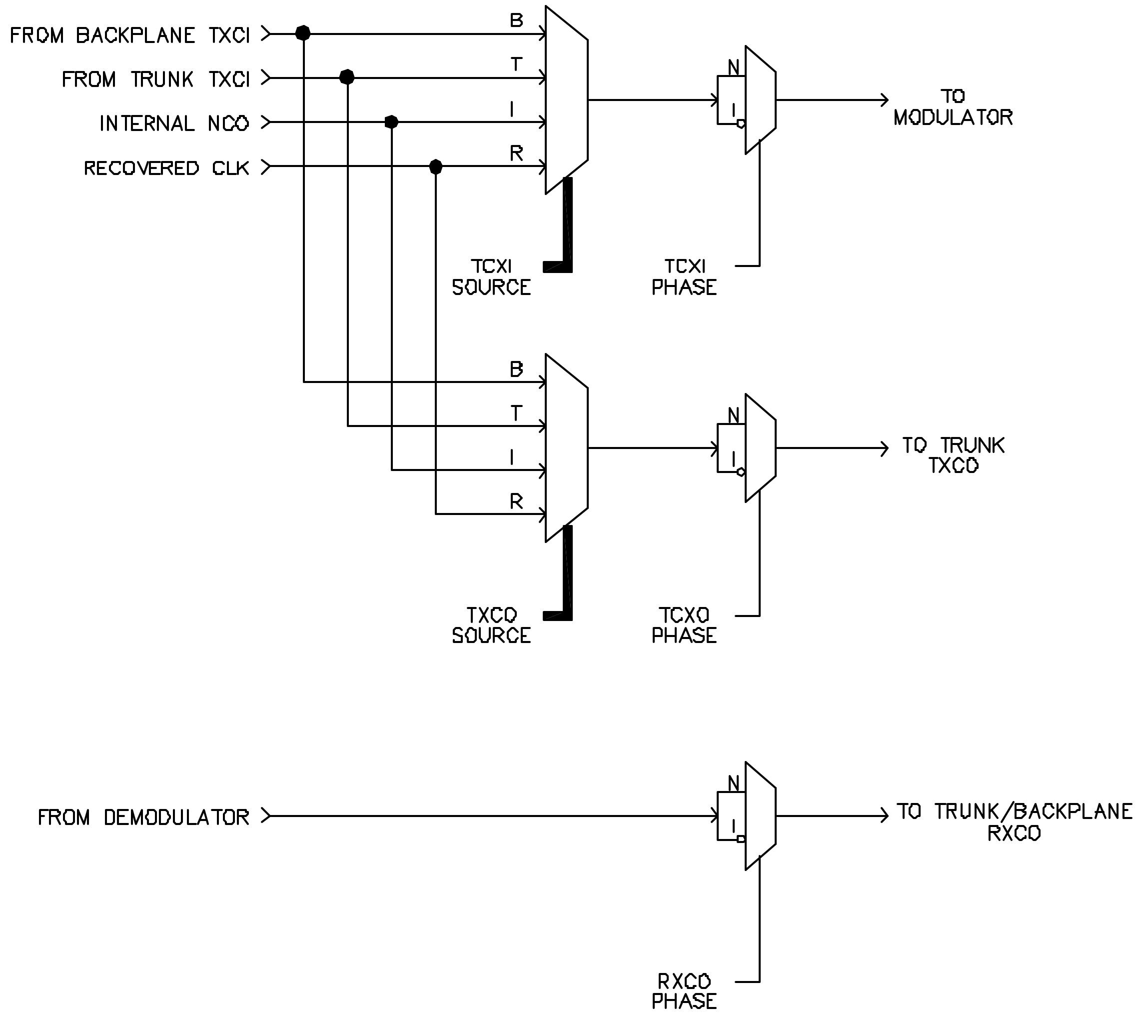
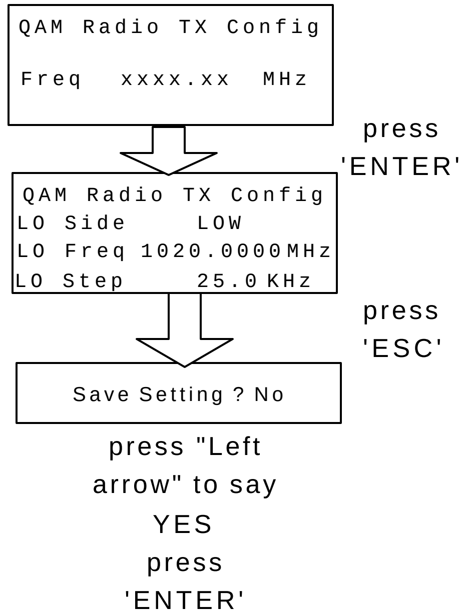


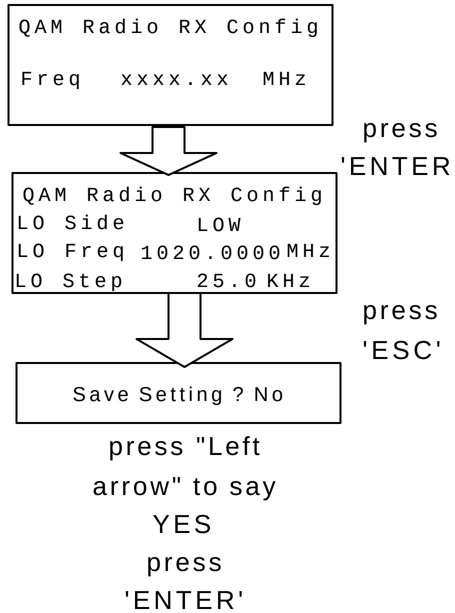

**Figure 3-4. User Clock Options Conceptual Diagram**

## 3.4.20 QAM Radio TX Configure




| **Function** | **Settings** | **Summary** |
|---|---|---|
| FREQ | 2300.00 MHz | Displays the frequency of the transmitter and allows the user to make frequency changes. |
| LO Side | LOW | LOW: LO freq is less than carrier freq. |
| | HIGH | High: LO freq is greater than carrier freq. |
| LO Freq | 2370 MHz | |
| LO Step | 25.0 KHz | Programming frequency step size |

### 3.4.21 QAM Radio RX Configure




| Function | Settings | Summary |
|---|---|---|
| FREQ | 2300.00MHz | Displays the frequency of the receiver and allows the user to make frequency changes. |
| LO Side | LOW | LOW: LO freq is less than carrier freq. |
| | HIGH | High: LO freq is greater than carrier freq. |
| LO Freq | 2370.00 MHz | |
| LO Step | 25.0 KHz | Programming frequency step size |

# 3.5 NMS/CPU PC Configuration Software

The NMS/CPU card is configured with a Windows-based PC software package. The hardware is accessed through the serial port on the NMS card back panel. See the manual for Moseley NXE1-20 *Configuration Software* for more information.

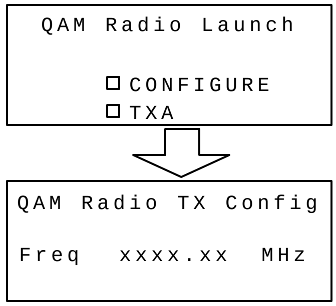
# 3.6 Up/Down Converter: Frequency Adjust

### 3.6.1 TX Frequency Adjust

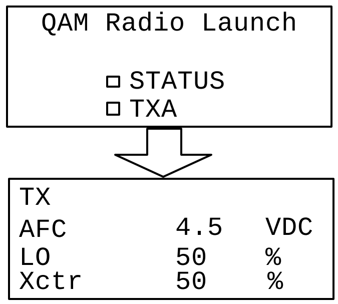
It is possible to change the carrier frequency of the transmitter via the front panel.

Before changing frequency ensure that this is carried out in a controlled environment with test equipment to ensure that you are transmitting the defined frequency:

1. Power-up the unit and navigate the LCD screens as follows:




1. Using the cursors, change to the desired frequency. Press ENTER and the TX will most likely lose AFC LOCK.
2. Navigate the LCD screens to monitor the AFC voltage as follows



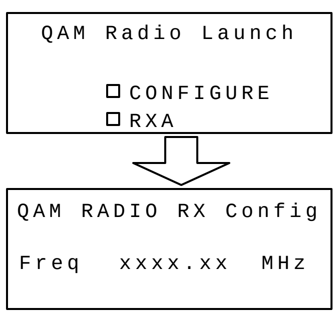

1. Ensure that the voltage reads 0.5 to 9.5 +/- .25 VDC.
2. The TX should achieve AFC LOCK and the operation is successful.

### 3.6.2 AFC Level—RX

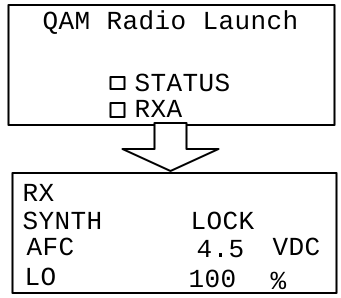
It is possible to change the operating frequency of the receiver via the front panel.

Before changing frequency ensure that this is carried out in a controlled environment with test equipment to ensure that you are transmitting the defined frequency:

1. Power-up the unit and navigate the LCD screens as follows:




1. Using the cursors, change to the desired frequency. Press ENTER and the RX will most likely lose AFC LOCK.
2. Navigate the LCD screens to monitor the AFC voltage as follows




3. Ensure that the voltage reads 0.5 to 9.5 +/- .25 VDC.
4. The RX should achieve AFC LOCK and the operation is successful.

# 4 Data Interface Cables

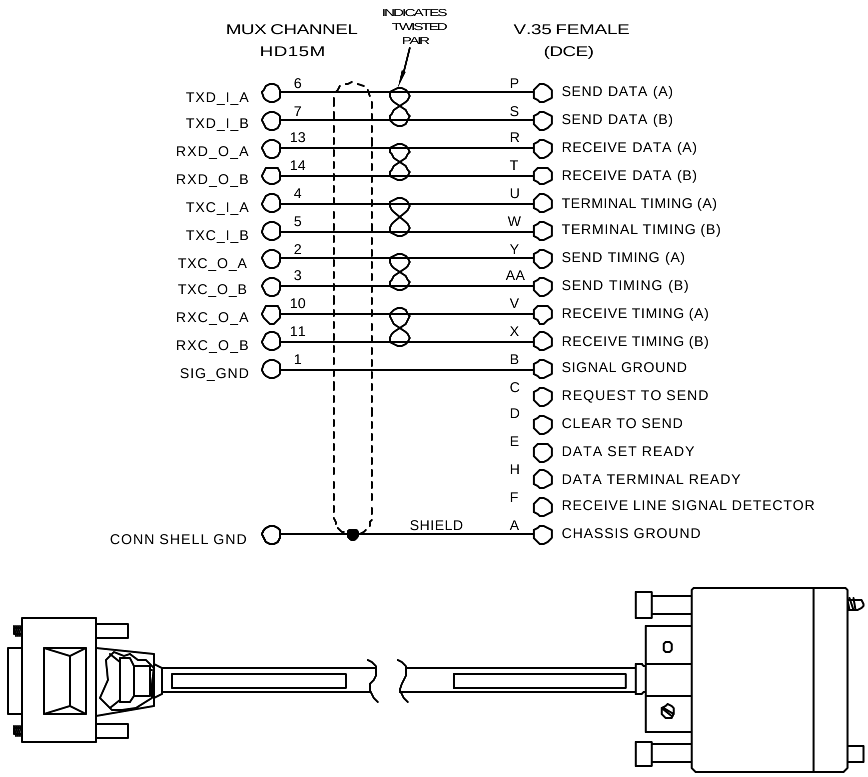



**Figure 4-10. Mux Channel – V.35 (DCE)**

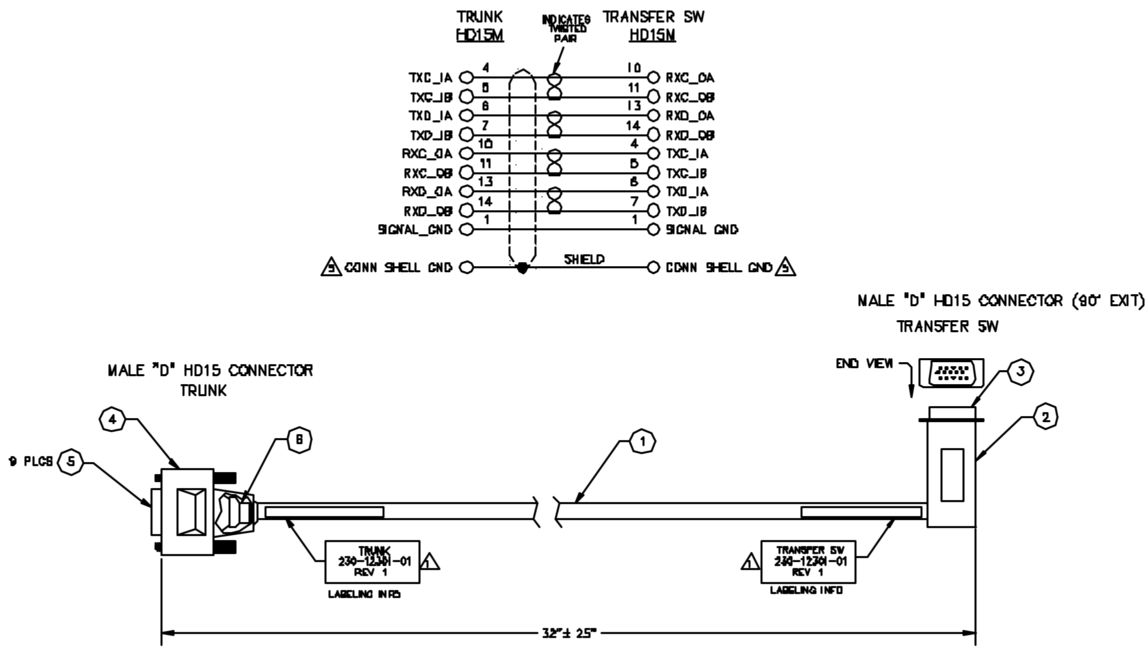



**Figure 4-12. Trunk to Trunk Cable (Mux-Trunk Null)**

# 5 Appendix

## 5.1 Path Evaluation Information

### 5.1.1 Introduction

#### 5.1.1.1 Line of Site

For the proposed installation sites, one of the most important immediate tasks is to determine whether line-of-site is available. The easiest way to determine line-of-site 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).

#### 5.1.1.2 Refraction

Because the path of a radio beam is often referred to as line-of-site, 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 denser 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.

#### 5.1.1.3 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 effect 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.  This will be the case when the total phase delay is equal to one wavelength (or equal to any integer multiple of the carrier wavelength); this will also 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 simplest 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:

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

Where,

$d_1$ and $d_2$ = distances in statute miles from a given point on a microwave path to the ends of the path (or path segment).

$f$ = frequency in MHz.

$F_1$ = 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.

### 5.1.1.4 K Factors

The matter of establishing antenna elevations to provide minimum fading would be relatively simple was 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.

$d_1$ = distance in miles (statute) from a given end of the microwave path to an arbitrary point along the path.

$d_2$ = 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.

#### 5.1.1.5 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.

## 5.1.2 Path Analysis

### 5.1.2.1 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**.

### 5.1.2.2 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:

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

Where,

***A*** = free space attenuation between isotropics in dB.

***F*** = frequency in GHz.

***D*** = path distance in miles.

### 5.1.2.3 Path Balance Sheet/System Calculations

A typical form for recording the gains and losses for a microwave path is shown in Section 5.2.7. 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.

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.

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) |
|---|---|---|
| 450 MHz | 3.46 dB | 2.65 dB |
| 1000 MHz | 5.38 dB | 4.12 dB |
| 2000 MHz | 8.02 dB | 6.11 dB |
| 6000 MHz | 15.6 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. Losses are up to 1.5 dB per terminal. These only apply for full duplex systems. These depend on the type of filter used. If the bandpass filters are used, the Tx and Rx losses are 0.75 dB. If the Notch filters are used, the losses are 1.5 dB. For even coupler MHSB applications, add 3 dB power divider losses.

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 gain from line 4.

L. Line 13. Enter the total loss from line 11.

M. Line 14. Subtract line 13 from line 12. This is the unfaded signal level to be expected at the receiver. (Convert from dBm to microvolts here for reference).

N. Line 15. Using the information found in Table 5-4 and 5-5 below, enter here the minimum signal required for 1x10E-3 BER.

**Table 5-4.NXE1-20 System Performance vs. Data Rate**

| Data Rate (kbps) | 768 | 1544 | 2048 | 2xE1 | 4xE1 |
|---|---|---|---|---|---|
| Rx signal (dBm), 16 QAM | -95 | -94 | -93 | -90 | -87 |
| Occupied (FCC) Spectrum (kHz) | 200 | 450 | 600 | 1200 | 2400 |

‡ Due to ETSI sensitivity specifications, this is QPSK mode only.
Sensitivity is –102 dBm.
For other modulation rates relative to 16 QAM, see Table 5-5.

**Table 5-5.NXE1-20 Modulation rates relative to 16 QAM**

| Modulation Type | Threshold Differential | Normalized Bandwidth |
|---|---|---|
| QPSK | -3 dB | 2.0 |
| 16 QAM | 0 dB | 1.0 |

O. Line 16. Subtract line 15 from line 14 and enter here. This is the amount of fade margin in the system.

P. Line 17. Enter the Terrain Factor.

> ***a*** (terrain factor)
> = 4 for smooth terrain.
> = 1 for average terrain.
> = 1/4 for mountainous, very rough, or very dry terrain.

Q. Line 18. Enter the Climate Factor.

> ***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.

R. Line 19. Enter the minimum Annual Outage (from Table 5-6).

S. Line 20. Enter the Reliability percentage (from Table 5-6).

### 5.1.2.4 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:

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

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 |

### 5.1.2.5 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.

### 5.1.2.6 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 (sum of lines 1, 2, 3)** | **_____________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 U _________; dB/100 ft) | -_____________dB |
| 8. | Connector Loss (Total) | -_____________dB |
| 9. | Branching losses | -_____________dB |
| 10. | Obstruction losses | -_____________dB |
| **11.** | **Total loss (sum of lines 5 through 10)** | **_____________dB** |

**SYSTEM CALCULATIONS**

| | | |
|---|---|---|
| 12. | Total Gain (line 4) | +_______________dBm |
| 13. | Total Loss (line 11) | -_______________dB |
| **14.** | **Effective Received Signal** | |
| | **(line 12-line 13) (__________uV)** | **_______________dBm** |
| 15. | Minimum Signal Required (BER = 1X10E-4) | -_______________dBm |
| **16.** | **Fade Margin (line 14-line 15)** | **_______________dB** |
| 17. | Terrain Factor | _______________ |
| 18. | Climate Factor | _______________ |
| 19. | Annual Outage | _______________min. |
| 20. | Reliability | _______________% |

# 5.2 Abbreviations & Acronyms

| | |
|---|---|
| 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 |
| CMRR | Common Mode Rejection Ratio |
| Codec | Coder-Decoder |
| CPFSK | Continuous-Phase Frequency Shift Keying |
| 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 |
| EIRP | Effective Isotropic Radiated Power |
| EMI | Electromagnetic Interference |
| ESD | Electrostatic Discharge/Electrostatic Damage |
| FEC | Forward Error Correction |
| FET | Field effect transistor |
| FMO | Frequency Modulation Oscillator |
| FPGA | Field Programmable Gate Array |
| FSK | Frequency Shift Keying |
| FT1 | Fractional T1 |
| IC | Integrated circuit |
| IEC | International Electrotechnical Commission |
| IF | Intermediate frequency |
| IMD | Intermodulation Distortion |
| 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 |
| Mbps | Megabits per second |
| Modem | Modulator-demodulator |
| Ms | Millisecond |
| MSB | Most significant bit |
| MUX | Multiplex, Multiplexer |
| μs | Microsecond |
| μV | Microvolts |
| NC | Normally closed |
| NMS | Network Management System |
| NO | Normally open |
| PCB | Printed circuit board |
| PCM | Pulse Code Modulation |
| PGM | Program |
| PLL | Phase-Locked Loop |
| QAM | Quadrature Amplitude Modulation |
| R | Transmission Rate |
| RF | Radio Frequency |
| RPTR | Repeater |
| RSL | Received Signal Level (in dBm) |
| RSSI | Received Signal Strength Indicator/Indication |
| RX | Receiver |
| SCA | Subsidiary Communications Authorization |
| SCADA | Security Control and Data Acquisition |
| SNR | Signal-to-Noise Ratio |
| SRD | Step Recovery Diode |
| STL | Studio-Transmitter Link |
| TDM | Time Division Multiplexing |
| THD | Total harmonic distortion |
| TP | Test Point |
| TTL | Transistor-transistor logic |
| TX | Transmitter |

| | |
|---|---|
| Vrms | Volts root-mean-square |
| Vp | Volts peak |
| Vp-p | Volts peak-to-peak |
| VRMS | Volts, root-mean-square |
| VSWR | Voltage standing-wave ratio |
| ZIN | Input Impedance |
| ZOUT | Output Impedance |

# 5.3 Conversion Chart

microvolts to dBm (impedance = 50 ohms)

| microvolts | dBm | microvolts | dBm |
|---|---|---|---|
| 0.10 | -127.0 | 180 | -61.9 |
| 0.25 | -119.0 | 200 | -61.0 |
| 0.50 | -113.0 | 250 | -59.0 |
| 0.70 | -110.1 | 300 | -57.4 |
| 1.0 | -107.0 | 350 | -56.1 |
| 1.4 | -104.1 | 400 | -54.9 |
| 2.0 | -101.0 | 450 | -53.9 |
| 2.5 | -99.0 | 500 | -53.0 |
| 3.0 | -97.4 | 600 | -51.4 |
| 3.5 | -96.1 | 700 | -50.1 |
| 4.0 | -94.9 | 800 | -48.9 |
| 4.5 | -93.9 | 900 | -47.9 |
| 5.0 | -93.0 | 1,000 | -47.0 |
| 6.0 | -91.4 | 1,200 | -45.4 |
| 7.0 | -90.1 | 1,400 | -44.1 |
| 8.0 | -88.9 | 1,600 | -42.9 |
| 9.0 | -87.9 | 1,800 | -41.9 |
| 10 | -87.0 | 2,000 | -41.0 |
| 11 | -86.2 | 2,500 | -39.0 |
| 12 | -85.4 | 3,000 | -37.4 |
| 14 | -84.1 | 3,500 | -36.1 |
| 16 | -82.9 | 4,000 | -34.9 |
| 18 | -81.9 | 4,500 | -33.9 |
| 20 | -81.0 | 5,000 | -33.0 |

| **microvolts** | **dBm** | **microvolts** | **dBm** |
| --- | --- | --- | --- |
| 25 | -79.0 | 6,000 | -31.4 |
| 30 | -77.4 | 7,000 | -30.1 |
| 35 | -76.1 | 8,000 | -28.9 |
| 40 | -74.9 | 9,000 | -27.9 |
| 45 | -73.9 | 10,000 | -27.0 |
| 50 | -73.0 | 22.36 mV | -20 (10 mW) |
| 60 | -71.4 | 70.7 mV | -10(100 mW) |
| 70 | -70.1 | 223.6 mV | 0 (1 mW) |
| 80 | -68.9 | 707.1 mV | +10 (10mW) |
| 90 | -67.9 | 2.23 V | +20(100 mW) |
| 100 | -67.0 | 7.07 V | +30 (1 W) |
| 120 | -65.4 | 15.83 V | +37 (5 W) |
| 140 | -64.1 | 22.36 V | +40 (10 W) |
| 160 | -62.9 | | |