LCe-4 Integrated Headend Controller Installation Manual

NORTEL NETWORKS™

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NOTE: 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 cause the user will be required to correct the interference at his own expense.

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This product conforms to the provisions of Council Directive 89/336/EEC and 73/23/EEC.

LCe-4 Integrated Headend Controller Installation Manual

This manual in conjunction with the Nortel Networks, Data Over Cable Division Provisioning Server (LCn) User Guide describes how to install and configure the Integrated Headend Controller (LCe-4). This manual is intended for the hardware installer and the network manager.

Suppression/Update Information:This is a new manual.

Revision 01

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NORTEL NETWORKS™

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About This Document

The *LCe-4 Integrated Headend Controller Installation Manual* describes how to:

- Install the LCe-4 for operation on your HFC systems
- Select the return channel attenuation
- Adjust the LCe's output
- Read the LCe's control panel
- Set the LCe's transmit and receive frequencies
- Monitor the output of the LCe's signal to the forward combiner

The *LCe-4 Integrated Headend Controller Installation Manual* provides the LCe's major specifications, instructions for setting up the integrated cable TV single-channel translators, and verifying the LCe's HFC signal levels.

If you are a cable TV technician and/or installation technician trained to perform system installations, you need to read this manual.

If you want	Go to
The LCe's physical description and specifications and/or a list of required tools and materials.	Chapter 1
Set up procedures for the LCe, including rack mount instructions.	Chapter 2
The location and description of the unit's control panel and status LEDs and how to set input and output frequencies.	Chapter 3
The console port interface for remote management.	Chapter 4

Conventions Used in This Guide

angle brackets (< >)	Indicate that you choose the text to enter based on the description inside the brackets. Do not type the brackets when entering the command. Example: if command syntax is **ping** *<ip_address>*, you enter **ping 192.32.10.12**
bold text	Indicates text that you need to enter, command names, and buttons in menu paths. Example: Enter **wfsm &** Example: Use the **dinfo** command. Example: ATM DXI > Interfaces > **PVCs** identifies the PVCs button in the window that appears when you select the Interfaces option from the ATM DXI menu.
brackets ([ ])	Indicate optional elements. You can choose none, one, or all of the options.
Capitalized word	Indicates a key that you press. For example: Press Return or Enter. When you see two key names, press and hold the first key, and then type the second character. For example: To Press Control-C, press and hold the Control key, and then press the C key.
ellipsis points	Horizontal (. . .) and vertical (⋮) ellipsis points indicate omitted information.
italic text	Indicates variable values in command syntax descriptions, new terms, file and directory names, and book titles.
quotation marks (“ ”)	Indicate the title of a chapter or section within a book.
`screen text`	Indicates data that appears on the screen. Example: `Set Nortel Networks Trap Monitor Filters`
separator (>)	Separates menu and option names in instructions and internal pin-to-pin wire connections. Example: Protocols > AppleTalk identifies the AppleTalk option in the Protocols menu. Example: Pin 7 > 19 > 20
vertical line (|)	Indicates that you enter only one of the parts of the command. The vertical line separates choices. Do not type the vertical line when entering the command. Example: If the command syntax is **show at routes** | **nets**, you enter either **show at routes** or **show at nets**, but not both.

Acronyms

ASIC	Applications Specific Integrated Circuit
BootP	Bootstrap Protocol
BRI	Basic Rate Interface
BS	Block Sync
BW	Bandwidth
CDM	Cable Data Modem
CM	Cable Modem
dB	Decibel
dBc	Decibel Carrier
dBm	Decibel Milliwatt
dBmV	Decibel Millivolt
DCE	Data Communications Equipment
DES	Data Encryption Standard
DHCP	Dynamic Host Configuration Protocol
FSH	Field Support History Log
FTP	File Transfer Protocol
GUI	Graphical User Interface
HDLC	High-Level Data Link Control
HFC	Hybrid Fiber Coax
HRN	Headend Reference Node
IP	Internet Protocol
IRQ	Interrupt Request
ISP	Internet Service Provider
Kbps	Kilobytes per Second
LAN	Local Area Network
LCb	LANcity Multiple User Cable Modem
LCD	Liquid Crystal Display
LCe	LANcity Integrated Headend Controller
LCh	LANcity Headend Equalization Node
LCn	LANcity Provisioning Server
LCP	LANcity Personal Cable Modem
LCT	LANcity Transmaster (Frequency Translator)
LCw	LANcity Work Group Bridge
MAC	Media Access Control

MAU	Media Access Unit
Mbps	Megabytes Per Second
MIB	Management Information Base
MSO	Multiple System Operator
MTBF	Mean Time Between Failures
MTD	Max Transit Delay
NIC	Network Interface Card
NMS	Network Management System
NVRAM	Non-Volatile Random Access Memory
OSI	Open Systems Interconnection
OSPF	Open Shortest Path First (Protocol)
PPP	Point-to-Point Protocol
QPSK	Quadrature Phase Shift Keying
RDBMS	Relational Database Management System
RF	Radio Frequency
RMA	Return Merchandise Authorization
RX	Receive
SMDS	Switched Multimegabit Data Service
SNMP	Simple Network Management Protocol
STP	Spanning Tree Protocol, Shielded Twisted Pair
TCP/IP	Transmission Control Protocol/Internet Protocol
Telnet	Telecommunication Network
TFTP	Trivial File Transfer Protocol
Tmra	Maximum Rated Ambient Temperature
TPE	Twisted-Pair Ethernet
TX	Transmit
UTP	Unshielded Twisted Pair
WAN	Wide Area Network

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Valbonne, France	33-4-92-96-69-68	33-4-92-96-69-98	baypoint@baynetworks.com

*For cable modems and cable modem family products, use Express Routing Code 174.

Associated Document

Refer to the following document for further information:

- *Nortel Networks, Broadband Technology Division User Guide - Provisioning Server - LCn* describes how to install and use the basic functions of the Provisioning Server (LCn). Also included is information on setting up a network using the LCn.

Safety Precautions

This document provides safety precautions to follow when installing the Integrated Headend Controller.

For your protection, observe the following safety precautions when setting up your equipment:

- Follow all warnings and instructions marked on the equipment.
- Ensure that the voltage and frequency of your power source matches the voltage and frequency inscribed on the equipment's electrical rating label.
- Never push objects of any kind through openings in the equipment. Dangerous voltages may be present. Conductive foreign objects could produce a short circuit that could cause fire, electric shock, or damage to your equipment.

Symbols

The following international symbols appear in this book in places where you must perform procedures requiring proximity to electrical current.Modifications to Equipment

Do not make mechanical or electrical modifications to the equipment. The Integrated Headend Controller may not meet regulatory compliance if modified.

Caution – You risk damaging your equipment if you do not heed the instructions.

Warning – Hazardous voltage is present. To lessen the risk of electrical shock and danger to personal health, follow the instructions carefully.

Placement of the Integrated Headend Controller

Caution – To ensure reliable operation of the Integrated Headend Controller and to protect it from overheating, do not block or cover openings in the equipment. Never place the Integrated Headend Controller near a radiator or heat register.

Power Cord Connection

Warning – The Integrated Headend Controller is shipped with a grounding-type (3-wire) power cord. To reduce the risk of shock, always plug the cord into a grounded power outlet.

Warning - The Integrated Headend Controller is designed to work with single-phase power systems, having a grounded neutral conductor. To reduce the risk of electrical shock, do not plug the Integrated Headend Controller into any other type of power system. Contact your facilities manager or certified electrician if you are not sure what type of power is supplied to your building.

Note:The LCeEA-xx must be operated with the supplied line cord or with a line cord meeting IEC227 H03 VV-F or IEC227 H03 VVH2-F having conductors with a cross sectional area not less than .75 mm^2**.**

The Integrated Headend Controller Cover

Warning – It is not safe to operate the Integrated Headend Controller without the cover in place. Failure to take this precaution may result in personal injury and system damage.

Chapter 1
Introduction

This manual explains how to install an LCe-4 Integrated Headend Controller.

This chapter describes the LCe's physical characteristics and specifications. Chapter 1 also provides a list of required tools and materials.

Before You Begin

You should be familiar with cable TV systems. Many of the operations described by this guide could disrupt the entire cable TV system if performed improperly.

This guide assumes you are familiar with the LCe-4 System's architecture and its technical terms such as Pacer, max loop delay, etc. If you are not familiar with these terms, refer to the *Nortel Networks, Broadband Technology Division Training Manual.*

You must have the permission and authorization of the cable TV system operator before you begin the installation.

Installation Tools and Equipment Required

When installing the LCe on a cable TV network, a portion of the installation process involves testing the cable's forward and return frequency signal levels. These tests are in preparation for installing the LCPs and LCbs. The following sections describe the required tools and test equipment and their uses.

Tools You May Need

There are no special tools required to install the LCe. The tool kit should include:

- 7/16-inch open end wrench
- Phillips screwdriver

Installation and Verification Equipment You Need

The following equipment is required during initial system set up and installation:

- A CW signal generator is required during initial system set up and installation.

  This device is used to inject a RF carrier signal on the provided reverse channel of the cable TV network. This allows the user to measure the input and output signal levels and verify the operating frequency.

- Spectrum analyzer or power meter and tone generator

  Instruments such as the spectrum analyzer, power meter and tone generator may be used to create and measure signals, signal levels and operating frequencies.

Additional Installation Equipment You May Need

It is recommended that the following additional installation equipment is within easy access:

- Flash light
- Power extension cords/strips
- Multimeter (Ohm meter/volt meter)
- 75 Ohm Attenuators (various values, i.e., 3, 6, 10 dB)
- Splitters, directional couplers (single port, multi-port, various values)
- Coaxial cables (various lengths)

Physical Description

The LCe-4 Integrated Headend Controller provides a highly integrated headend solution for the cable operator. As subscriber penetrations increase and new data channels are installed, headend rack space becomes a precious commodity, requiring space-efficient equipment. In only 3.5 inches of space, the LCe integrates all the equipment necessary to support two data channels including: frequency translators, cable TV-to-Ethernet bridges, data bandwidth allocator, and timing/frequency/amplitude reference (see Figure 1-1).

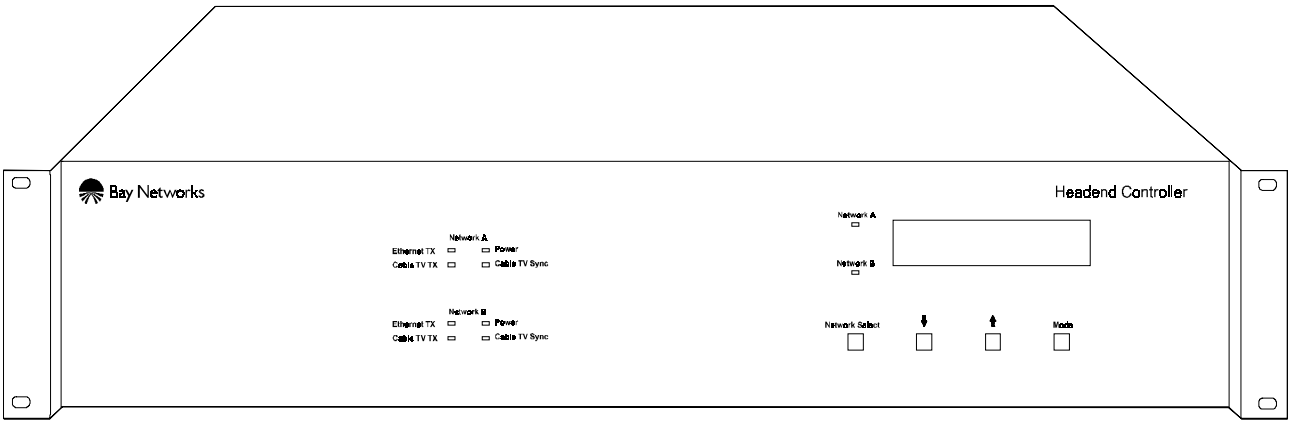


Figure 1-1 LCe-4 Integrated Headend Controller

Wiring complexity is minimized by integrating the required components for RF level settings to and from the headend reference nodes. Only RF connections for the upstream and downstream channels are required, providing an easy-to-manage wiring plan for the headend.

The LCe is at the heart of the Nortel Networks LANcity cable modem Plug-and-Play technology, minimizing the installation and maintenance costs of a data network. A cable modem need only be physically installed at the customer premises, with no local configuration or cable adjustment required. Functions such as channel selection, transmit level adjustment, frequency effect compensation and bandwidth allocation are done automatically and periodically under the control of the LCe.

The cable TV data channel is part of the worldwide Internet, and the LCe provides the connectivity. Integrating a very high performance bridge architecture provides interconnectivity between multiple data channels and an Internet router. The open and scalable Nortel Networks LANcity network architecture enables either direct connectivity through the Ethernet port or a routed or switched solution using equipment from the leading internetworking vendors.

The LCe system is frequency-agile over its operating range of 8.75 to 42 MHz upstream and 88 to 750 MHz downstream (band edge to band edge) in 250 KHz increments. The LCe allows configuration of modem frequencies through the easy-to-use front panel control or the serial port connection, which enables remote configuration using a telephone modem. Refer to Chapter 4, Console Port Interface, for more information on the LCe’s serial connection. Data channels can be moved in frequency, allowing a dynamic management of spectrum.

LCe-4 Dual Headend Reference Cable Modems

The headend reference cable modem section of the LCe provides references for Nortel Networks LANcity Cable Data Modems (CDMs). The reference nodes receive Nortel Networks LANcity cable TV network operational parameters (including the upstream and downstream frequencies) from the Nortel Networks LANcity Provisioning Server (LCn). The reference cable modems broadcast these parameters periodically on each of their specific downstream channels, so Nortel Networks LANcity CDMs (LCP, LCb, and LCw) on those specific networks can receive them. Each CDM can then use those network parameters to contact the LCn for its definitive operational parameters.

Headend Reference Cable Modem Functions

The reference nodes provide the following functions:

- Dynamically allocate data bandwidth
- Transmit periodic reference packets, allowing CDMs to equalize dynamically for downstream cable plant characteristics such as group delay, tilt and micro-reflections
- Transmit periodic broadcasts of the base network parameters allowing newly-installed CDMs to scan for the assigned receive frequency and then obtain the information needed to contact the LCn

Headend Reference Cable Modem LEDs

Following is a brief description of the Headend Reference Cable Modem LEDs:

Ethernet TX	Indicates Ethernet Transmit
Power	Indicates AC Power is ON
Cable TV TX	Indicates Cable TV Transmit
Cable TV Sync	Indicates Diagnostic Status and Block Synchronization achieved

The Headend Reference Cable Modem goes through the following sequence when it is connected to a properly rated power outlet using the supplied power cord. The Provisioning Server (LCn) must be connected during initial power up and the LCn must be configured for the LCe in order for the Headend Reference Cable Modems to achieve Block Sync.

The Power LED, activates within three seconds of plugging in the LCe. If this does not happen, unplug the power and verify that the power source is functional.

The LCe Power Up Diagnostics run during the first 30 seconds after power is on. The diagnostics use all four LEDs during the test.

The LCe's Headend Reference Cable Modems receive their authorization from the LCn and achieve Block Sync. The Power LED and the Cable TV Sync LED will remain illuminated. If no remote modems are on the network, the LCe will periodically drop Block Sync and then reestablish Block Sync.

If there is transmit traffic on either the Ethernet or Broadband networks, the respective transmit LEDs will flash intermittently when traffic is present.

LCe-4 Dual Frequency Translators

The frequency translator section of the LCe consists of a local controller and two frequency translators. The controller has remote control capabilities, but all functions can be performed locally without any remote connection.

LCe-4 Controls

Mode Information

The first line on the display is the Mode Information Line. It shows the settings for the currently selected mode. The six possible operating modes are:

1. Mode 0: Input Frequency Adjustment/Display
2. Mode 1: IF Power Adjustment/Display
3. Mode 2: Output Frequency Adjustment/Display
4. Mode 3: RF Power Adjustment/Display
5. Mode 4: RF Output Enable/Disable
6. Mode 5: Remote Address Select

Status Information

The second line on the display is the Status Information Line. The Status Line is divided as follows:

The two leftmost characters refer to the status of Network A. The possible displayed conditions are as follows:

- Ae – indicates that the RF output for Network A is enabled
- Am – indicates that the RF output for Network A is muted
- Ad – indicates that the RF output for Network A is disabled

The next two characters refer to the status of Network B. The possible displayed conditions are as follows:

- Be – indicates that the RF output for Network B is enabled
- Bm – indicates that the RF output for Network B is muted
- Bd – indicates that the RF output for Network B is disabled

The next three characters indicate the local control status. The possible displayed conditions are as follows:

- L/R – indicates that both local and remote control is enabled.
- R – indicates that only remote control is enabled.

The final four characters refer to the error status of the Frequency Translator. The displayed characters correspond to a 16-bit hexadecimal error code. Each bit in the error code corresponds to a specific error condition. The bit definitions for the error code are shown in Table 1-1.

Table 1-1 LCe-4 Translator Error Message Table

Bit 0 (LSB)	0001	Unit A DownConverter Variable LO Unlocked
Bit 1	0002	Unit A DownConverter Fixed LO Unlocked
Bit 2	0004	Unit A UpConverter Variable LO Unlocked
Bit 3	0008	Unit A UpConverter Fixed LO Unlocked
Bit 4	0010	Unit B DownConverter Variable LO Unlocked
Bit 5	0020	Unit B DownConverter Fixed LO Unlocked
Bit 6	0040	Unit B UpConverter Variable LO Unlocked
Bit 7	0080	Unit B UpConverter Fixed LO Unlocked
Bit 8	0100	30 Volt Supply too low
Bit 9	0200	10 Volt Supply too low
Bit 10	0400	5 Volt Supply too low
Bit 11	0800	Temperature Sensor above 90 degrees Celsius

If there are multiple error conditions, the four-bit code becomes the hexadecimal sum of the failure codes.

Examples:

- Bits 0, 4, and 5 fail, the four-bit code is 0031
- Bits 0, 1, 2, 3, and 10 fail, the four-bit code is 040F
- Bits 4, 5, 8, 9, and 10 fail, the four-bit code is 0730

Specifications

Installation and Operating Environment

- Rack mount
- Dimensions: 17.25” x 15.75” x 3.5”
- Weight: 24 lbs.
- Operating Temperature: 0 to 40 degrees C
- Storage Temperature: -40 to +66 degrees C
- Humidity: 20% to 80% non-condensing
- Input Voltage: 88 to 260 Volts, 47 to 63 Hz
- Input Power: 70 watts max, @ 110 volts
- 85 watts max, @ 220 volts
- Ethernet connectivity: AUI

Performance

- Filtering rate: 14,000 pkts/sec
- Forwarding rate: 13,000 pkts/sec
- Distance features:
  - Round trip delays to 1.25 msec
  - Typical coax up to 200 miles
  - Typical fiber up to 160 miles

Modulation Specifications

- Data Rate: 10 Mbps transmit and receive
- Modulation: Quadrature Phase Shift Keying (QPSK)
- Spectral Efficiency: 1.67 bits/Hz

Regulatory Specifications

- Safety: UL 1950, CSA 22.2 #950, EN60950
- Emissions: FCC Class A, EU Class A, EN61000-3-2, EN61000-3-3
- Immunity: EN50082-1, EN55024

RF Electrical Specifications

- Displayed RF Out power measurement accuracy ±4 dB over operating range with a 75 Ohm load on the output port
- IF Level: User set to +37 dBmV ± 0.4 dB (with every frequency change)
- Forward channel output level: 42 dBmV to 58 dBmV adjustable
- Return channel input level auto configured to +1 dBmV ± 2 dB
- Gain: 57 dB, Variable 0 to -16 dB, allowed
- Gain variation over any 5 MHz channel: 2.0 dB Peak to Valley
- Input frequency range: 11.75 to 39 MHz Center Frequency
- Selectable in 250 KHz increments
- Output frequency range: 91 to 747 MHz Center Frequency
- Selectable in 250 KHz increments
- Stability: ± 2.0 KHz, 0 to +40° C
- Impedance all ports: 75 Ohms
- Output return loss: >8 dB (In Operating Channel)
- Input return loss: >12 dB (5 to 42 MHz)
- Spurs/harmonics: ≥55 dBc 54 to 750 MHz
- Noise Figure: <9 dB at maximum gain

Cable Television Network Requirements

- Allowed Amplitude variation inband
- Forward channel: 1 dB/MHz, 5 dB total
- Reverse channel: 1 dB/MHz, 5 dB total
- Allowed Group delay variation inband
- Forward channel: 60 nsec/MHz, 240 nsec total
- Reverse channel: 200 nsec/MHz, 800 nsec total
- Allowed tap to tap level variation: <27 dB

Chapter 2
System Installation

This chapter describes the set up procedures for the installation of the LCe-4 with detailed descriptions of set up requirements.

Unpacking and Inspection

Carefully remove the equipment from its packing material and set it on a solid surface such as a table or desk. If it appears damaged in any way, notify the carrier, and keep all packing materials for inspection by the carrier's agent.

Taking Inventory

Check the packing slip to verify you have everything you ordered. The unit's shipping box contains the following:

- LCe and its power cord
- One copy of the document *LCe-4 Integrated Headend Controller Installation Manual*
- LCe Rear Rack Support Kit
- LCeEA-4 Headend Controller User Interface Software Disk

Mounting

Rack Requirements

The Nortel Networks Integrated Headend Controller is designed to be mounted in a standard 19" rack, compliant with EIA RS-310

.

Caution – The 19" rack suitable for Nortel Networks Integrated Headend Controller installation must support a minimum of 25 pounds. Do not mount the Nortel Networks Integrated Headend Controller in any manner that could cause a hazardous condition due to uneven mechanical loading.

Cooling Requirements

The LCe is designed for standard rack mounting in a 19” equipment rack. It requires 3.5 inches of vertical rack space. It should be installed in a rack allowing some access to the back of the unit. The LCe should be free of strong RF radiation emanating from local equipment in the rack. Power line transients that may cause damage to the unit should be avoided. It should be installed in a location with adequate ventilation. It is designed to operate at temperatures ranging from 5°C to +40°C.

As with all electrical equipment, operation at excessive temperature accelerates the deterioration of components and adversely affects performance. For this reason, measures should be taken to prevent the buildup of excessive heat in the rack.

Precautions should include:

- Full rack space between every unit
- Forced ventilation in an enclosed rack

Caution – The LCe has vents on the front panel for air intake. The LCe also has a fan on the back panel. When you install the LCe in a rack, make sure objects do not block the vents on the front panel or the fan on the back.

If the LCe is installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient. Therefore, consideration should be given to installing the LCe in an environment compatible with the maximum rated ambient temperature (Tmra) as specified in the Specifications section in Chapter 1.

Installation of the equipment in a rack should be such that the amount of air flow required for safe operation of the equipment is not compromised.

Power Requirements

The equipment has an international auto-ranging internal power supply which allows it to be powered from any 100-120, 220-240 VAC (50-60 Hz) source.

Note the total current consumption of all equipment on the same line before applying power to the LCe. Avoid sharing an AC source which feeds heavy motors or other equipment that requires large current drains.

Caution – Circuit Overloading: Consideration should be given to the connection of the LCe to the supply circuit and the effect that overloading of circuits might have on overcurrent protection and supply wiring. Appropriate consideration of the LCe's nameplate ratings should be used when addressing this concern.

Warning – To reduce the risk of electric shock, always plug the Nortel Networks Integrated Headend Controller power cord into a grounded Power outlet. Power outlet ground must be permanently connected to the power service earth ground

Rear Panel Connections

There are nine connectors on the rear panel of the LCe. The following Table 2-1 describes their functions and cable requirements. Familiarize yourself with each item prior to putting the unit into service.

Table 2-1 Rear Panel Connections

Connector	Function	Type
Translator A - RF In	Return channel input	‘F’
Translator A - RF Out	Forward channel output	‘F’
Translator B - RF In	Return channel input	‘F’
Translator B - RF Out	Forward channel output	‘F’
Network A - Ethernet	Network A’s Provisioning Server (LCn) connection and internetworking access point	15 Pin D subminiature AUI
Network B - Ethernet	Network B’s Provisioning Server (LCn) connection and internetworking access point	15 Pin D subminiature AUI
Remote control access data loop	Translator remote control input and daisy chain output	Two 9-pin D-Sub connectors
AC Power Receptacle	Power input	Single-phase power with grounded neutral conductor

Rack Installation

The LCe should be supported at the rear of the unit. The Rear Rack Mount Support Kit is provided for this purpose. Perform the following procedure to install the LCe in a rack.

1. Referring to Figure 2-1, measure the distance between outer surfaces of front and rear mounting rails in the 19” rack.
2. Install Rear Support Plates to both sides of the LCe so that dimension A equals the distance measured in step 1, minus 1.29 inches.
3. Orient the plates so that the captive nuts are on the outside. Use the two 6-32 x 3/8” screws that are provided. If necessary, install clip nuts on front and rear mounting rails where the LCe will be positioned.
4. Install the LCe in the rack. Support unit and align holes in front mounting ears with holes in the front mounting rail. Secure with four 10-32 x ¾” Truss Head screws and nylon washers that are provided.
5. Align Rear Support Bracket with captive nuts in Rear Support Plate and holes in rear mounting rail. Secure to rear mounting rail with four 10-32 x ¾” Truss Head screws that are provided. Secure to Rear Support Plate with four 6-32 x 3/8” screws that are provided.
6. Remove the LCe Controller Access Cover from LCe to gain access to LCe functions. Replace cover when setup is complete, to prevent accidental changing of settings.

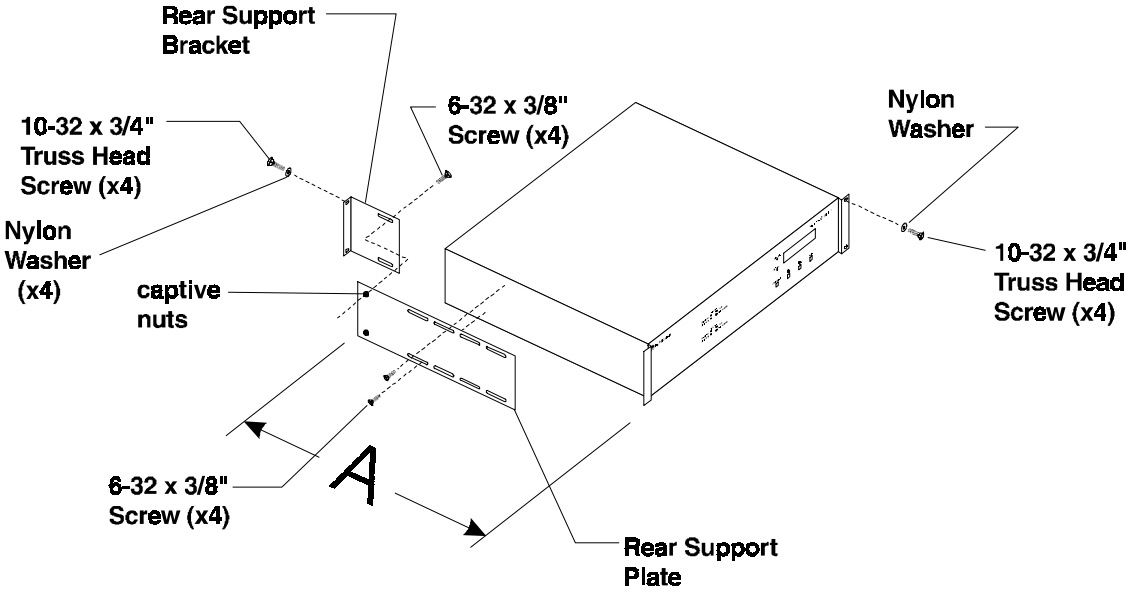


Figure 2-1 LCe-4 Rear Rack Mount Support View

Chapter 3
Operator Instructions

This chapter describes the LCe-4's operator instructions and provides a detailed description of setting up the LCe.

Setting LCe's Reverse Channel Input Level

The reverse channel input is automatically set by the LCe internal headend reference nodes to be:

+1 dBmV ± 2 dB

The remote nodes auto adjust their transmitters for the reverse path attenuation to match the level of the internal headend reference node transmitter level, at the input of the Translator. Optimization of the remote nodes auto adjustment is done by installing appropriate attenuation to the reverse channel inputs for both A and B Networks at the LCe.

Selecting the Reverse Channel Attenuation

The designed output level of the last active device of the network must be known. If fiber connects the last amplifier, you have to know the designed output level of the Fiber Receiver node at the headend.

The designed input level to the first active device of the reverse channel is a prerequisite to knowing the designed output level of the last active device.

1. Locate the reverse combiner. It is selected for connecting to the input of Network A or B (labeled Reverse at the 'F' connector) of the LCe.
2. Record the loss for that combiner and any other loss between the combiner and the last amplifier driving the input of the combiner.
3. Subtract the loss in step 2 from the designed output level. It is the level as predicted at that output with the required input to the trunk amplifiers.

Example:

30	dBmV Designed last active device output level
- 7	dBCombiner Loss
=23	dBmV

Select Reverse Channel Pad to provide optimum LCP signal to first active amplifier. The Output Level of the combiner is used as the starting point.

4. Example:

23	dBmV Level to be padded for LCT input
minus +1	dBmV Desired input level to LCT input
=22	dB Reverse Channel Pad

The automatic power adjust causes all transmitters to hit the input of the RF-to-Fiber Transceiver, or the first active amplifier, at the same level.

The automatic power adjustment range is 27 dB.

The attenuation for the reverse (upstream) path at the headend determines the value of the signal level at the input to the reverse channel amplifiers.

In forward path calculations, the key reference point is the output level of the amplifier. For reverse path calculations, the input level to the first active device becomes the key reference point. Once the level is known, by system design, all reverse path losses and gains back to the headend and translator are accounted for.

The key for selecting the attenuation for the reverse path is knowing the input level to the first active device (see Figure 3-1).

The cable modems minimum output is +30 dBmV. The path loss from the subscriber location to the first active device must be sufficient enough so that a lower level is not required to reach the designed input level of the first active device.

When this process is followed, the reverse path is optimized for the 27 dB of cable modem TX range. The path loss from the subscriber to the first active device cannot exceed 27 dB. If exceeded, the cable modem transmitter would be at its maximum output and not be able to reach the TX level required to provide optimum performance.

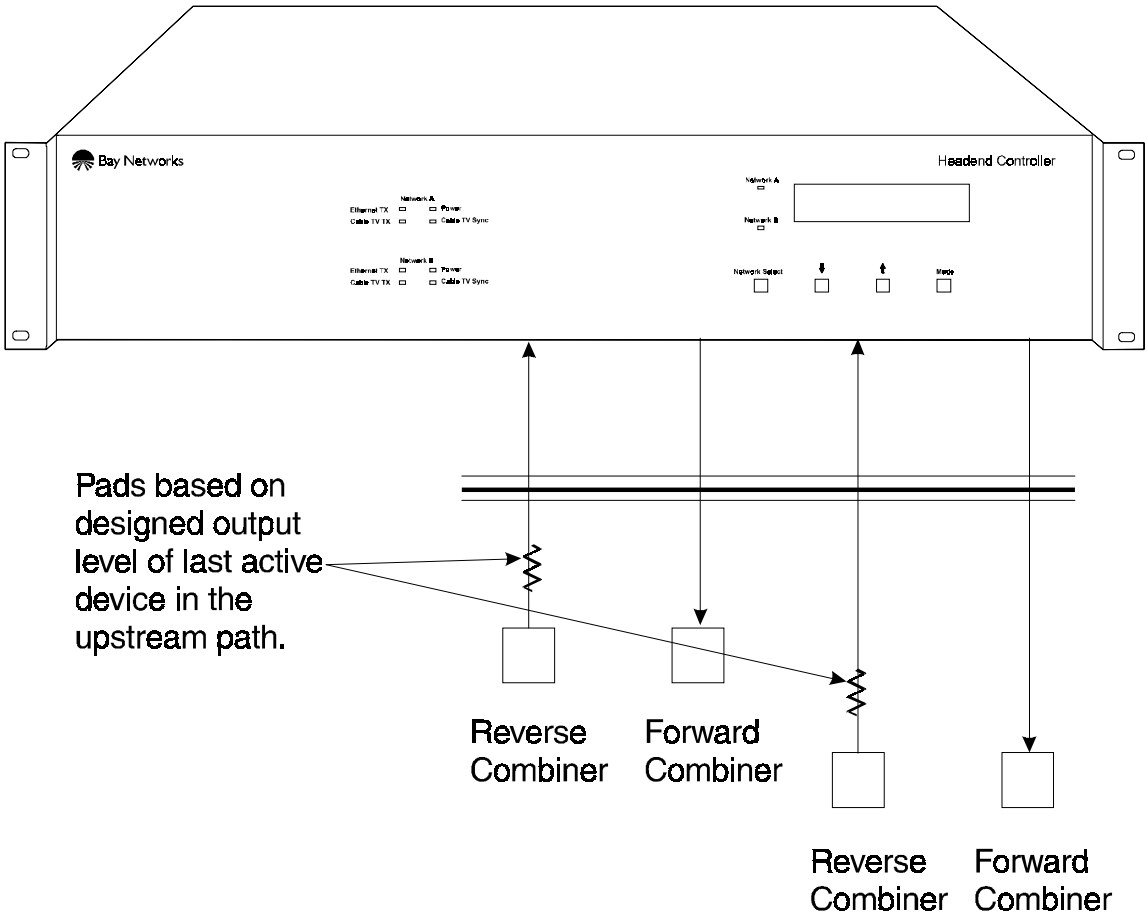


Figure 3-1 Selecting the Reverse Channel Pad

Selecting Reverse Attenuation When Multiple Nodes Are Combined

To optimize the reverse path for the correct signal levels, the output of the reverse combiner should be within ± 1.5 dB of the lowest signal before padding.

In the example shown in Figure 3-2, six nodes are combined. The test signal is injected to be at the designed input level for the first active element/amplifier.

As the test signal is injected, measure the input level to the combiner at the headend and record the level. The lowest level signal becomes the reference for adjusting the level to the input of the combiner. In the figure, the lowest level signal is the input at **F**, 24 dBmV.

The signals should be padded at the input of the combiner to be within ± 1.5 dB of the lowest signal. If a signal is 2 dB hotter than the lowest signal, add a 3 dB pad to make it 1 dB lower. See the input at **D**.

If a signal is 4 dB hotter than the lowest signal, add a 3 dB pad to make it 1 dB hotter. See the input at **B**.

This ensures that when the remote nodes auto-adjust their transmit levels, they will not exceed the designed input level of the first active device.

Follow the reverse pad selection instructions for the pad on the output of the combiner.

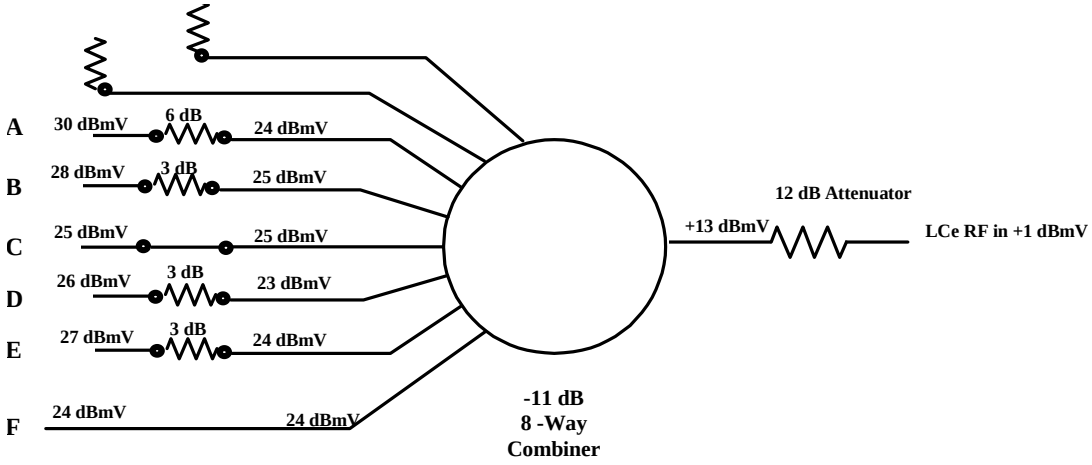


Figure 3-2 Selecting Attenuation When Multiple Nodes Are Combined

Maintaining Reverse Channel Signal-to-Noise Optimization

Limiting The Number of Combining Segments

As each segment of the network is combined at the headend, the noise from each segment will combine and give an aggregate value at the LCe input. The number of combined segments should be limited to a number that does not create a signal-to-noise ratio less than 25 dB. This allows 3 dB of headroom from the LCP's 22 dB signal-to-noise specification. Every doubling of segments decreases the base signal-to-noise ratio by 3 dB.

LCe Networks A and B Forward Channel Output Level

The output level is set at the factory with a +1 dBmV signal connected to the reverse channel input of Networks A and B. The RF output frequency is set to 627 MHz, and the RF Output is adjusted for +55 dBmV. The output power over the 91 to 747 MHz range varies by ±2 dB. When setting the gain for the operational frequency, do not set the output to greater than +58 dBmV or lower than +42 dBmV as verified with a calibrated measuring device.

The IF level must be set to 37 dBmV ± 0.4 dB as shown on the front panel display, every time you set/change frequency settings (Mode 1 – See Chapter 1, LCe – Controls, Mode Information).

Setting LCe's Forward Channel Output Level

For the initial installation of the LCe, the LCn must be connected locally to each Ethernet port of the headend Reference Nodes. Thereafter, the LCn may be left connected or connected remotely via an LCP, LCw or an LCb.

Configure the LCn for the LCe's Headend Reference Cable Modems operating channel frequencies and other configuration parameters.

Power up the LCe with the LCn connected via the Ethernet ports.

Using the front panel controls, set the LCe's input and output frequencies for both the A and B Networks. Refer to the Operating Controls Section.

Monitor the front panel LEDs (Cable TV Sync) for the Block Sync achieved indication.

With Block Sync achieved, the forward channel Network A and B outputs will be active. This allows the output level to be set using the LCe's front panel display and controls, or using the LCe Remote User Interface without having an input signal at the Network A or B inputs.

Before setting the output level, set the IF level using the front panel LCD value. Set the IF level to +37 dBmV ± 0.4 dB. When using the front panel LCD to set the output level, the forward channel output must be terminated into 75 Ohms.

The output can be set by selecting the RF Level Adjust Mode, or by using "external padding."

The RF Level Adjust Mode has an operational range of 16 dB.

Note: Do not adjust the output to be lower than +42 dBmV. If levels below +42 dBmV are required, use external attenuation.

Examples:

1. The Network A, Block Sync Data output measures +58 dBmV. The user-defined output requirement is +54 dBmV. (No signal connected to the Network A, RF Input.)

   Adjust the Network A RF Output Level with the front panel or remote controls until the level reported at the LCD, remote display, or measurement tool, reads the desired level of +54 dBmV.

2. The Network B Block Sync Data output measures +57 dBmV. The user-defined output requirement output is +45 dBmV. (No signal connected to the Network B, RF Input.)

   Adjust the Network B RF Output Level with the front panel or remote controls until the level reported at the LCD, remote display, or measurement tool, reads the desired level of +45 dBmV.

3. The Network A Block Sync data output measures +58 dBmV. The user-defined output requirement output level is +55 dBmV. (No signal connection to the Network A RF input.)

   Insert a 3 dB attenuator to the Network A's forward channel output.

4. The Network B Block Sync data output measures +57 dBmV. The user-defined output requirement output level is +37 dBmV. (No signal connection to the Network B forward channel output.)

   Insert a 20 dB attenuator to the Network B's forward channel output.

To monitor the output of Network A or B while the Network is operational, it is recommended to use an output of the forward combiner or to install single tap directional couplers or two way splitters directly at the Network A and B outputs. All unused ports should always be terminated.

The IN port of the directional coupler should be connected to the RF output of the LCe. Use the tap port of the directional coupler as the test point. Connect the output port of the directional coupler to the forward channel coaxial cable. To minimize the throughput loss, a 20 dB (or higher) directional coupler is recommended. If the throughput loss is not a problem, a two way splitter can be used to provide the RF output test point.

Note: When reading the power value on the LCD, the RF output must be terminated with a 75 Ohm terminator or into a 75 Ohm system. The output will drop out approximately every two minutes when there are no cable modems connected to the system.

Note: A signal level meter (SLM), Spectrum Analyzer, or power meter *cannot* be used to measure an active data channel accurately, unless the instrument is specifically designed to measure a periodic QPSK signal through vendor-specific options. Contact your instrument vendor for information on calibration factors needed to obtain an accurate measurement.

Measuring the LCe QPSK Output Signal

To measure the QPSK signal at the output of the Headend controller, the following methods are recommended:

1. Power Meter: (recommend: HP437B meter, HP8482A Power Sensor, and HP11852B min loss pad)

Caution: The power meter power sensor is sensitive to shock, and precautions should be taken to protect the sensor from shock.

The minimum loss pad converts from 50 Ohms to 75 Ohms and a type N female to type F female adapter is required to allow connection to a coaxial cable.

This method can only be done at the headend in a stand-alone state, with block synchronization achieved. The time on and time off variables are random values when the network is operational, and so this method can not be used to measure the power on an operational network. The accuracy of this measurement is as good as the sensor accuracy, but should be within ± 1 dB.

- Headend Controller has block sync and is not attached to a CATV network. It is in a stand-alone state.
- Set the IF level to +37 dBmV ± 0.4 dB, with the LCe front panel controls or remote interface.
- Attach a Calibrated Power Meter, Sensor/Min Loss Pad, to the Forward Channel Output.
- The following formula shows how the correction factor has been calculated:

  $10\log [t_{on} / (t_{on} + t_{off})] + (\text{min loss pad value}) = \text{Correction Factor}$

  $t_{on} = 387\ \mu s$ (Synchronization signaling on period)

  $t_{off} = 31.254$ ms (Synchronization signaling off period)

  $10\log [387\ \mu s / (387\ \mu s + 31254\ \mu s)] = |\ 19.12\ |$ (absolute value)

  The value of the minimum loss pad is added to the Correction Factor

  19.12 + 5.7 dB = 24.82 dB Correction Factor (for average power)

- Example:

  Value measured on Power Meter = Minus 16.28 dBm

  (Value measured on Power Meter) + (Correction Factor) = Power dBm

  -16.28 dBm + 24.82 = +8.54 dBm

  To convert to dBmV, add the value to 49 dBmV

  +8.54 + 49 dBmV = 57.54 dBmV

2. Spectrum Analyzer: (Recommended HP8591E or HP8591C)

   The accuracy of a spectrum analyzer will vary from model to model. The two Hewlett Packard models recommended have been used with the following settings and displayed an accuracy within +2 dB, -4 dB. We cannot guarantee, however, that the spectrum analyzer will always maintain this level of accuracy, as all the variables that could affect the accuracy are not known. The QPSK signal is a periodic signal occupying 6 MHz of bandwidth.

   Spectrum Analyzers from other vendors have not been evaluated for this measurement, and are likely to measure the QPSK power value differently from the Hewlett Packard Models. The equipment manufacturer should be contacted to determine if any calibration factor is required to assure an accurate measured value.

Set the spectrum analyzer as follows:

Frequency	as required
Resolution Bandwidth	3 MHz
Video Bandwidth	auto, or 1 MHz
Frequency Span	10 MHz
Max Hold	On
Marker	±1 MHz from center frequency
Input Impedance	Select 75 Ohms from Amplitude menu

Operating Controls

Four soft touch push buttons and a LCD display are located on the front panel. The Unit Select button allows the user to select which network (Net A or Net B) will be displayed. The MODE button allows the user to cycle through each of six different displays. The UP/DOWN arrow buttons adjust the settings for the currently selected mode. If no configuration adjustments are being made via the front panel controls, the display back light will shut off after a four minute time-out.

Input Frequency Adjust

After power up initialization, the first line of the display will read:

- Fin XXX.XX MHz
- where XXX.XX is the last stored frequency at shutdown

The displayed frequency corresponds to the frequency at the center of the band. (i.e., channel T-8 [11.75 - 17.75 MHz] = 14.75 MHz)

To adjust the input frequency, use the UP/DOWN arrow buttons. Single stepping will allow 250 KHz adjustment, while keeping the buttons depressed will change the frequency more quickly. If the display does not read as above, step the MODE button until the top line reads Fin XXX.XX MHz and use the UP/DOWN arrow buttons to change the input frequency.

During frequency change, the output is muted for five seconds to avoid undesirable interference; and mute is displayed in the status line.

IF Level Adjust

The IF level must be adjusted to +37 dBmV ± 0.4 dB every time the input or output frequencies are set/changed.

When the IF Level Adjust Mode is selected, the first line of the display will read:

- IFout XX.X dBmV
- where XX.X is the currently measured IF power

To configure the translator for optimum performance for both noise and intermodulation products, the IF level should be adjusted to +37 dBmV. An IF level less than +37 dBmV will degrade noise performance and a level above +37 dBmV will promote intermodulation products. To set the IF level, cycle the MODE button to the “IFout XX.X dBmV” display. The IF level can now be adjusted to +37 dBmV using the UP/DOWN arrow buttons. While in this mode the approximate IF output level will be displayed on the top line of the Display. If the IF level is too high or too low, an appropriate warning will be displayed.

Output Frequency Adjust

When the Output Frequency Mode is selected, the first line of the display will read:

- Fout XXX.XX MHz
- where XXX.XX is the currently stored output frequency

The displayed frequency corresponds to the frequency at the center of the band. (i.e., VHF channel 80 (RRR) [558.00 - 564.00 MHz] =561.00 MHz)

To adjust the output frequency, use the UP/DOWN arrow buttons. Single stepping will allow 250 KHz adjustment, while keeping the buttons depressed will change the frequency more quickly.

During frequency change, the output is muted for five seconds to avoid undesirable interference; and mute is displayed in the status line.

RF Level Adjust

The maximum recommended output is 58 dBmV; the minimum allowed output is 42 dBmV. The displayed value on the LCD or Remote User Interface is accurate to ± 4 dB.

When the RF Level Adjust Mode is selected, the first line of the display will read:

- RFout XX.X dBmV
- where XX.X is the currently measured RF power

To set the RF level, cycle the MODE button to the “RFout XX.X dBmV” display. The RF level can now be adjusted using the UP/DOWN arrow buttons. While in this mode the approximate RF output level will be displayed on the top line of the Display. If the RF level is too high or too low an appropriate warning will be displayed.

RF Output Enable

When the RF Output Enable Mode is selected, and the output is currently enabled, the first line of the display will read:

- RFout Enabled

When the RF Output Enable Mode is selected, and the output is currently disabled, the first line of the display will read:

- RFout Disabled

To Enable or Disable the RF Output, cycle the MODE button to the above display. The RF Output status can then be adjusted using the UP/DOWN arrow buttons. Depressing either button will cause the display to toggle between Enabled and Disabled.

Remote Address

When the Remote Address Mode is selected, the first line of the display will read:

- Address XXX
- where XXX is the current remote address

To select a new Remote Address, cycle the MODE button to the above display. The selected address can then be changed using the UP/DOWN arrow buttons. The range of allowed addresses is from 001 to 999. All units are shipped from the factory with address 999 pre-selected.

Chapter 4
Console Port Interface

This chapter describes the LCe-4's console port interface for remote management.

Operation

The frequency translator may be controlled via the RS-232 Remote Interface connector. The connector has two sockets. The top socket is used for input, and the bottom socket is for use in a daisy-chain configuration. Up to 10 units may be daisy-chained and controlled at one time from a single serial port.

Connecting the input connector on the first unit to a computer terminal configures a daisy chain. The input connector on the second unit should be connected to the daisy-chain connector on the first unit. Each successive unit in the chain should be connected similarly.

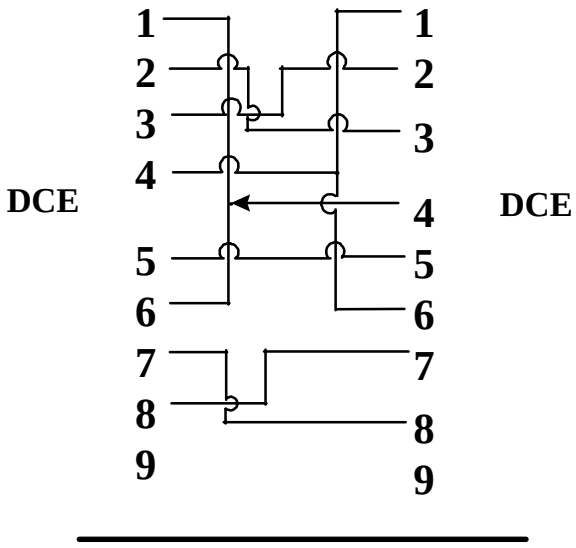
The input data rate can be 9600 or 19200 bps. The frequency translator will automatically determine which data rate is in use and adjust accordingly. There are no user settings relating to baud rate selection.

Remote Connector Cabling

Figure 4-1 shows the pinout for a 9-pin to 9-pin cable used to connect the LCe's Remote Connector to a PC.

This cable is also used to daisy-chain LCe's. Refer to the LCe Daisy Chain Configuration section for more information.

Figure 4-2 shows the pinout for a 9-pin to 9-pin cable used to connect the LCe's Remote Connector to a telephone modem.



1 DCD - Data Carrier Detect
2 RD - Receive Data
3 TD - Transmit Data
4 DTR - Data Terminal Ready
5 SG - Signal Ground
6 DSR - Data Set Ready
7 RTS - Request to Send
8 CTS - Clear to Send
9 RI - Ring Indicator

Figure 4-1 DB9 F/F Null ModemCable Pinout

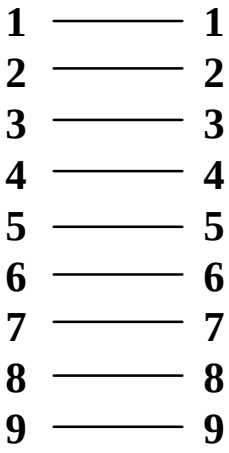


Figure 4-2 LCe-4 DB9 Serial Modem Cable Pinout

LCe-4 Daisy Chain Configuration

The bottom serial port connector is the daisy chain connector. It is used to connect to the input of another LCe. The LCe's can be daisy-chained up to a total of ten units. Figure 4-1 shows the pinouts of the LCe's 9-pin serial ports.

Figure 4-3 is an example of the LCe daisy chain cabling.

Refer to Chapter 3, Operating Control's - Remote Address section for information on using the LCe's front panel switches to assign unit configuration addresses.

Refer to the, LCe-4 Headend Controller User Interface's – Remote Address section in this chapter for information on using the LCe's PC user interface application to assign unit configuration addresses.

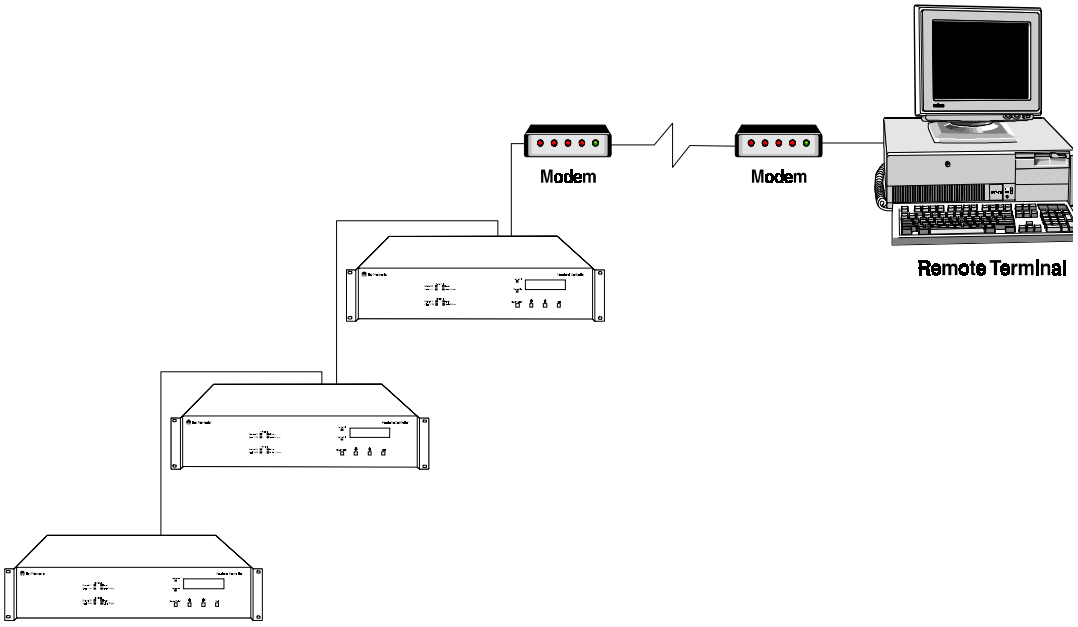


Figure 4-3 LCe-4 Daisy Chain Cabling Example

LCe-4 Headend Controller User Interface

You use the PC-based LCe-4 Headend Controller software to access the LCe remotely. Refer to the following sections for descriptions on how to verify and modify the LCe's frequency translator's parameters.

Installing The LCe-4 User Interface on a PC

Install the two-disk LCe-4 User Interface software on a PC that you will use to connect directly to the LCe via null modem cable, or on a PC that you connect remotely to the LCe via dial-up modem.

When you install the LCe User Interface on a PC running Windows 95, you will view dialogue boxes as shown in Figure 4-4.

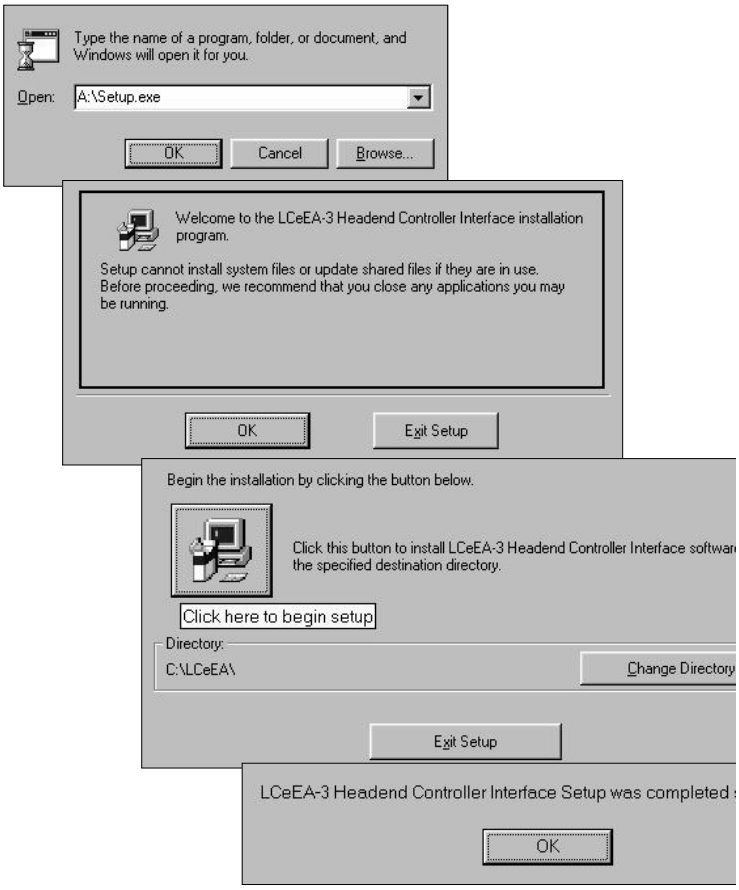


Figure 4-4 LCe-4 User Interface Software Install Dialogue Boxes

LCe-4 User Interface Software Access Screen

Figure 4-5 displays the LCe-4 User Interface screen when the software is launched. The current revision number of the software is displayed on its title/revision screen prior to opening the main screen.

All functions are entered and processed via the main screen. Descriptions of each function selection are provided in paragraphs following the main screen figure.

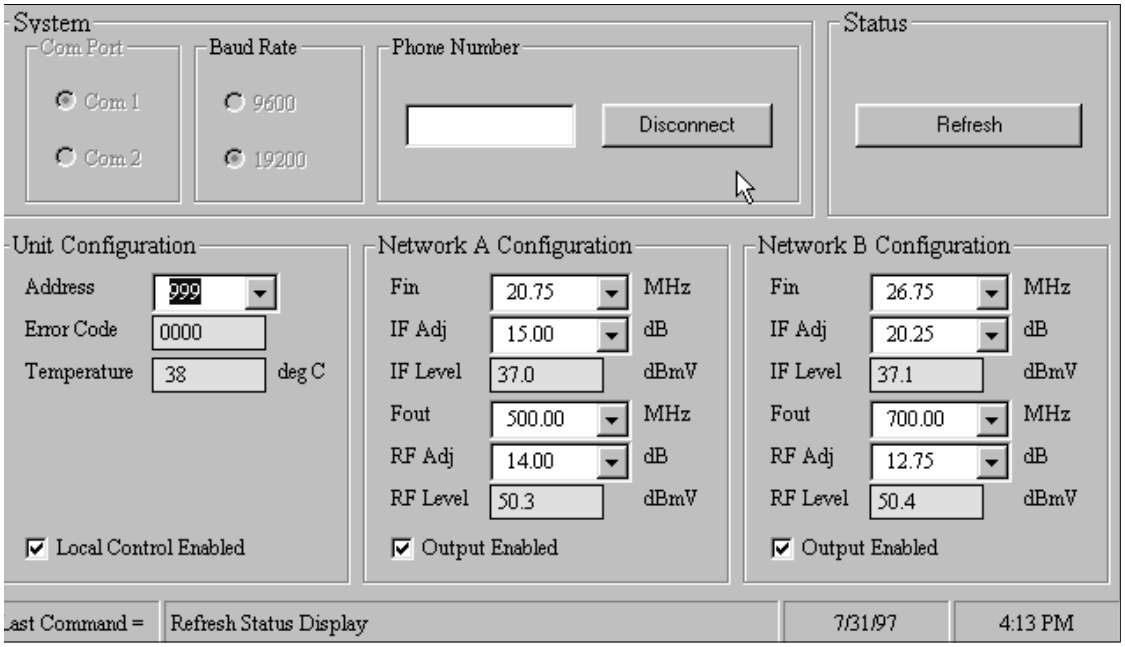


Figure 4-5 LCe-4 User Interface Main Screen

The LCe-4 User Interface Main Screen is divided into six areas.

- System
- Status
- Unit Configuration
- Network A Configuration
- Network B Configuration
- Status Bar

System

The System area of the LCe-4 User Interface main screen is where you:

- Select the serial port of the PC that connects you to the LCe,
- Choose the baud rate at which you wish the PC to operate,
- Enter a phone number and initiate the dial-up connection process or,
- Initiate the direct connection process.

Refer to the Remote Connector Cabling section for information on connecting your PC to the LCe.

Com Port

Use the Comm 1 and Comm 2 option buttons to select the Com Port that you will use to connect the PC to the LCe.

Baud Rate

Use the 9600 and 19200 option buttons to select the baud rate of the PC serial port that you will use to connect to a dial-up modem to connect the PC to the LCe.

Local Connect

Use the Local Connect button to initiate the connection if connected via direct cable connection. Upon successful connection, the Local Connect button becomes the Disconnect button. Use the Disconnect button to release the PC's communications port connecting the PC to the LCe via a direct connect cable.

Phone Number

Use the Phone Number field to enter the phone number of a dial-up modem that you will use to connect the PC to the LCe.

The Local Connect button becomes a Remote Connect button upon entering a phone number. Upon successful connection, the Remote Connect Button becomes the Disconnect button. Use the Disconnect button to release the PC's communications port connecting the PC to the LCe via a dial-up modem.

Local and remote telephone modem requirements:

- Both must be Hayes-compatible.
- Remote modem (modem connected to LCe) must be set up to power up in auto-answer mode and set to answer on one ring.
- Remote modem interface rate should be set up to follow connection rate.

Connection speed after pressing connect button:

- Local Connect – approximately 3 seconds
- Remote Connect – approximately 25 seconds

Status

Use the Status button to refresh and update the LCe-4 User Interface screen.

Unit Configuration

The Unit Configuration area provides entry space via a pull down menu for the LCe's three-digit decimal address. This area also provides an entry box to check off whether or not the LCe is enabled for local control. In addition, the Unit Configuration area displays error codes and the current temperature.

Address

Use the Address pulldown to select a specific identifier when your PC is connected to more that one LCe in the daisy chain configuration as discussed in the LCe Daisy Chain Configuration section.

The range of allowed addresses is from 001 to 999. All units are shipped from the factory with address 999 pre-selected.

Local Control Enabled

You can use the Local Control Enabled option box to lock out the LCe's front panel control buttons. When the LCe-4 User Interface is connected to an LCe and the Local Control Enabled box is not checked, the LCe's front panel buttons are disabled.

Error Code

Table 1-1 – LCe-4 Translator Error Message Table, in Chapter 1, provides brief descriptions of the Error Code messages.

Temperature

The Temperature display box provides the current sampled temperature in Celsius for the addressed LCe.

An error code is initiated to the 4-digit error value if the temperature exceeds 90º Celsius.

Network A Configuration

This area of the LCe-4 User Interface screen provides the pulldown entry and display fields for Network A's pertinent LCe translator parameters. These fields include:

- Fin (Input Frequency, measured in MHz)
- IF Adj (Intermediate Frequency Adjust, measured in dB)
- IF Level (Intermediate Frequency Level, measured in dBmV)
- Fout (Output Frequency, measured in MHz)
- RF Adj (Radio Frequency Adjust, measured in dB)
- RF Level (Radio Frequency Level, measured in dBmV)
- Output Enabled

Fin

After connecting, the Network A Configuration Fin pulldown entry field will read:

- Fin XXX.XX MHz
- where XXX.XX is the last stored frequency at shutdown

The displayed frequency corresponds to the frequency at the center of the band (i.e., channel T-8 [11.75 - 17.75 MHz] = 14.75 MHz).

To adjust the input frequency, use the mouse cursor and click on the entry field's pulldown arrow. Click on the desired center frequency.

During frequency change, the output is muted for five seconds to avoid undesirable interference. Modified frequencies are implemented as soon as the frequency is selected.

IF Adj

The IF level must be adjusted to +37 dBmV ± 0.4 dB every time the input or output frequencies are set/changed.

After connecting, the Network A Configuration IF Adj pulldown entry field will read:

- IFout XX.X dBmV
- where XX.X is the currently measured IF power

To configure the translator for optimum performance for both noise and intermodulation products, the IF level should be adjusted to +37 dBmV. An IF level less than +37 dBmV will degrade noise performance and a level above +37 dBmV will promote intermodulation products.

To set the IF level, use the mouse cursor and click on the entry field's pulldown arrow. The IF level can now be adjusted to +37 dBmV by using the mouse cursor to select an appropriate attenuation number. While in this mode the approximate IF output level will be displayed in the IF Level display box.

IF Level

The IF Level indicates the currently measured Intermediate Frequency power. See IF Adj, above.

Fout

After connecting, the Network A Configuration Fout pulldown entry field will read:

- Fout XXX.XX MHz
- where XXX.XX is the currently stored output frequency

The displayed frequency corresponds to the frequency at the center of the band. (i.e., VHF channel 80 (RRR) [558.00 - 564.00 MHz] =561.00 MHz).

To adjust the output frequency, use the mouse cursor and click on the entry field's pulldown arrow. Click on the desired center frequency.

During frequency change, the output is muted for five seconds to avoid undesirable interference. Modified frequencies are implemented as soon as the frequency is selected.

RF Adj

The maximum recommended output is 58 dBmV; the minimum allowed output is 42 dBmV. The output is as measured not as displayed on the local LCD or the remote user interface.

After connecting, the Network A Configuration RF Adj pulldown entry field will read:

- RFout XX.X dBmV
- where XX.X is the currently measured RF power

To set the RF level, use the mouse cursor and click on the entry field's pulldown arrow. The RF level can now be adjusted using the mouse cursor to select an appropriate attenuation number.

While in this mode, the approximate RF output level will be displayed in the RF Level display box.

RF Level

The RF Level indicates the currently measured Radio Frequency power. See RF Adj, above.

Output Enabled

When the RF Output Enabled box is selected, and the output is currently enabled, then the RF out is enabled.

When the RF Output Enabled box is selected, and the output is currently disabled, then the RF out is disabled.

Network B Configuration

This area of the LCe-4 User Interface screen provides the pulldown entry and display fields for Network B's pertinent LCe translator parameters. Refer to Network A Configuration for descriptions of the parameters.

Status Bar

The Status Bar displays the date and time and the last entered command.

Using Terminal Emulation

Terminal Configuration

It is possible to communicate with the LCe-4 using any standard terminal program (i.e., the Terminal.exe with Win3.1 or Win95). It is also possible to use HyperTerminal with Win95. The following connection settings are required to communicate with the LCe-4.

Port settings

Comm Port	=	COM 2
Baud	=	19200
Data Bits	=	8
Stop Bits	=	1
Parity	=	none
Flow Control	=	none (off)

Emulation

VT100

Miscellaneous

Function, arrow, and Ctrl keys as Terminal Keys

Append LF (line feed) to incoming line ends

Generating Commands with Windows-Based Terminal Emulators

The following sequence can be used to enter commands to the LCe-4 using Windows-based terminal emulator software.

1. Open Notepad.exe.
2. Enter the desired command using proper structure as described in the next section. Use the Enter or Return key to generate the CR at the end of the command line.
3. Highlight the entire command line including the CR.
4. From the Edit menu, select copy.

   In Windows 3.11 Terminal.exe:

5. From Edit menu select paste.

   In Windows 95 HyperTerminal

5. Position pointer in the terminal window and Right click mouse or open the Edit menu and select Paste to Host.

Using Function Keys

When programming F Keys to perform commands, always add the carriage return symbol ^M at the end of the command string.

Command Structure

The command structure consists of a sequence of ASCII characters terminated by a carriage return. There can be a maximum of 4 ms between consecutive message bytes. All ASCII characters are case-insensitive. Commands are to be in one of the following two general formats:

```
<start>ADD<sp>NET<sp>CC<sp>CRC<cr>
```

or

```
<start>ADD<sp>NET<sp>CC<sp>PARM<sp>CRC<cr>
```

Most commands to a single network at a single address may be concatenated by using an ASCII ampersand (“&”) character (see the detailed command descriptions for commands that cannot be concatenated). Concatenated commands will be in one of the following two general formats:

```
<start>ADD<sp>NET<sp>CC<sp>&<sp>CC<sp> . . . <sp>CRC<cr>
```

or

```
<start>ADD<sp>NET<sp>CC<sp>PARM<sp>&<sp>CC<sp> . . . <sp>CRC<cr>
```

The message must conclude with either a carriage return (ASCII 13) or a carriage return and linefeed (ASCII 13 followed by ASCII 10).

ADD = Address (three ASCII characters)

Addresses are three-digit numbers. Three digits (including leading zeros) are required to correctly define an address.

NET = Network (one ASCII character)

A = Network A

B = Network B

CC =Command Code (two ASCII characters)

FI = Set Input Frequency

FO = Set Output Frequency

AI = Set IF Attenuation

AR = Set RF Attenuation

OE = Enable RF Output

OD = Disable RF Output

LE = Enable Local Control

LD = Disable Local Control

SU = Unit Status Request

SC = Configuration Status Request

CRC = CRC-16 checksum (three characters)

The checksum is preferred, but not required. If the checksum is used, the first character is an ASCII “V” followed by the low and high bytes, respectively, of the computed CRC-16 checksum (the checksum characters are not necessarily ASCII). The checksum is to be computed on all characters after the initial <start> character up to, and including, the first “V” character in the CRC section. If the checksum is not used, the three characters should be ASCII “NNN.” These characters MUST be uppercase.

PARM is one or more characters, and is command-specific.

<start> ASCII Asterisk character (*)

<sp> ASCII Space character

<cr>ASCII Carriage Return character (^M)

ASCII Control Character Set

Hex	Oct	Binary	Dec	Key	Symbol	Meaning
0	0	0	0	^@	NUL	NULL
1	1	1	1	^A	SOH	Start Heading
2	2	10	2	^B	STX	Start Text
3	3	11	3	^C	ETX	End Text
4	4	100	4	^D	EQT	End of Transmission
5	5	101	5	^E	ENQ	Enquiry
6	6	110	6	^F	ACK	Acknowledge
7	7	111	7	^G	BEL	Bell
8	10	1000	8	^H	BS	Backspace
9	11	1001	9	^I	HT	Horizontal Tab
0A	12	1010	10	^J	LF	Newline (Linefeed)
0B	13	1011	11	^K	VT	Vertical Tab
0C	14	1100	12	^L	FF	Form Feed
0D	15	1101	13	^M	CR	Carriage Return
0E	16	1110	14	^N	SO	Shift Out
0F	17	1111	15	^O	SI	Shift In
10	20	10000	16	^P	DLE	Data Link Escape
11	21	10001	17	^Q	DC1	Device Control 1
12	22	10010	18	^R	DC2	Device Control 2
13	23	10011	19	^S	DC3	Device Control 3
14	24	10100	20	^T	DC4	Device Control 4
15	25	10101	21	^U	NAK	Negative Acknowledgement
16	26	10110	22	^V	SYN	Synchronous Idle
17	27	10111	23	^W	ETB	End of Transmissin Block
18	30	11000	24	^X	CAN	Cancel
19	31	11001	25	^Y	EM	End of Medium
1A	32	11010	26	^Z	SUB	Substitute
1B	33	11011	27	^[	ESC	Escape
1C	34	11100	28	^\	FS	File Separator
1D	35	11101	29	^]	GS	Group Separator
1E	36	11110	30	^^	RS	Record Separator
1F	37	11111	31	^_	US	Unit Separator

Response Structure

The response structure consists of a sequence of ASCII characters, terminated by a carriage return. Responses will be in one of the two following general formats:

<start>ADD<sp>R<sp>RC<sp>CRC<cr>

or

<start>ADD<sp>R<sp>RC<sp>PARM<sp>CRC<cr>

There will be one response returned for all commands.

ADD = Address (three characters)

The address of the unit that is responding to the command.

R = ASCII “R” character (one character)

Indicates that this is a response to a previous message.

RC = Response Code (three characters)

OK = Command Accepted

ERR = Command Denied because of Syntax Error

CRC = Command Denied because of CRC-16 error

(Note: For non-concatenated commands, a response code of ERR indicates that the command failed before the unit’s settings were changed. For concatenated commands, a response code of ERR indicates that the command failed during processing. The unit’s settings may have been partially modified depending upon which subcommand generated the error. For example, assume a three-part concatenated command is sent to the unit. If the second part generates an error, the first part will have been processed correctly and the unit settings would reflect this. The second part failed, so the unit settings will not have been modified. The third part will have been discarded, so the unit settings will again not be modified.)

CRC = CRC-16 checksum (3 characters)

The response checksum is always valid. The first character will be an ASCII “V” followed by the low and high bytes, respectively, of the computed CRC-16 checksum (the checksum characters are not necessarily ASCII). The checksum will be computed on all characters after the initial <start> character up to, and including, the first “V” character in the CRC section.

PARM = one or more characters, and is command-specific

<start> ASCII Asterisk character

<sp> ASCII Space character

<cr> ASCII Carriage Return character

Command Descriptions and System Responses

This section defines each of the command codes and the associated parameters.

Set Input Frequency

Description:	Sets input frequency for the specified network.
Command Code:	FI
Parameters:	Desired frequency in MHz, in the form XXX.XX. Leading zeros are optional, but not required. The decimal point and two trailing characters are required. Valid input frequencies are between 11.75 MHz and 110.00 MHz. Valid trailing characters are 00, 25, 50, and 75.
Response:	OK or ERR or CRC

Set Output Frequency

Description:	Sets output frequency for the specified network.
Command Code:	FO
Parameters:	Desired frequency in MHz, in the form XXX.XX. Leading zeros are optional, but not required. The decimal point and two trailing characters are required. The range of acceptable output frequencies is 55.00 MHz to 860.00 MHz. Allowed trailing characters are 00, 25, 50, and 75.
Response:	OK or ERR or CRC

Set IF Attenuation

Description:	Sets the IF attenuation for the specified network.
Command Code:	AI
Parameters:	Desired IF output attenuation in dB, in the form XX.XX. Leading zeros are optional, but not required. The decimal point and two trailing characters are required. Valid attenuation values are between 0 dB and 48 dB in 0.25 dB steps. Valid trailing characters are 00, 25, 50 or 75.
Response:	OK or ERR or CRC

Set RF Attenuation

Description:	Sets the RF attenuation for the specified network.
Command Code:	AR
Parameters:	Desired IF output attenuation in dB, in the form XX.XX. Leading zeros are optional, but not required. The decimal point and two trailing characters are required. Valid attenuation values are between 0 dB and 40 dB in 0.25 dB steps. Valid trailing characters are 00, 25, 50, or 75.
Response:	OK or ERR or CRC

Enable RF Output

Description:	Turns on the RF output to the specified network.
Command Code:	OE
Parameters:	None
Response:	OK or ERR or CRC

Disable RF Output

Description:	Turns off the RF output to the specified network.
Command Code:	OD
Parameters:	None
Response:	OK or ERR or CRC

Enable Local Control

Description:	Enables local control of the Frequency Translator. The network is irrelevant and can be either A or B. This command cannot be concatenated.
Command Code:	LE
Parameters:	None
Response:	OK or ERR or CRC

Disable Local Control

Description: Disables local control of the Frequency Translator. The network is irrelevant and can be either A or B. This command cannot be concatenated.

Command Code: LD

Parameters: None

Response: OK or ERR or CRC

Status Unit Request

Description: The Status Unit Request command returns the factory model and revision history for the unit at the time of shipping. The detailed contents of the reply are shown in the response section. The network is irrelevant and can be either A or B. This command cannot be concatenated.

Command Code: SU

Parameters: None

Response: OK or ERR or CRC

If the response is OK, then the following parameters will also be returned in space-delimited format in the order shown below. (Note: X may be replaced by any valid character. All other characters will be as shown.)

Parameter (Units)	Format	Example
Model	XXXXXXXX	FT3020
Options	XXXXXXXX	ABCD
Hardware Revision	XXXX	1.00
Software Revision	XXXX	1.00
Controller SN	XXXXXX	012345
Display SN	XXXXXX	012345
Unit A Upconverter SN	XXXXXX	012345
Unit A Downconverter SN	XXXXXX	012345
Unit B Upconverter SN	XXXXXX	012345
Unit B Downconverter SN	XXXXXX	012345
Miscellaneous	132 chars	

Status Configuration Request

Description: The Status Configuration Request command returns the current configuration. The detailed contents of the reply are shown in the response section. The network is irrelevant and can be either A or B. This command cannot be concatenated.

Command Code: SC

Parameters: None

Response: OK or ERR or CRC

If the response is OK, then the following parameters will also be returned in space-delimited format in the order shown below. (Note: X may be replaced by any valid character. All other characters will be as shown.)

Parameter (Units)	Format	Example
Error Code	XXXX	0D63
Local Control	E or D	E
Temperature (deg C)	XX	50
Network A	A	A
Input Freq (MHz)	XXX.XX	110.00
IF Attenuation (dB)	XX.X	10.5
IF Power (dBmV)	XX.X	37.1
Output Freq (MHz)	XXX.XX	498.25
RF Attenuation (dB)	XX.X	05.5
RF Power (dBmV)	XX.X	57.0
RF Output	E or D	E
Network B	B	B
Input Freq (MHz)	XXX.XX	011.75
IF Attenuation (dB)	XX.X	04.0
IF Power (dBmV)	XX.X	36.9
Output Freq (MHz)	XXX.XX	498.25
RF Attenuation (dB)	XX.X	06.0
RF Power (dBmV)	XX.X	58.3
RF Output	E or D	E

CRC Calculations

The CRC calculations are performed using a table-driven approach. The polynomial used is X^16 + X^15 + X^2 + 1.

Only the basic algorithm and lookup table will be described here. Sample code is also included for generating the lookup table. For further information, this approach is described in detail in the following paper:

Perez, Aram, Byte-wise CRC Calculations, IEEE Micro, June 1983, pp. 40–50

The algorithm for the CRC calculation is as follows:

1. Exclusive-OR the input byte with the low-order byte of the CRC register to get X.
2. Shift the CRC register eight bits to the right.
3. Exclusive-OR the CRC register with the contents of the table, using X as an index.
4. Repeat steps 1 through 3 for all message bytes.

Notes: The CRC register is 16 bits long, and should be cleared to 0 before beginning the calculations.

For the transmit message: After all the message bytes have been processed, the CRC is tagged on to the end of the message with the least significant byte first.

For the received message: After all the received message bytes have been processed, the resulting CRC should be zero. If it is not zero, at least one bit error has occurred. If it is zero, it is assumed that no errors have occurred.

Example

In the following table, the transmitted message is shown in the first column. The second column shows the value labeled as “X” in the algorithm. The third column shows the table value obtained from the lookup table using “X” as an index. The final column shows the computed CRC at each step of the calculation. The first row shows the values before beginning the calculation, while the last two rows add the final computed CRC onto the transmit message.

TX DATA BYTE	X TERM	TABLE VALUE	TX CRC
--	0	0	0
86	86	A281	A281
22	A3	7940	79E2
17	F5	47C0	47B9
2D	94	AF01	AF46
9C	DA	9B81	9B2E
BD	93	6D40	6DDB
7B	A0	7800	786D
9C	F1	84C1	84B9
70	C9	56C0	5644
6E	2A	DF81	DFD7
FF	28	1E00	1EDF
59	86	A281	A29F
EB	74	2700	27A2
45	E7	4A40	4A67
8	6F	2C40	2C0A
38	32	D581	D5AD
60	CD	95C1	9514
-- END OF TX MSG --			
14 <– CRC LOW BYTE	--	--	--
95 <- CRC HIGH BYTE	--	--	--

In the following table, the received message is shown in the first column. The second column shows the value labeled as “X” in the algorithm. The third column shows the table value obtained from the lookup table using “X” as an index. The final column shows the computed CRC at each step of the calculation. The first row shows the values before beginning the calculation. The last row shows that the CRC computed on the received message is zero.

RX DATA BYTE	X TERM	TABLE VALUE	RX CRC
--	0	0	0
86	86	A281	A281
22	A3	7940	79E2
17	F5	47C0	47B9
2D	94	AF01	AF46
9C	DA	9B81	9B2E
BD	93	6D40	6DDB
7B	A0	7800	786D
9C	F1	84C1	84B9
70	C9	56C0	5644
6E	2A	DF81	DFD7
FF	28	1E00	1EDF
59	86	A281	A29F
EB	74	2700	27A2
45	E7	4A40	4A67
8	6F	2C40	2C0A
38	32	D581	D5AD
60	CD	95C1	9514
14	0	0	95
95	0	0	0

Lookup Table

The following table is used in the CRC-16 calculations. All values in the table are in Hex format

.

X TERM	ENTRY	X TERM	ENTRY	X TERM	ENTRY	X TERM	ENTRY
------	-----	------	-----	------	-----	------	-----
0	0	40	F001	80	A001	C0	5000
1	C0C1	41	30C0	81	60C0	C1	90C1
2	C181	42	3180	82	6180	C2	9181
3	140	43	F141	83	A141	C3	5140
4	C301	44	3300	84	6300	C4	9301
5	3C0	45	F3C1	85	A3C1	C5	53C0
6	280	46	F281	86	A281	C6	5280
7	C241	47	3240	87	6240	C7	9241
8	C601	48	3600	88	6600	C8	9601
9	6C0	49	F6C1	89	A6C1	C9	56C0
A	780	4A	F781	8A	A781	CA	5780
B	C741	4B	3740	8B	6740	CB	9741
C	500	4C	F501	8C	A501	CC	5500
D	C5C1	4D	35C0	8D	65C0	CD	95C1
E	C481	4E	3480	8E	6480	CE	9481
F	440	4F	F441	8F	A441	CF	5440
10	CC01	50	3C00	90	6C00	D0	9C01
11	CC0	51	FCC1	91	ACC1	D1	5CC0
12	D80	52	FD81	92	AD81	D2	5D80
13	CD41	53	3D40	93	6D40	D3	9D41
14	F00	54	FF01	94	AF01	D4	5F00
15	CFC1	55	3FC0	95	6FC0	D5	9FC1
16	CE81	56	3E80	96	6E80	D6	9E81
17	E40	57	FE41	97	AE41	D7	5E40
18	A00	58	FA01	98	AA01	D8	5A00
19	CAC1	59	3AC0	99	6AC0	D9	9AC1
1A	CB81	5A	3B80	9A	6B80	DA	9B81
1B	B40	5B	FB41	9B	AB41	DB	5B40
1C	C901	5C	3900	9C	6900	DC	9901
1D	9C0	5D	F9C1	9D	A9C1	DD	59C0
1E	880	5E	F881	9E	A881	DE	5880
1F	C841	5F	3840	9F	6840	DF	9841

X TERM	ENTRY	X TERM	ENTRY	X TERM	ENTRY	X TERM	ENTRY
20	D801	60	2800	A0	7800	E0	8801
21	18C0	61	E8C1	A1	B8C1	E1	48C0
22	1980	62	E981	A2	B981	E2	4980
23	D941	63	2940	A3	7940	E3	8941
24	1B00	64	EB01	A4	BB01	E4	4B00
25	DBC1	65	2BC0	A5	7BC0	E5	8BC1
26	DA81	66	2A80	A6	7A80	E6	8A81
27	1A40	67	EA41	A7	BA41	E7	4A40
28	1E00	68	EE01	A8	BE01	E8	4E00
29	DEC1	69	2EC0	A9	7EC0	E9	8EC1
2A	DF81	6A	2F80	AA	7F80	EA	8F81
2B	1F40	6B	EF41	AB	BF41	EB	4F40
2C	DD01	6C	2D00	AC	7D00	EC	8D01
2D	1DC0	6D	EDC1	AD	BDC1	ED	4DC0
2E	1C80	6E	EC81	AE	BC81	EE	4C80
2F	DC41	6F	2C40	AF	7C40	EF	8C41
30	1400	70	E401	B0	B401	F0	4400
31	D4C1	71	24C0	B1	74C0	F1	84C1
32	D581	72	2580	B2	7580	F2	8581
33	1540	73	E541	B3	B541	F3	4540
34	D701	74	2700	B4	7700	F4	8701
35	17C0	75	E7C1	B5	B7C1	F5	47C0
36	1680	76	E681	B6	B681	F6	4680
37	D641	77	2640	B7	7640	F7	8641
38	D201	78	2200	B8	7200	F8	8201
39	12C0	79	E2C1	B9	B2C1	F9	42C0
3A	1380	7A	E381	BA	B381	FA	4380
3B	D341	7B	2340	BB	7340	FB	8341
3C	1100	7C	E101	BC	B101	FC	4100
3D	D1C1	7D	21C0	BD	71C0	FD	81C1
3E	D081	7E	2080	BE	7080	FE	8081
3F	1040	7F	E041	BF	B041	FF	4040

Sample Code

The sample code shows how to compute the lookup table used in the CRC-16 calculations. It also demonstrates how to compute the CRC-16 checksums for both the receive and transmit messages.

All code was generated using Microsoft Visual Basic, Professional Edition, Version 5.0 ™. It should also work with other versions.

Program: CRC Sample Code

Written by: Douglas Fast

Date: 1997 March 4

Note: This sample code generates the CRC-16 lookup table and demonstrates how to compute, receive and transmit CRC-16. The polynomial used is

X^16 + X^15 + X^2 + 1

The algorithm for the TX CRC calculation is as follows:

```
Do for all message bytes
         X<-(TXCRC AND $00FF) XOR DBTX
         TXCRC = (TXCRC / 256) XOR TBL(X)
   Loop
         Tag the CRC onto the outgoing burst (LSB first);
```

The algorithm for the RX CRC calculation is as follows

```
Do for all message bytes
         X = (RXCRC AND $00FF) XOR DBRX
         RXCRC = (RXCRC / 256) XOR TBL(X)
   Loop
         X = (RXCRC AND $00FF) XOR (TXCRC AND 255)
         RXCRC = (RXCRC / 256) XOR TBL(X)
         X = (RXCRC AND $00FF) XOR ((TXCRC / 256) AND 255)
         RXCRC = (RXCRC / 256) XOR TBL(X)
```

At this point, all received message bytes have been processed by CRC, and the RXCRC should be zero. If it is not zero, at least one bit error has occurred. If it is zero, it is assumed that no errors have occurred. The probability of an error escaping detection is 1/65536 for a 16 bit CRC.

Routine: Definitions for the CRC routines

Variables: TBL() holds the precomputed lookup table

TXCRC stores the computed transmit CRC-16

RXCRC stores the computed receive CRC-16

Public TBL(0 To 255) As Long stores the CRC-16 lookup table

Public TXCRC As Long stores the computed TX CRC-16

Public RXCRC As Long stores the computed RX CRC-16

Routine: Initializes the CRC-16 lookup table

Public Sub CRC_Initialize() initialize form

```
XMAX = 255           initialize CRC-16 lookup table
For X = 0 To XMA
  X7 = (X And 128) / 128
  X6 = (X And 64) / 64
  X5 = (X And 32) / 32
  X4 = (X And 16) / 16
  X3 = (X And 8) / 8
  X2 = (X And 4) / 4
  X1 = (X And 2) / 2
  X0 = X And 1
  R15 = X7 Xor X6 Xor X5 Xor X4 Xor X3 Xor X2 Xor X1 Xor X0
  R14 = X6 Xor X5 Xor X4 Xor X3 Xor X2 Xor X1 Xor X0
  R13 = X7 Xor X6
  R12 = X6 Xor X5
  R11 = X5 Xor X4
  R10 = X4 Xor X3
  R9 = X3 Xor X2
  R8 = X2 Xor X1
  R7 = X1 Xor X0
  R6 = X0
  R5 = 0
  R4 = 0
  R3 = 0
  R2 = 0
```

```
  R1 = 0
  R0 = R15
  TX=R15*32768+R14*16384+R13*8192+R12*4096+R11*2048+R10*1024
  TX=TX+R9*512+R8*256+R7*128+R6*64+R5*32+R4*16+R3*8
  TX = TX + R2 * 4 + R1 * 2 + R0
  TBL(X) = TX
Next X
End Sub
```

Name: CRCTxCompute

Purpose: Computes the CRC-16 on an array of bytes

Arguments: bytOutput() - Contains the input byte array. This array must be long enough to also contain the computed CRC (i.e. it must be dimensioned 4 characters longer than required)

Returns: bytOutput() - Contains the resulting array including the computed CRC-16

Public Sub CRCTxCompute(ByRef bytOutput() As Byte)

```
  Dim I As Integer
  Dim intLength As Integer
  Dim DBTX As Byte
  Dim X As Byte
    TXCRC = 0: X = 0
  intLength = UBound(bytOutput())calculate upper array bound
  bytOutput(intLength-3)=Asc(" ")add preliminary CRC characters
  bytOutput(intLength - 2) = Asc("V")
  For I = 0 To intLength - 2     compute CRC
    DBTX = bytOutput(I)
    X = (TXCRC And 255) Xor DBTX
    TXCRC = Int(TXCRC / 256) Xor TBL(X)
  Next
  bytOutput(intLength-1)=TXCRC And 255add CRC characters LSB first
  bytOutput(intLength) = Int(TXCRC / 256) And 255
End Sub
```

Name: CRCRxCompute

Purpose: computes the CRC-16 on an array of bytes

Arguments: bytInput() - Contains the input byte array. This array must contain only the received message including CRC. The result is computed using all the elements in this array.

Returns: Error Code - 0 = success, 1 = fail

Function intCRCRxCheck(bytInput() As Byte) As Integer

```
  Dim I As Integer
  Dim DBRX As Byte
  Dim X As Byte

  RXCRC = 0: X = 0

 For I = 0 To UBound(bytInput())
        DBRX = bytInput(I)
        X = (RXCRC And 255) Xor DBRX
        RXCRC = Int(RXCRC / 256) Xor TBL(X)
    Next

    If RXCRC = 0 Then              check computed CRC
        intCRCRxCheck = 0            if 0 then success
    Else
        intCRCRxCheck = 1            otherwise fail
    End If

End Function
```

Appendix

Channel Allocation Chart

EIA/ NCTA Channel	Old Designation Historical Reference	Standard-Video Frequency	Data Channel Center Frequency	HRC Video Frequency	HRC Data Channel Center Frequency
T-7		7.00	8.75	NA	NA
T-8		13.00	14.75	NA	NA
T-9		19.00	20.75	NA	NA
T-10		25.00	26.75	NA	NA
T-11		31.00	32.75	NA	NA
T-12		37.00	38.75	NA	NA
2		55.25	57.00	54.00	55.75
3		61.25	63.00	60.00	61.75
4		67.25	69.00	66.00	67.75
1-IRC/ HRC	A-8, 4+	73.25	75.00	72.00	73.75
5		77.25	79.00	78.00	79.75
5-IRC	A-7	79.25	81.00	NA	NA
6		83.25	85.00	84.00	85.75
6-IRC	A-6	85.25	87.00	NA	NA
95	A-5	91.25	93.00	90.00	91.75
96	A-4	97.25	99.00	96.00	97.75
97	A-3	103.25	105.00	102.00	103.75
98	A-2	109.25	111.00	108.00	109.75
99	A-1	115.25	117.00	114.00	115.75
14	A	121.25	123.00	120.00	121.75
15	B	127.25	129.00	126.00	127.75
16	C	133.25	135.00	132.00	133.75
17	D	139.25	141.00	138.00	139.75
18	E	145.25	147.00	144.00	145.75
19	F	151.25	153.00	150.00	151.75

EIA/ NCTA Channel	Old Designation Historical Reference	Standard-Video Frequency	Data Channel Center Frequency	HRC Video Frequency	HRC Data Channel Center Frequency
20	G	157.25	159.00	156.00	157.75
21	H	163.25	165.00	162.00	163.75
22	I	169.25	171.00	168.00	169.75
7		175.25	177.00	174.00	175.75
8		181.25	183.00	180.00	181.75
9		187.25	189.00	186.00	187.75
10		193.25	195.00	192.00	193.75
11		199.25	201.00	198.00	199.75
12		205.25	207.00	204.00	205.75
13		211.25	213.00	210.00	211.75
23	J	217.25	219.00	216.00	217.75
24	K	223.25	225.00	222.00	223.75
25	L	229.25	231.00	228.00	229.75
26	M	235.25	237.00	234.00	235.75
27	N	241.25	243.00	240.00	241.75
28	O	247.25	249.00	246.00	247.75
29	P	253.25	255.00	252.00	253.75
30	Q	259.25	261.00	258.00	259.75
31	R	265.25	267.00	264.00	265.75
32	S	271.25	273.00	270.00	271.75
33	T	277.25	279.00	276.00	277.75
34	U	283.25	285.00	282.00	283.75
35	V	289.25	291.00	288.00	289.75
36	W	295.25	297.00	294.00	295.75
37	AA	301.25	303.00	300.00	301.75
38	BB	307.25	309.00	306.00	307.75
39	CC	313.25	315.00	312.00	313.75
40	DD	319.25	321.00	318.00	319.75
41	EE	325.25	327.00	324.00	325.75
42	FF	331.25	333.00	330.00	331.75
43	GG	337.25	339.00	336.00	337.75
44	HH	343.25	345.00	342.00	343.75
45	II	349.25	351.00	348.00	349.75

EIA/ NCTA Channel	Old Designation Historical Reference	Standard-Video Frequency	Data Channel Center Frequency	HRC Video Frequency	HRC Data Channel Center Frequency
46	JJ	355.25	357.00	354.00	355.75
47	KK	361.25	363.00	360.00	361.75
48	LL	367.25	369.00	366.00	367.75
49	MM	373.25	375.00	372.00	373.75
50	NN	379.25	381.00	378.00	379.75
51	OO	385.25	387.00	384.00	385.75
52	PP	391.25	393.00	390.00	391.75
53	QQ	397.25	399.00	396.00	397.75
54	RR	403.25	405.00	402.00	403.75
55	SS	409.25	411.00	408.00	409.75
56	TT	415.25	417.00	414.00	415.75
57	UU	421.25	423.00	420.00	421.75
58	VV	427.25	429.00	426.00	427.75
59	WW	433.25	435.00	432.00	433.75
60	XX	439.25	441.00	438.00	439.75
61	YY	445.25	447.00	444.00	445.75
62	ZZ	451.25	453.00	450.00	451.75
63	AAA	457.25	459.00	456.00	457.75
64	BBB	463.25	465.00	462.00	463.75
65	CCC	469.25	471.00	468.00	469.75
66	DDD	475.25	477.00	474.00	475.75
67	EEE	481.25	483.00	480.00	481.75
68	FFF	487.25	489.00	486.00	487.75
69	GGG	493.25	495.00	492.00	493.75
70	HHH	499.25	501.00	498.00	499.75
71	III	505.25	507.00	504.00	505.75
72	JJJ	511.25	513.00	510.00	511.75
73	KKK	517.25	519.00	516.00	517.75
74	LLL	523.25	525.00	522.00	523.75
75	MMM	529.25	531.00	528.00	529.75
76	NNN	535.25	537.00	534.00	535.75
77	OOO	541.25	543.00	540.00	541.75
78	PPP	547.25	549.00	546.00	547.75

EIA/ NCTA Channel	Old Designation Historical Reference	Standard-Video Frequency	Data Channel Center Frequency	HRC Video Frequency	HRC Data Channel Center Frequency
79		553.25	555.00	552.00	553.75
80		559.25	561.00	558.00	559.75
81		565.25	567.00	564.00	565.75
82		571.25	573.00	570.00	571.75
83		577.25	579.00	576.00	577.75
84		583.25	585.00	582.00	583.75
85		589.25	591.00	588.00	589.75
86		595.25	597.00	594.00	595.75
87		601.25	603.00	600.00	601.75
88		607.25	609.00	606.00	607.75
89		613.25	615.00	612.00	613.75
90		619.25	621.00	618.00	619.75
91		625.25	627.00	624.00	625.75
92		631.25	633.00	630.00	631.75
93		637.25	639.00	636.00	637.75
94		643.25	645.00	642.00	643.75
100		649.25	651.00	648.00	649.75
101		655.25	657.00	654.00	655.75
102		661.25	663.00	660.00	661.75
103		667.25	669.00	666.00	667.75
104		673.25	675.00	672.00	673.75
105		679.25	681.00	678.00	679.75
106		685.25	687.00	684.00	685.75
107		691.25	693.00	690.00	691.75
108		697.25	699.00	696.00	697.75
109		703.25	705.00	702.00	703.75
110		709.25	711.00	708.00	709.75
111		715.25	717.00	714.00	715.75
112		721.25	723.00	720.00	721.75
113		727.25	729.00	726.00	727.75
114		733.25	735.00	732.00	733.75
115		739.25	741.00	738.00	739.75
116		745.25	747.00	744.00	745.75

Comparison of LCe Products

Features	DE3804015-Domestic DE3804016-International	DE3837033-Domestic DE3837034-International
Serial port Remote Interface Software	Does not have software package for serial port interface, the software scripts are provided in the manual. It supports 9600 bps.	Serial port remote interface software for remote control of the translator settings, using a visual basic windows interface. Direct serial port connection to PC, or through telephone modem at 9600, or 19200bps. Windows 95 required.
Power output value displayed	Does not have this feature.	Power output value displayed in dBmV, for constant carrier and QPSK signal, on front panel LCD and over remote interface to visual basic graphical display.
Local and remote control of translator output enable/ disable	Has local control of output disable. Does not have remote control of output disable.	Has both features.
Bandpass filtering, 3 dB point	3 dB bandpass: 6.0 MHz.	3 dB bandpass: 5.4 MHz. Provides improved adjacent channel filtering from the upstream.
Selectable lock out of local control	Does not have local lock out feature.	Local control can be locked out allowing only remote control of the translator settings, also local and remote control can be both enabled.
Local and remote adjustment of output power	Requires tuning a front panel potentiometer, and/or doing an enable/disable of the preamp switch. Does not have remote control for adjusting output power.	Front panel local control with push button interface. Remote interface has attenuation values from a pop-up menu.
Translator error code shown on the front panel and remote interface	Does not have failure monitoring or coding.	There are 16 translator failure conditions monitored internally. If any of these failures or multiple failures occur, they are displayed with the four digit error code. This provides the operator with a quick check of the translator condition.

Features	DE3804015-Domestic DE3804016-International	DE3837033-Domestic DE3837034-International
Internal thermal monitoring, to detect a thermal overload	Does not have thermal monitoring.	If thermal monitor exceeds 90 degrees Celsius, it sets an alarm and reports an error to the four digit error code.
Australian: emission and safety conformance Japanese: VCCI approval	Does not have these approvals and will not.	These approvals are currently being sought.
Reverse channel operating range	5.0 MHz to 42 MHz band-edge to band-edge.	8.75 MHz to 42 MHz band-edge to band-edge. Note: Range has been reduced.
Forward channel operating range	54 MHz to 750 MHz band-edge to band-edge	88 MHz to 750 MHz band-edge to band-edg. Note: Range has been reduced.

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