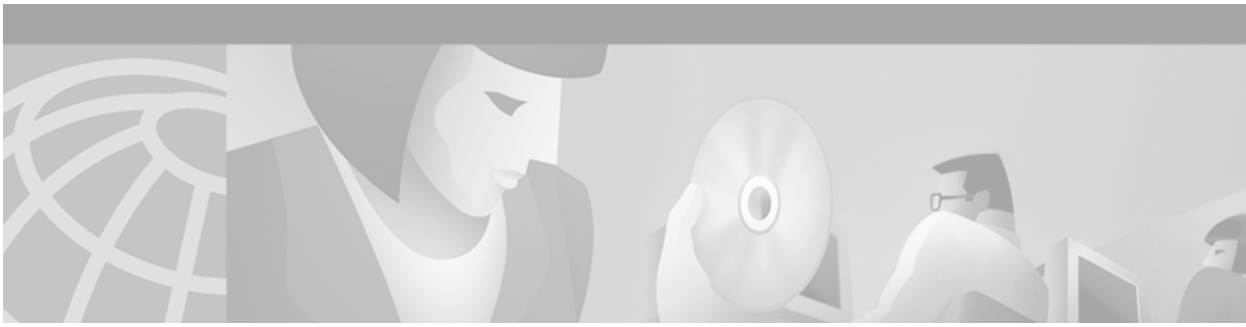


Preface

Objectives

This document provides a general overview of all hardware and software components of the Cisco VCO/4K Open Programmable Switch.

Audience

This guide is designed for system administrators and other personnel assigned to the task of installing and operating the VCO/4K switch.

Document Organization

This document is organized as follows:

- Chapter 1, “System Architecture,” provides a general overview of the VCO/4K design architecture.
- Chapter 2, “Product Description,” provides a brief review of all VCO/4K hardware and software components.
- Chapter 3, “Open Architecture and Call Control,” describes the VCO/4K host and administration interfaces, including resource control, supervision templates, inpulse and outpulse rules, and commands and reports.
- Chapter 4, “Technical Specifications,” includes specifications for all VCO/4K hardware and software modules.

Conventions

This document uses the following conventions:

Note Means *reader take note.* Notes contain helpful suggestions or references to material not covered in the manual.

Caution Means *reader be careful.* In this situation, you might do something that could result in equipment damage or loss of data.

Warning **Warning Means *danger.* You are in a situation that could cause bodily injury. Before you work on any equipment, you must be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. To see translated versions of the warning, refer to the *Regulatory Compliance and Safety* document that accompanied the device.**

Related Documentation

Related documentation includes:

- *Cisco VCO/4K Hardware Planning Guide*
- *Cisco VCO/4K Site Preparation Guide*
- *Cisco VCO/4K Hardware Installation Guide*
- *Cisco VCO/4K System Maintenance Manual*
- *Cisco VCO/4K Troubleshooting Guide*
- *Cisco VCO/4K Mechanical Assemblies*
- *Cisco VCO/4K Card Technical Descriptions*
- *Cisco VCO/4K Software Installation Guide*
- *Cisco VCO/4K System Administrator's Guide*
- *Cisco VCO/4K Standard Programming Reference*
- *Cisco VCO/4K Extended Programming Reference*
- *Cisco VCO/4K System Messages*
- *Cisco VCO/4K Supervision and Call Progress Tone Detection*
- *Cisco VCO/4K Conferencing Guide*
- *Cisco VCO/4K SS7 Subsystem Manual, ANSI Software Version 5.2*
- *Cisco VCO/4K ITU Subsystem Manual, ITU Software Version 5.2*
- *Cisco VCO/4K China Integrated SS7 Manual*
- *Cisco VCO/4K ISDN Supplement*
- *Cisco VCO/4K ASIST/API Programming Reference*
- *Cisco VCO/4K TeleRouter Reference Guide*
- *Cisco VCO/4K Ethernet Guide*
- *Cisco VCO/4K MIB Reference*
- *Cisco VCO/4K Country Supplements*

Obtaining Documentation

The following sections provide sources for obtaining documentation from Cisco Systems.

World Wide Web

You can access the most current Cisco documentation on the World Wide Web at the following sites:

- http://www.cisco.com
- http://www-china.cisco.com
- http://www-europe.cisco.com

Documentation CD-ROM

Cisco documentation and additional literature are available in a CD-ROM package, which ships with your product. The Documentation CD-ROM is updated monthly and may be more current than printed documentation. The CD-ROM package is available as a single unit or as an annual subscription.

Ordering Documentation

Cisco documentation is available in the following ways:

- Registered Cisco Direct Customers can order Cisco Product documentation from the Networking Products MarketPlace:

  http://www.cisco.com/cgi-bin/order/order_root.pl

- Registered Cisco.com users can order the Documentation CD-ROM through the online Subscription Store:

  http://www.cisco.com/go/subscription

- Nonregistered Cisco.com users can order documentation through a local account representative by calling Cisco corporate headquarters (California, USA) at 408 526-7208 or, in North America, by calling 800 553-NETS(6387).

Documentation Feedback

If you are reading Cisco product documentation on the World Wide Web, you can submit technical comments electronically. Click **Feedback** in the toolbar and select **Documentation**. After you complete the form, click **Submit** to send it to Cisco.

You can e-mail your comments to bug-doc@cisco.com.

To submit your comments by mail, for your convenience many documents contain a response card behind the front cover. Otherwise, you can mail your comments to the following address:

Cisco Systems, Inc.
Document Resource Connection
170 West Tasman Drive
San Jose, CA 95134-9883

Obtaining Technical Assistance

Cisco provides Cisco.com as a starting point for all technical assistance. Customers and partners can obtain documentation, troubleshooting tips, and sample configurations from online tools. For Cisco.com registered users, additional troubleshooting tools are available from the TAC website.

Cisco.com

Cisco.com is the foundation of a suite of interactive, networked services that provides immediate, open access to Cisco information and resources at anytime, from anywhere in the world. This highly integrated Internet application is a powerful, easy-to-use tool for doing business with Cisco.

Cisco.com provides a broad range of features and services to help customers and partners streamline business processes and improve productivity. Through Cisco.com, you can find information about Cisco and our networking solutions, services, and programs. In addition, you can resolve technical issues with online technical support, download and test software packages, and order Cisco learning materials and merchandise. Valuable online skill assessment, training, and certification programs are also available.

Customers and partners can self-register on Cisco.com to obtain additional personalized information and services. Registered users can order products, check on the status of an order, access technical support, and view benefits specific to their relationships with Cisco.

To access Cisco.com, go to the following website:

http://www.cisco.com

Technical Assistance Center

The Cisco TAC website is available to all customers who need technical assistance with a Cisco product or technology that is under warranty or covered by a maintenance contract.

Contacting TAC by Using the Cisco TAC Website

If you have a priority level 3 (P3) or priority level 4 (P4) problem, contact TAC by going to the TAC website:

http://www.cisco.com/tac

P3 and P4 level problems are defined as follows:

- P3—Your network performance is degraded. Network functionality is noticeably impaired, but most business operations continue.
- P4—You need information or assistance on Cisco product capabilities, product installation, or basic product configuration.

In each of the above cases, use the Cisco TAC website to quickly find answers to your questions.

To register for Cisco.com, go to the following website:

http://www.cisco.com/register/

If you cannot resolve your technical issue by using the TAC online resources, Cisco.com registered users can open a case online by using the TAC Case Open tool at the following website:

http://www.cisco.com/tac/caseopen

Contacting TAC by Telephone

If you have a priority level 1(P1) or priority level 2 (P2) problem, contact TAC by telephone and immediately open a case. To obtain a directory of toll-free numbers for your country, go to the following website:

http://www.cisco.com/warp/public/687/Directory/DirTAC.shtml

P1 and P2 level problems are defined as follows:

- P1—Your production network is down, causing a critical impact to business operations if service is not restored quickly. No workaround is available.
- P2—Your production network is severely degraded, affecting significant aspects of your business operations. No workaround is available.

CHAPTER 1

Introduction

The Cisco Systems Virtual Central Office (VCO) series offers an integrated hardware and software solution that delivers the power and flexibility of a fully open telecommunications system. This includes enhanced services such as voice/fax messaging, operator services, and voice dialing, as well as technologies, such as ISDN and the Advanced Intelligent Network.

System Architecture

The system architecture of the VCO/4K incorporates four discrete elements:

Multi-Level Call Control—The VCO/4K gives you real-time control and the ability to tailor call treatments. The system is open at many levels—switching, service circuits, and network interfaces. Its host control and programmability make it easy to integrate computer and telecommunications environments.

Switching—The VCO/4K features a robust, nonblocking, switching matrix and a distributed network subsystem designed with industry-standard hardware and software. It allows economical, modular growth of ports. This switching function minimizes the requirements for costly external resources (such as speech recognition) by connecting to them only when needed instead of tying them up for the entire call.

Variety of Network Interfaces—A wide variety of interfaces includes standard analog and digital interfaces for public networks, such as E&M, T1, ISDN, Primary Rate Interface (PRI), and E1. The VCO/4K can interface with virtually any network environment, providing a bridge between mature and evolving technologies.

Internal Service Circuits—VCO/4K service circuits provide the features and flexibility you need for application-specific call handling, such as tone detection and generation, call progress analysis, conferencing, and voice prompting. The basic philosophy behind every VCO/4K is to provide a total application solution for advanced telecommunications systems. This philosophy incorporates the VCO/4K open architecture, modular growth, standards compliance, reliability, and fault tolerance. Each of these elements is discussed further in the following sections.

Open Architecture

The VCO/4K offers basic switching functions and multilevel call control for a wide range of network interface and internal service circuits.

Instead of being locked into a standard call treatment, VCO/4K open architecture call control allows you to design custom call scenarios. You can define new call treatments to match changing market demands.

A communications link allows the VCO/4K to inform a host computer about events detected on network interfaces and any processing already performed. The host, in turn, provides call control instructions to the VCO/4K. Optional TeleRouter software provides autonomous call routing functions on the VCO/4K without host intervention.

Because of its open architecture, the VCO/4K can operate with a wide variety of host computers, from PCs to mainframes. You can choose a host computer and operating system to suit the application, not the switch. This open architecture design also supports multihost, multiswitch environments.

VCO/4K network interfaces also support connection to a variety of telecommunications equipment, such as voice storage and retrieval units, facsimile devices, and telephone sets. Applications are not constrained by proprietary equipment.

Modular Growth

Modular design, in both hardware and software, makes the VCO/4K a platform for growth. You can add greater call handling capacity and new features without making existing equipment or software obsolete. The VCO/4K also gives you a technical growth path. Its basic system architecture supports incorporating new technologies so that your services can evolve as the network evolves.

All VCO/4Ks use the same standard system software. Applications developed and tested on a smaller laboratory system can be easily deployed on larger systems. All control interfaces are identical on all VCO/4Ks.

Standards Compliance

The VCO/4K is designed and manufactured in compliance with exacting industry standards. For system hardware, this includes:

- Network Equipment–Building System (NEBS) criteria
- GR-63-CORE with Zone 4 Earthquake
- Bellcore's GR-1089-CORE Safety and Physical Protection

Caution The front door must remain on during system operation and the PCB card retainer bars must remain intact to comply with these requirements.

If your system arrived with blank card assemblies (blank faceplate and blank metal blade) installed, these assemblies must also remain in their original locations, unless you replace them with a functional system card. These blank card assemblies are carefully configured to compartmentalize the system for safety reasons and are critical to maintain compliance.

- UL 1950 Standard for Information Technology Equipment
- Federal Communication Commission (FCC) Rules, Parts 15 and 68
- Canadian Standards Association Standard C22.2 No. 225-M90

- Europe:
  - EN 60950 Safety of ITE
  - EN 55022 Class A, 1994, EMI
  - EN 50082-1: 1992, EMC
- Japan:
  - IEC 950 Safety of ITE
  - VCCI, Class 1, EMI
- Australia and New Zealand: AS/NZS 3548: 1995, Class B, EMI

FCC Part 68 Specifications

This section describes the FCC Part 68 requirements. This text is provided to Cisco Systems, Inc. by Dash, Straus & Goodhue, Inc. as an exact copy of the information required by the FCC.

1. The Federal Communications Commission (FCC) has established Rules which permit this system to be directly connected to the telephone network. Standardized jacks are used for these connections. This equipment should not be used on party lines or coin lines.
2. If this system is malfunctioning, it may also be causing harm to the telephone network. The system should be disconnected until the source of the problem is determined and until repair has been made. If this is not done, the telephone company may temporarily disconnect service.
3. The telephone company might make changes in its technical operations and procedures. If such changes affect compatibility or use of this system, the telephone company is required to give adequate notice of the changes. You will be advised of your right to file a complaint with the FCC.
4. Before connecting this system, you must inform the local telephone company of the following information:

Port ID	REN/SOC	FIC[1]	USOC[2]
T1	6.0P	N/A (XD Device)	N/A (XD Device)
4-Span T1	6.0P	N/A (XD Device)	N/A (XD Device)
ICC with 16-Span T1 I/O Module	N/A	04DU9-BN/1SN	6.0P

1. Facility Interface Code
2. Uniform Service Order Code

The ringer equivalence number (REN) is used to determine how many devices can be connected to your telephone line. In most areas, the sum of the RENs of all devices on any one line should not exceed five (5.0). If too many devices are attached, they may not ring properly.

5. Allowing this equipment to be operated in such a manner that prevents proper answer supervision is a violation of Part 68 of the FCC Rules.

   Proper answer supervision includes the following conditions:

   a. This equipment returns answer supervision to the PSTN when DID calls are:

   – Answered by the called station

   – Answered by the attendant

   – Routed to a recorded announcement that can be administered by the CPE user

   – Routed to a prompt

   b. This equipment returns answer supervision on all DID calls forwarded to the PSTN. Permissible exceptions are:

   – A call is unanswered.

   – A busy tone is received.

   – A reorder tone is received.

6. The software contained in the Model VCO/4K allows you access to the network must be upgraded to recognize newly established network area codes and exchanges codes as they are placed into service.

   Failure to upgrade the premises systems or peripheral equipment to recognize the new codes as they are established restricts the customer and the customer's employees from gaining access to the network and to these codes.

   Bell Communications Research (BELLCORE) publishes the North American Numbering Plan (NANP) information. An abbreviated summary of the newly established area codes and exchange codes is also available. You can contact Bellcore at (908) 699-6700 to obtain appropriate information to keep your equipment upgraded.

7. This equipment is capable of providing users access to interstate providers of operator services through the use of access codes.

   It is a violation of the Telephone Operator Consumers Act of 1990 for interstate providers to modify this equipment to block access dialing codes.

8. In the event of equipment malfunction, all repairs should be performed by our company or an authorized agent. It is the responsibility of users requiring service to report the need for service to our company or to one of our authorized agents.

Reliability and Fault Tolerance

VCO/4K design and technology provides reliability and fault tolerance that is critical to the success of emergency response and high revenue-generating applications. Features that contribute to reliability and fault tolerance are as follows:

- Full redundancy options for all major subsystems, including:
  - Control
  - Storage
  - Bus communications
  - Power supplies
  - Host links

  - Tone plan
  - System synchronization
- Alarm notification, consistent with Bellcore standards, such as:
  - Messages to host, printer, and log file
  - Visual indicators
  - Relay contact closures for audible alarms
- Diagnostic, maintenance, and administration access to the system from a variety of locations:
  - Local access via system console
  - Remote access via modem or Telnet (with optional Ethernet Communications Package)
  - Host command support for changing port status, configuring T1/PRI timing source, switching controllers (redundant systems), and other functions
- SNMP Network Management
- High mean time between failure (MTBF)
- Network interface and service circuit cards that can be changed while the system is up and running
- No host feature for handling calls on host failure

CHAPTER 2

Product Description

The VCO/4K consists of the following hardware and software components:

Basic VCO/4K system—The system enclosure, power subsystem, combined controller, digital switching matrix, distributed network subsystem, system generic software, and comprehensive product documentation.

Network interface circuits—A wide array of standard analog and digital line and trunk interfaces for connection to the Public Switched Telephone Network (PSTN) and specialized telecommunications equipment.

Internal service circuits—Special-purpose circuits that provide internal resource pools for application-specific call handling functions, such as voice prompt recording and playback, tone detection and generation, call progress analysis, and conferencing.

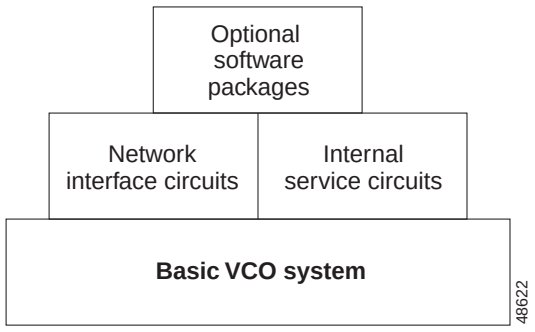
Optional software packages—Optional software packages are described in the "Optional Software/Hardware" section on page 2-12.

Note This document represents the most current information about the VCO/4K. If you need information pertaining to VCO/4K assemblies, circuit cards, or other components that are not included in this document, see the following URL on Cisco's web site for legacy VCO/4K information:

http://www.cisco.com/univercd/cc/td/doc/product/tel_pswt/index.htm

Figure 2-1 shows the layout of the VCO system.

Figure 2-1 The VCO/4K

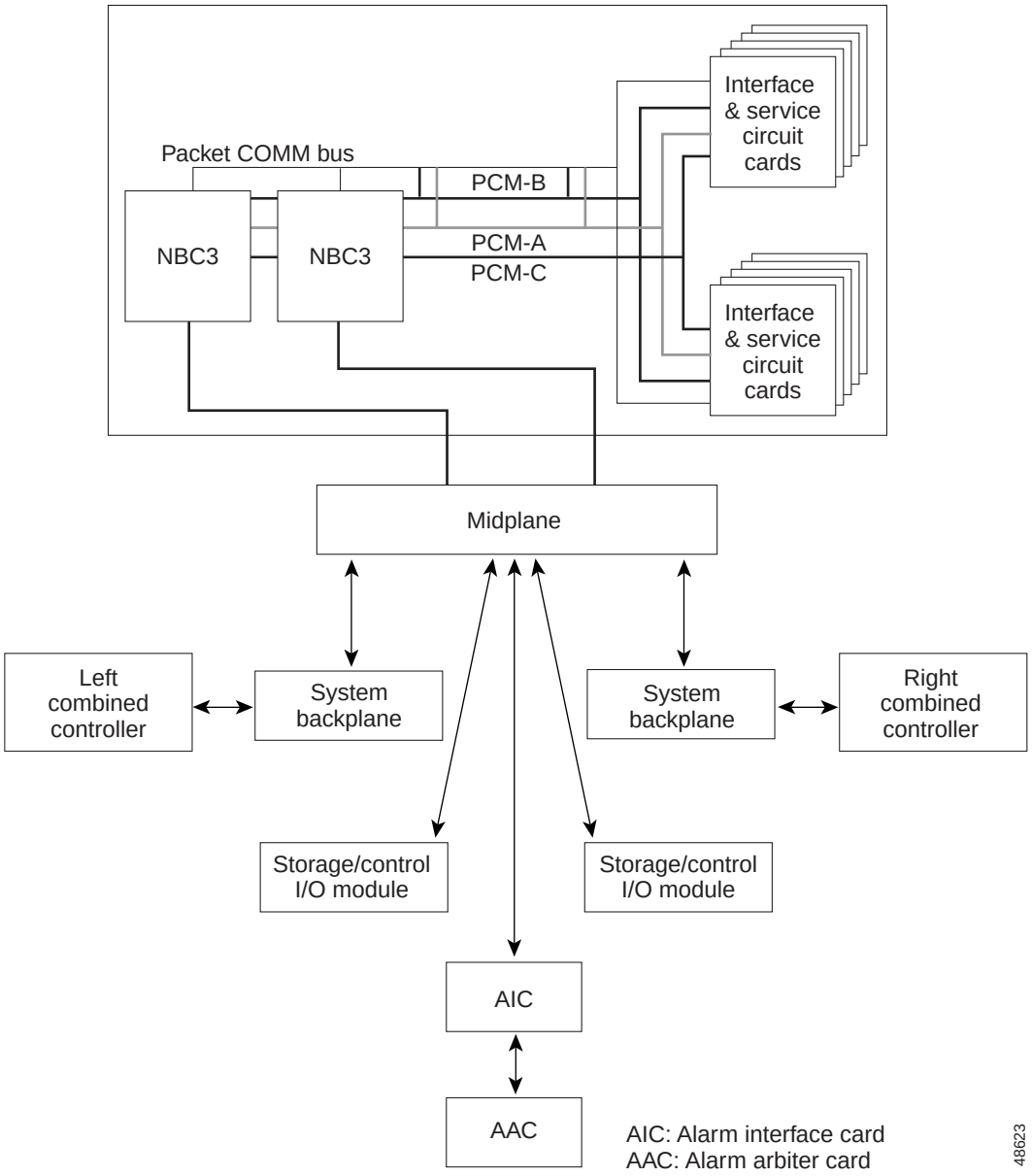


Each VCO component is discussed in the following sections.

VCO/4K System Overview

The VCO/4K open architecture digital switch can be used in a wide range of telecommunications applications. Regardless of the application, all system configurations include common hardware and software. Figure 2-2 shows a logical representation of the VCO/4K architecture.

Figure 2-2 VCO/4K System Architecture



Distributed Processing

A hierarchical distribution of system control optimizes system performance. Microprocessors on each network interface and internal service circuit card perform a portion of the event processing. This distribution of system control reduces the chance of performance degradation due to a single-point failure.

The switching matrix comprising the distributed network subsystem also uses a distributed architecture. The VCO/4K switches digital data-streams between logical port addresses, with analog-to-digital and digital-to-analog conversions performed on the network interface cards. The switching matrix accommodates nonblocking network interface and service circuit ports through a PCM voice bus switching architecture.

Switching Matrix and Distributed Network Subsystem

The VCO/4K network subsystem's interface capacity depends on the number of service circuit ports required for the desired level of system performance. Contact Cisco Systems Technical Assistance Center (TAC) for detailed system performance information.

The VCO/4K does not incorporate a central switching network. Instead, each port interface or service circuit card carries, on-board, all required analog-to-digital conversion circuitry and the portion of the nonblocking PCM network required for the number of port or service circuits on the card.

Interface port, tone generator, tone receiver, digital conferencing, call progress analyzer (CPA), and voice prompt and record cards, mount in a universal backplane bus structure.

You can mount any service circuit or port interface card in any unreserved card slot on this backplane bus, subject to main distribution frame (MDF) adapter constraints. (The first six slots are reserved.) All control information is referenced to port addresses rather than physical addresses. Call processing software reads port assignments for line/trunk interfaces and system services from the database. For example, the software reads tones, voice announcements, CPAs, conference ports, dual tone multifrequency (DTMF), and multifrequency (MF) receivers. System administration utilities let you add, move, and change lines and trunks.

Port Addressing

When a port-oriented card is placed in the port subrack and configured via the system administration tables, the controller acknowledges it and assigns it a range of port addresses, as defined in the database. Each port is associated with a time slot, during which a write/read sequence is performed.

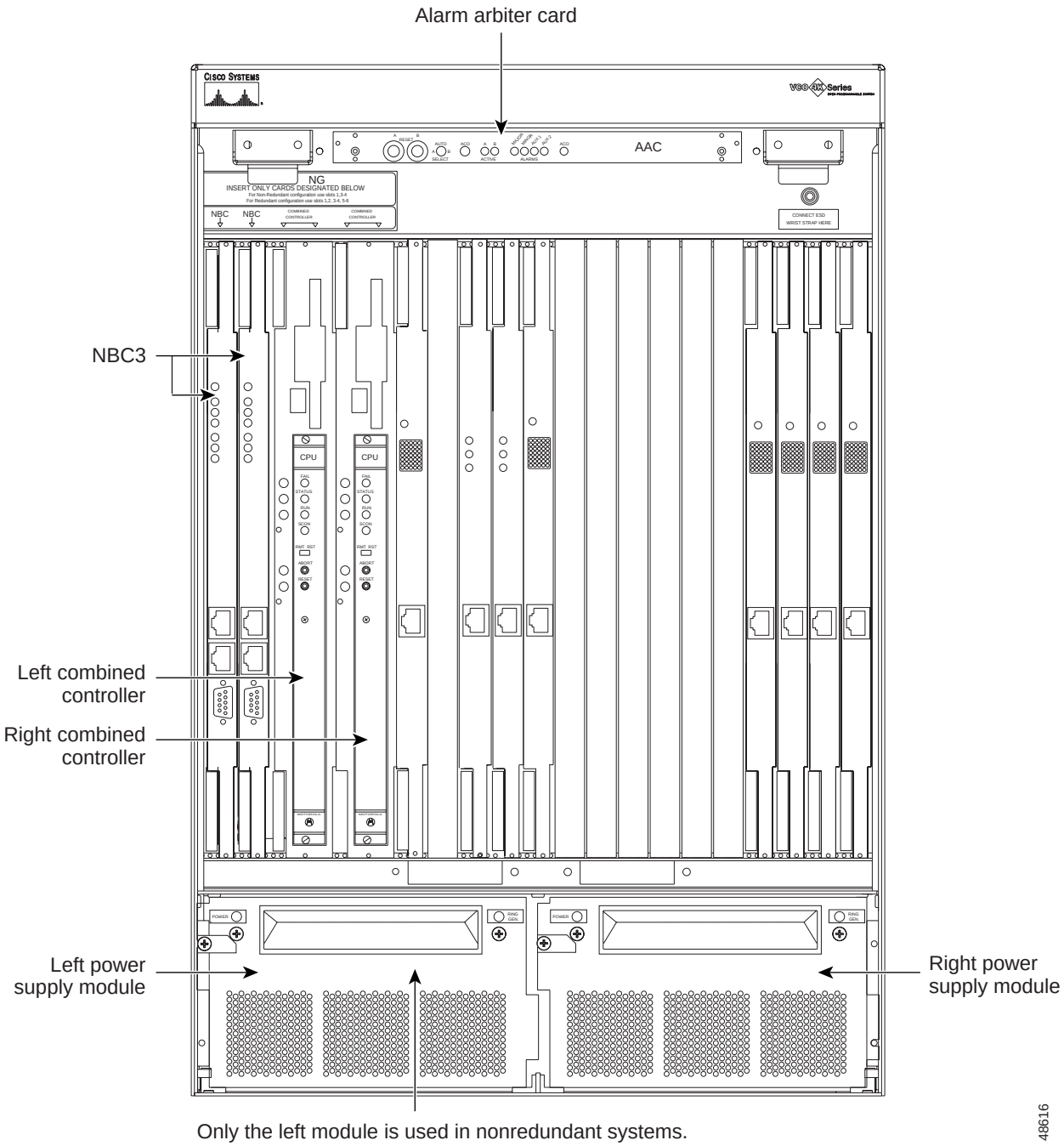
Each line, trunk, or service channel is assigned its own transmit (write) time slot address. Call processing software connects ports by dynamically assigning or mapping a receive (read) time slot for the duration of a call.

Service circuits, such as outpulse channels, voice announcement ports, call progress tone analyzers, conference ports, DTMF, and MF receivers, are similarly mapped. For example, an off hook condition may cause call processing software to map a line or trunk port to dial tone from a DTG card.

VCO/4K Architecture

The VCO/4K system enclosure meets the enclosure requirements of *UL 1459 Standard for Telephone Equipment (2nd Edition)* in customer premises installations. Redundant power supply modules and redundant combined controllers add to the reliability of the VCO/4K. The system also includes AC and DC power input options. Figure 2-3 shows a front view of the VCO/4K with the door removed.

Figure 2-3 VCO/4K Front View



Equipment Layout

A nonredundant VCO/4K system contains the following functional units:

- Control subsystem
- Storage/Control I/O module (with hard drive)
- Power subsystem
- Alarm Arbiter Card

The following subsections discuss these functional units.

Control Subsystem

The control subsystem consists of the Network Bus Controller (NBC3) and the combined controller.

Network Bus Controller

The NBC3 extends the full-duplex path from the combined controller and supports a separate communications (COMM) bus to all port-oriented cards in the port subracks. This controller includes phase lock loop (PLL) circuitry to synchronize system timing with incoming E1 or T1 bit streams.

Combined Controller

The Combined Controller consists of the following components:

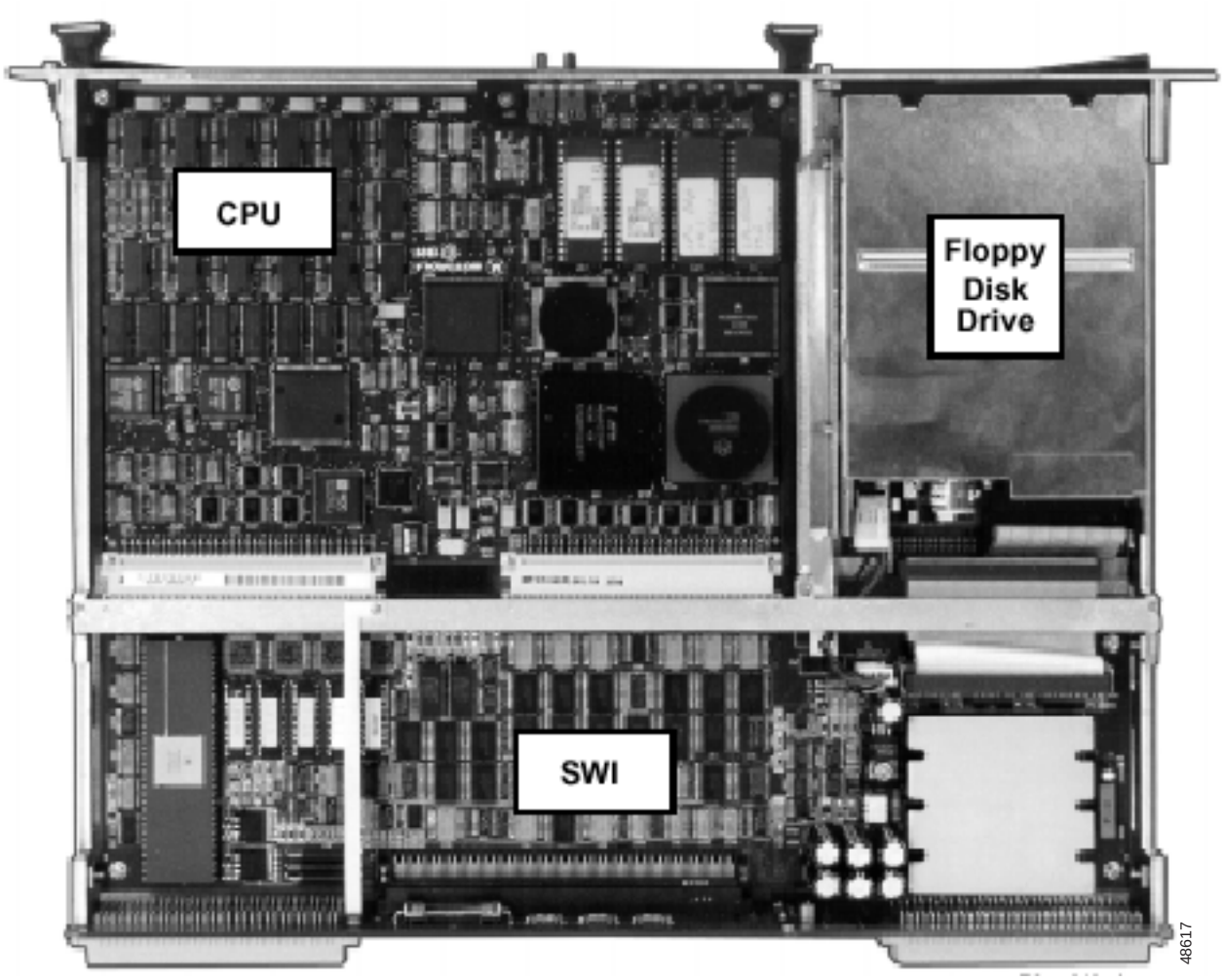
Central Processing Unit (CPU)—An MC68030-based computer with a floating-point MC68882 coprocessor, on-board Dynamic RAM (DRAM), battery-backed clock/calendar, and Small Computer Systems Interface (SCSI) bus interface.

Switch Interface (SWI) Card—Provides a full-duplex, high speed, direct memory access (DMA) controlled, parallel bus path to the NBC3. In redundant VCO/4K systems, the SWI communicates with the other controller via the update channel.

Floppy Disk Drive—A 3.5-inch, 1.44-MB floppy disk drive that allows you to make backup copies of the system database.

Figure 2-4 shows the components on the combined controller.

Figure 2-4 Combined Controller



Storage/Control I/O Module

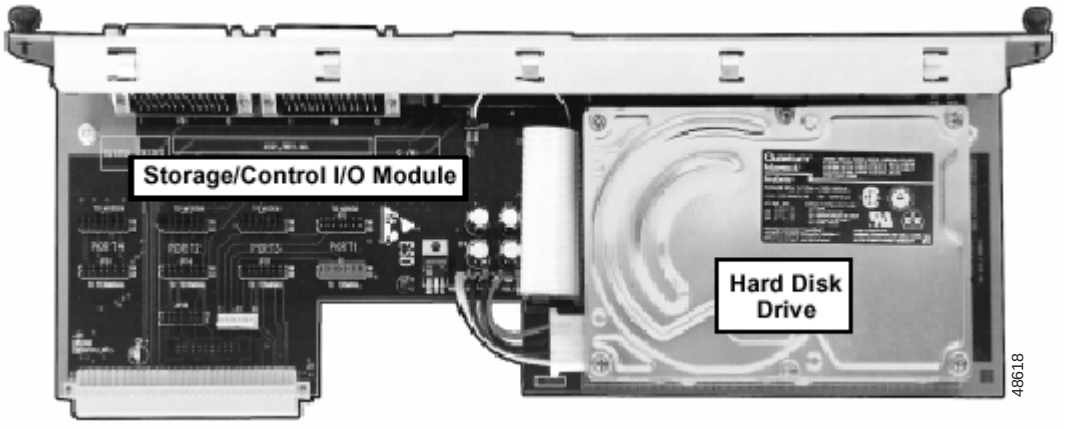
The Storage/Control I/O module provides the following interfaces, in addition to the hard disk drive:

- Serial Port 1 (DB-25 connector for system administration console)
- Serial Port 2 (DB-25 connector for remote maintenance modem)
- Serial Ports 3 and 4
- Ethernet Port (DB-15 connector for Ethernet connection)
- Printer Port (36-pin parallel (Centronics type) printer port)

The 270-MB hard disk drive provides storage for system generic, application download (i.e., NBC3, CPA, IPRC, MVDC, DRC-24/48), and system database and log files. With the Ethernet software option, you can configure log files to be passed on an Ethernet network.

Figure 2-5 shows the Storage/Control I/O module.

Figure 2-5 Storage/Control I/O Module



Power Subsystem

VCO/4K systems are equipped with a power subsystem that supplies ample power, at the required voltages, for various system configurations. The system consists of three main components—power entry module, power backplane, and power supply module. The power supply module accepts one of four inputs (-48 VDC, Dual -48 VDC, 120 VAC, or 240 VAC) and provides regulated DC voltages for system operation. The VCO/4K system is configured for redundant power supply modules. Each power supply module has an LED, which indicates the status of the unit.

Alarm Arbiter Card

The Alarm Arbiter Card (AAC) provides centralized control of controllers, system status indicators, and external alarm connections.

Network Interfaces

The basic VCO/4K system can be equipped with digital network interface circuit cards in any combination, up to the system's port and power capacity. Call control support for all network interface circuit types is part of the standard VCO/4K system software. VCO/4K system administration lets you designate network interface circuits on a single card as incoming, outgoing, or two-way.

Digital Network Interfaces

Digital Network Interfaces are as follows:

Four Span Programmable T1 (4xT1) Interface Cards—Programmable at the span level, these cards support four spans of 24, 56, or 64 kbps voice and data channels and comply with Bell System DS-1 specifications for transmission at 1.544 Mbps. These cards enable incoming, outgoing, and two-way service to 24 individual nonblocking channels on a span. Additional features include D4 and ESF format,

E&M, FXO, FXS, loop start, ground start, and clear signaling, law conversion, gain control, length, slip/OOF thresholds, and switch hook flash detect and send, wink detect and send, guard, off-hook minimum timing detection, and support of A-law / -law PCM coding.

Single Span T1 (T1) Interface Card—Provides a D3/D4 bipolar format, 1.544 Mbps PCM data stream to DS-1 carrier specifications; also supports wink detection and generation.

Single Span E1-CAS (E1) Card—Provides 32 x 64 kHz channels, supports A-law/ law PCM coding or clear channel data, and uses channel associated signaling (CAS) with all bit positions of timeslot 16 in every frame reserved for bit-oriented signaling data transmission.

PRI/N Card—Provides a D3/D4 bipolar or ESF format, 24-channel (23 B+D) 1.544 Mbps digital data stream. The PRI/N card supports North American Primary Rate connectivity with D-channel protocol handling of the user side and user side symmetrical. It is compatible with Northern Telecom and AT&T implementations of CCITT Q.921 Layer 2 and Q.931 Layer 3 protocols. The NFAS option controls up to 479 B-channels using only one D-channel. D-channel backup (D-channel redundancy) is also available. Requires optional ISDN PRI and/or NFAS software packages.

Four Span Programmable E1 (4xE1) Interface Card—Programmable at the channel level, the 4xE1:

- Supports four spans of 32 channels, consisting of:
  - 30 traffic channels
  - one synchronization channel
  - one signaling channel
- Supports 64 kbps voice and data channels
- Complies with CCITT G.704 specifications for transmission at 2.048 Mbps.

The 4xE1 enables incoming, outgoing, and two-way service to 32 individual nonblocking channels on a span. Additional features include the following:

- Signaling: CAS/R1, CAS/MERC, CCS/31B
- Slip/OOF thresholds
- Hookflash send
- Detect timing
- Law conversion
- Gain control

E1-PRI Card—Transmits a 2.048-MHz, 32-channel (30 traffic channels, one synchronization channel, and one signaling channel), bipolar digital data stream. The E1-PRI card interfaces with the following:

- DPNSS
- DASS2-Network Termination
- ISDN/NET5

Switches on the card can be set for the desired card type. There are separate download software packages available for DPNSS, NT-DASS2, and ISDN/NET5.

E1-CAS Card—Provides 32 x 64-kHz channels, supports A-law/ law PCM coding or clear channel data, and uses channel associated signaling (CAS) with all bit positions of timeslot 16 in every frame reserved for bit-oriented signaling data transmission.

Drop and Insert Card—Provides DS0 access to the switch matrix. This card supports a maximum of eight interfaces per card that operate at either 56 KB or 64 KB. It is configurable as DCE or DTE with normal or reverse bit-packing. This card supports both EIA/TIA-449 and V.35 (with user-supplied cables). The Drop and Insert card may be inserted into the system while the system is active.

Administration of the card is done through the existing System Administration Console. Configuration messages are sent to the card from the generic through the NBC interface.

All digital network interface cards allow clear channel for true 64 kbps throughput.

Interface Controller Card (ICC) and the T1 or E1 I/O Modules—The Interface Controller Card (ICC) is a high-capacity network interface engine. The ICC card employs Cisco Systems mid-plane architecture which enables it to connect with a series of I/O modules specific to different network interface requirements. The mid-plane isolates the unique physical characteristics of each type of connection leaving the ICC to perform all of the signaling and protocol processing independently. There are six I/O modules supporting 4, 8, or 16 network spans. A C-bus enabled, VCO switching platform (VCO/4K Series) with a full complement of ICC cards and 16-span I/O modules will support more than 4000 ports.

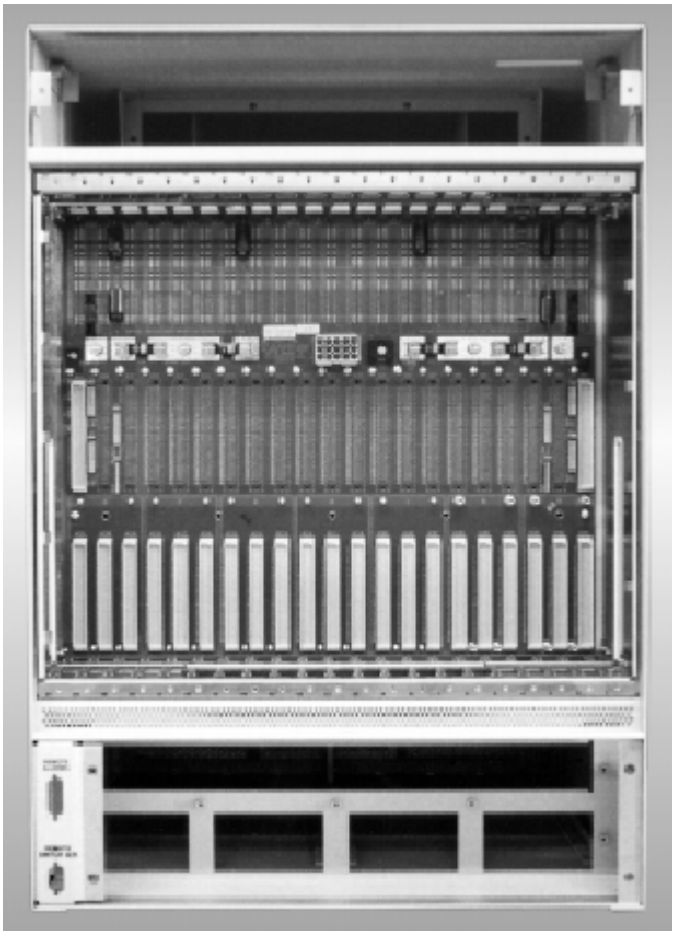
The ICC is fully programmable, enabling user control over individual channels.

Other features include on-board Flash memory for rapid configuration and boot-up time.

I/O Module Card Cage

The VCO/4K has a card cage in the front of the system and a card cage in the back. The system backplane is located in the middle. The 9U card cage in the back is used for inserting vertical I/O modules into slots with corresponding port cards. Figure 2-6 shows a back view of the VCO/4K without any I/O modules in the card cage so that the system backplane is visible.

Figure 2-6 VCO/4K Card Cage for I/O Modules



Access is at the rear of the system and slots are numbered from 1 to 21 to correspond with port subrack slots. For information about the vertical I/O modules, refer to the *Cisco VCO/4K Card Technical Descriptions.*

Service Circuits

VCO/4K service circuits provide internal pools of special-purpose resources for application-specific call handling functions. These resources are available to all network interface circuits, including PRI B-channels. You can use system administration utilities to group service circuits, except DTG tones and outpulse channels. The circuits on all service circuit cards are assigned and released by software control.

Service circuit cards are as follows:

Service Platform Card (SPC) with Service Resource Modules (SRMs)—The Service Platform Card combines the capabilities of individual service resource cards into a single card, which contains all of the functions previously provided by separate cards. The hardware design of the SPC allows the software operating within the SPC and the SPC's mezzanine card (the Service Resource Module, or SRM) the ability to exceed the older service resource function's feature set, while providing a much higher level of integration both logically and physically.

The Service Platform Card architecture allows any service resource function of the VCO/4K to be performed with this card as a base platform, given a minimum of one SRM mezzanine card on the board to perform the service function(s). Mezzanine cards have the capability to perform more than one service function. Services include the following:

- **CPA**—DSP-based tone detection board that determines the status of a call. CPA detects call states such as dial tone, busy, fast-busy (re-order), audible ringback, special information tones, ring back cessation, voice, voice cessation, and pager cue tones. You can also configure the CPA to detect predefined tones. The CPA provides the unique VCO/4K capability of internetworking ISDN to non-ISDN facilities.
- Various downloads are available for country-specific tone plans. For more information about country-specific tone plans, refer to the appropriate country-specific supplement.
- **Conference**—Provides conference ports that you can use to provide conference features. Up to eight incoming and/or outgoing lines or trunks can participate as listen-and-talk ports in a single conference, or up to seven listen-and-talk ports with as many listen-only ports as desired. You can adjust input levels to the conference and output levels from the conference.
- **DTG**—Provides standard system tones (i.e., dial tone, call progress tones, and MF/DTMF digits) and outpulse channels used to outpulse digits. System tones are available to all resources.
- **DTMF Receiver**—Includes DTMF receiver circuits that perform DTMF tone detection for all VCO trunk types.
- **MF Receiver**—Includes MF receiver circuits.
- **MFCR2**—Includes MF transceiver circuits that can be assigned to calls requiring CCITT R2 forward/backward signaling.

Integrated Prompt Recording Card (IPRC)— Provides an easy-to-implement, high-quality, digital voice prompting system. The IPRC receives commands from a host application and communicates those commands to a digital voice prompt unit to produce voice messages. These messages are then routed by the IPRC card to the designated outgoing VCO/4K port. The IPRC is available with either eight playback/four record ports, 64 playback/32 record ports, or 128 playback/32 record ports. Additionally, the IPRC supports up to 16 prompt libraries of up to 256 prompts each.

Optional Software/Hardware

The following optional software is available from Cisco Systems:

- Application Software Integration Support Tools (ASIST)
- Ethernet Communications Package for the VCO-to-host interface
- Integrated Services Digital Network (ISDN) Primary Rate Interface (PRI)
- ISDN Non-Facility Associated Signaling (NFAS)
- TeleRouter call routing software
- VF-EDIT voice prompt editing software
- ISDN/NET5
- Japanese ISDN software (NIT Domestic Specification)
- ANSI and ITU Integrated SS7

The following subsections discuss these software packages.

ASIST

ASIST software aids the development of host-controlled applications. ASIST products include:

ASIST/Application Programming Interface (API)—C language representation of the VCO Standard (2K) and Extended (4K) command/report host interface. It consists of a library of software modules that builds commands to control the VCO/4K and parse reports from the VCO/4K. ASIST/API is compatible with any operating system that supports the C programming language; source code is provided for this product. The host application must be written in C.

ASIST/Ethernet—Allows a UNIX-based host to communicate with a VCO/4K over the Ethernet. ASIST provides a library of routines which allows an application developer to build a socket interface over the Ethernet, using TCP/IP, to the VCO/4K.

Ethernet Communications Package

The Ethernet communications package supports Ethernet TCP/IP communications between the VCO/4K and one or more host computers.

The VCO/4K supports a single, thick-wire, DB-15 Ethernet port located on the Storage/Control I/O module. You can use an Ethernet transceiver to convert this interface to thin wire or twisted pair.

The VCO/4K implementation uses stream-oriented TCP protocol. TCP error handling includes checksum verification of messages, sequential message delivery, and protection against message duplication. TCP is also a connection-oriented protocol, typically involving a connection between a client and a server. The VCO/4K performs the role of a server in the client/server TCP model.

Ethernet communications on the VCO/4K supports a single physical link per VCO/4K CPU, each with multiple logical connections or sockets. A socket interfaces the Ethernet communications protocol and the application. The VCO/4K Ethernet implementation supports up to eight simultaneous sockets, using the BSD 4.3 Internet Domain sockets interface.

Additionally, the Ethernet Communications package supports Network File System (NFS). With NFS, you can send alarm and trace files to the host. The host can also use NFS to download voice prompts to the VCO/4K.

You can also use Telnet to route all system administration access through Ethernet instead of the local administration console. This is especially useful in remote administration.

ISDN PRI

ISDN PRI software provides call processing and administrative support for ISDN PRI calls. User side and user side symmetrical, CCITT Q.921/931 access to AT&T 4ESS, AT&T 5ESS, and NTI can be configured for each PRI card in the system.

PRI card operation supports Layers 1, 2, and 3 of the OSI model and call control to provide an interface with the ISDN network. The generic software downloads the application software to the PRI card. ISDN PRI interacts with the call processing functions running on the controller.

Full system administration support allows PRI card configuration, alarm detection and processing, and card maintenance functions. The PRI is compatible with most system administration utilities.

The ISDN PRI Package uses templates that shield you from much of the detailed interface. ISDN Message Templates, used with rule processing, enhance programmable reporting of ISDN events and facilitate construction of D-channel messages. ISDN Supervision Templates provide control of outgoing ISDN calls.

If necessary, the VCO/4K can also provide “pass through” of ISDN data, leaving most call processing decisions to the host computer. This allows the system to use nonstandard information elements (IEs) and to handle the special signaling requirements of private networks.

ISDN PRI Package features support not only pure ISDN calls, but calls using a mixture of ISDN and non-ISDN resources. All internal resources are available for ISDN calls. These mixed-resource cases, or internetworking scenarios, allow the VCO to be used as a gateway between the ISDN and traditional services networks.

ISDN NFAS

Standard ISDN PRI consists of 23 B+D channels, where a single signaling channel (D-channel) controls the remaining 23 bearer channels (B-channels) on the interface. In VCO terms, this means that ports 1 through 23 on the PRI/N card (B-channels) are controlled by port 24 (D-channel). The NFAS option extends D-channel control to B-channels not resident on the same interface. This allows a single D-channel to control up to 20 interfaces (a maximum of 479 B-channels). Additionally, ISDN NFAS supports 23 B+D PRI/N cards, T1 voice channels, and an optional D-channel backup. ISDN NFAS requires the ISDN PRI/N software package.

TeleRouter

TeleRouter is a software overlay to the generic software that allows the VCO/4K to interpret dialed digit information and execute call routing decisions based on the information. All standard generic functions are maintained. Additional TeleRouter capabilities allow the user to design switching scenarios completely within the VCO/4K. TeleRouter can be used in conjunction with a host computer in a normal VCO/4K hosted environment, or it can independently perform routing actions on the switch in an unhosted configuration.

Screen displays within standard system administration menus provide access to TeleRouter functions. These screen displays are used to create routing instruction tables. An additional inpulse rule token initiates the instructions included in the routing tables.

ISDN/NET5

ISDN/NET5 is available through the ISDN/NET5 E1-PRI package. NET5 runs only on the 120-ohm version of the E1-PRI card.

E1-PRI card operation supports Physical, Data Link, and Network Layers (1, 2, and 3) of the Open System Interconnect (OSI) model to provide interface with NET5 D-channel protocols. Application software stored on the system hard disk is downloaded to the E1-PRI card by the generic software. This application interacts with the call processing functions running on the system controller.

Full system administration support is provided to allow E1-PRI card configuration, alarm detection and processing, and card maintenance functions. Enhancements to system call processing allow ISDN/NET5 features and capabilities to be added to an application with no effect on existing applications.

The added commands, reports, and Inpulse/Outpulse Rule tokens conform to existing standards. ISDN/NET5 Message Templates and rule processing are used to enhance programmable reporting of events and facilitate construction of outgoing D-channel message. ISDN/NET5 Supervision Templates provide control of outgoing ISDN/NET5 calls.

These features support not only pure ISDN/NET5 calls, but also calls which use a mixture of ISDN/NET5 and non-ISDN/NET5 resources. All internal resources are available for use by ISDN/NET5 calls, including Call Progress Analyzers (CPAs). These mixed-resource cases, called *interworking* scenarios, allow the switch to be used as a gateway between the ISDN/NET5 and traditional services networks.

Japanese ISDN (NIT Domestic Specification)

NTTPRI is a Japanese version of ISDN PRI, complying with the Japan Approvals Institute for Telecommunications Equipment (JATE), and is a variant of CCITT PRI standard Q.931/I.451.

Generic Support of the NTTPRI card includes the following:

- Standard PRI/N card type
- NTTPRI download
- Card Configuration: separate screen for configurable parameters
- Call Processing: existing and new Layer 3 messages and information elements
- Call Clearing: CAUSE IEs are specific to the cause event

ANSI and ITU Integrated SS7

The Integrated SS7 product serves as a gateway between Signaling System No. 7 (SS7) intelligent networks and the PSTN by integrating the SS7 network with a VCO/4K system and host computer(s). This integration can significantly improve call processing because the call setup information arrives independent of the voice traffic. Independent signaling increases the call processing rate by a minimum of 60 percent over the rates of other signaling methods. SS7 integration also reduces network congestion and deployment costs through greater port utilization and alternative routing capabilities.

The ANSI and ITU Integrated SS7 products allows the service provider to implement the following enhanced services:

- ISDN User Part (ISUP) services for call processing and switching, such as:
  - Operator Services System support
  - ISDN or Feature Group D Interworking
  - Personal Communication Services (PCS)/Enhanced Services Billing
  - Integration of full Service Switching Point (SSP) functionality
  - Wireless and wire line internetworking
- Transactions Capabilities Applications Part (TCAP) applications, such as:
  - Credit card/debit card validation
  - Personal number/“follow me” services
  - Network-based services including 800 number routing and Automatic Call Distribution (ACD)
  - Mediated access
  - Cellular roaming services

The Integrated SS7 is a system consisting of both hardware and software components that are installed in a VME shelf and connected to the VCO/4K system. An Integrated SS7 system can support one VCO/4K system, and up to eight host computers that all reside on Ethernet LAN. The Integrated SS7 system connects directly to the Ethernet LAN and SS7 network.

CHAPTER 3

Open Architecture and Call Control

Open Architecture Advantage

Cisco Systems' approach to open architecture enables the seamless integration of computer and telecommunication environments. With the VCO/4K, a host computer can not only initiate pre-defined call treatments, but also provide call control access to every aspect of call handling, delivering the power and flexibility of a fully open telecommunications system.

The VCO/4K's open architecture provides the following benefits:

- Call treatment is under the application developer's control, enabling rapid development and deployment of new services. You can add new services and features to an application by making minor modifications to VCO/4K resource definitions.
- Decoupled VCO/4K hardware and software architectures support the addition of new interfaces and service circuit types. The VCO/4K accelerates the adoption of new technology.
- Host communication interfaces and protocols are compatible with a variety of host computers—from PCs to mainframes. You can choose the host computer, operating system, and development language to suit an application.
- Support for a full range of network interface and service circuit types allows maximum flexibility.
- Standard interfaces are compatible with equipment from a variety of vendors, such as voice store-and-forward, facsimile, analog telsets, and others. You are never constrained to proprietary interfaces, or locked into a single vendor.
- The VCO/4K provides a consistent control interface for the host computer, regardless of the resource. This makes the VCO/4K an effective bridge between diverse network environments. For example, you can outpulse a called number collected in an ISDN D-channel message as multi-frequency (MF) digits; the VCO/4K performs the required translation.
- As a network concentrator, the VCO/4K dramatically improves trunk utilization, helps reduce investment in expensive computer and peripheral equipment, and reduces the cost of the overall application solution.

Most VCO/4K-based applications rely on interaction between a host computer and the VCO/4K. This interaction is characterized by the application's software architecture. Figure 3-1 illustrates the VCO/4K under host control.

Figure 3-1 VCO/4K Under Host Control

Host Computer

- Controls and coordinates all application activites
- Issues commands based on application processing
- Interprets reports from VCO/4K
- Tracks VCO/4K resources, alarms, and errors

VCO/4K

- Executes Inpulse Rules base on command or event
- Executes Outpulse Rules base on command
- Reports events to host
- Processes host commands

48624

Basic Application Architecture

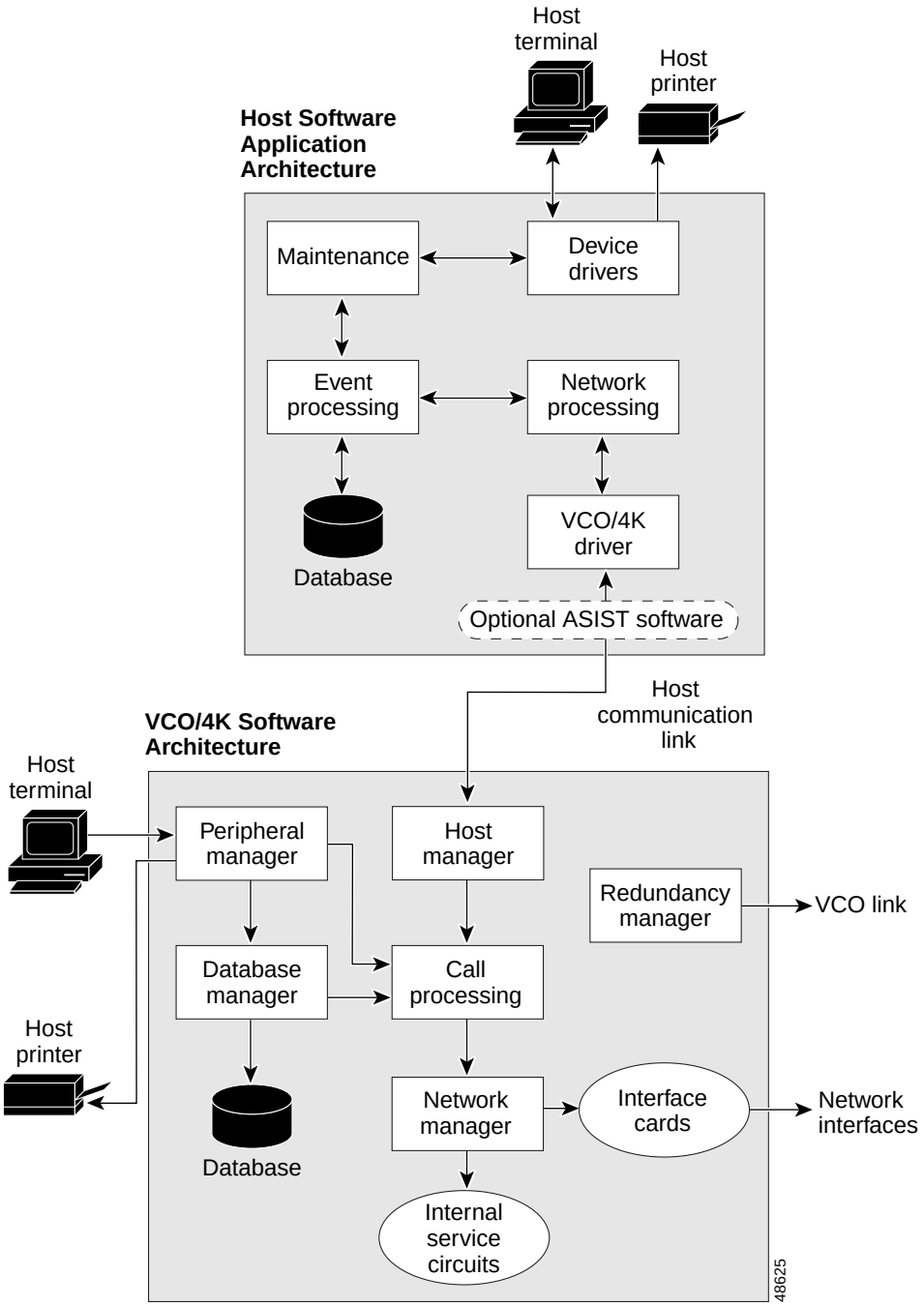
An application's software architecture defines the environment and processes required to implement the desired features and functions. VCO/4K-based applications use two integrated software architectures:

Generic Call Control (resident on the VCO/4K)—Provides multilevel call control, call processing, internal communication handling, system administration facilities, internal maintenance, and diagnostics.

Host Software (resident on the host)—Combines the operating system, programming language, existing applications, and VCO/4K-specific processes.

The VCO/4K generic and host application software are connected using the host communication links. Figure 3-2 shows a sample application software architecture.

Figure 3-2 Sample Application Software Architecture



The host computer can control every element of a call through the VCO/4K and dynamically coordinate the delivery of call and database information. The VCO/4K concentrates network interface and service circuit resources of different types into a single manageable entity.

General VCO/4K Call Flow

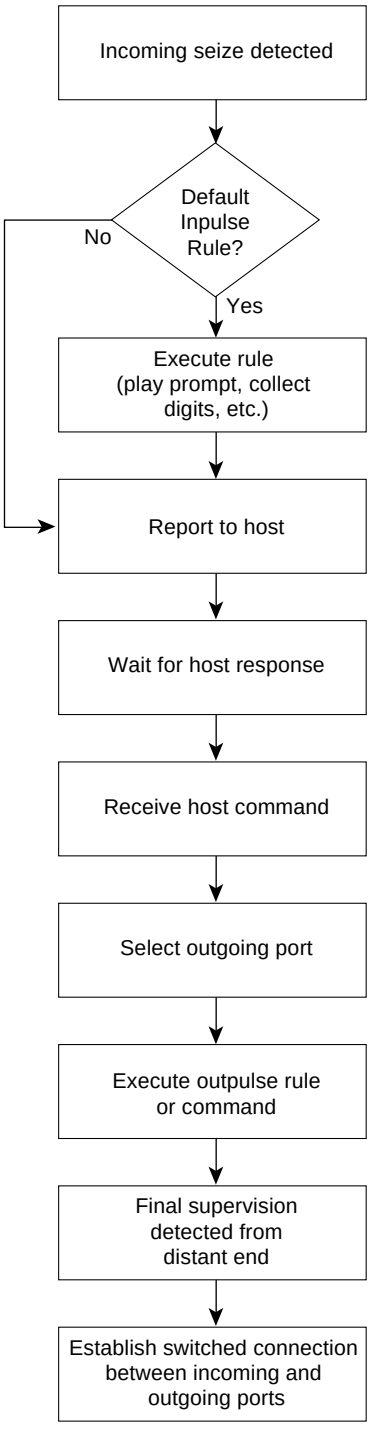
During a VCO/4K call, the following general actions are performed:

- A call request is detected.
- Information is collected.
- The call is managed depending on the collected information.

A sample VCO/4K call flow is shown in Figure 3-3.

Note This example shows a simple incoming call. More complicated call scenarios can be implemented using the host application.

Figure 3-3 Sample Call Flow



VCO/4K detects a seizure on an incoming port.

VCO/4K checks the database to determine if an Inpulse Rule has been defined for this incoming port.

VCO/4K executes the Inpulse Rule found in the database. Rule can include presenting a tone (such as dial tone or a beep) to a port, or collecting digits dialed by the end user.

Reports are sent to the host based on Inpulse Rule tokens. If there is no Inpulse Rule, VCO/4K informs the host of the incoming port off hook.

The VCO/4K waits for further instructions from the host unless TeleRouter is enabled.

The host computer sends a command to the VCO/4K. The command is based on host application processing and can specify to outpulse digits, send supervision signaling, or take other actions.

The outgoing port to be used can be specified by Port Address, or the VCO/4K can be instructed to hunt for an available port from a resource group.

Once an outgoing port has been selected, the VCO/4K performs actions based on the command received from the host.

The VCO/4K waits for final supervision to be detected by the outgoing port.

When an answer is detected, the VCO/4K connects the incoming port to the outgoing port, establishing a stable call.

48626

Call Control Elements

Call control elements provide the multilevel programmability that makes the VCO/4K effective in a wide range of applications. VCO/4K call control elements include the following:

- Resource definitions in the VCO/4K database
- Inpulse and outpulse rules
- Templates
- VCO/4K commands
- VCO/4K reports

These elements combine with call processing to provide the host computer with a consistent control interface for different network interface and service circuit types. The VCO/4K system uses rules, templates, and tables to provide call control.

Resource Definition

VCO/4K system administration software provides a menu-driven interface to define the system's configuration and resource characteristics. VCO/4K call processing uses this information to determine autonomous processing or other special resource management. The VCO/4K system database maintains the following information:

Configuration—Includes the type and physical location of the internal communications bus, the network interface, and service circuit cards and the relationship between this information, and the logical port addresses used in host commands and reports.

Class of Service (COS)—Assigns software operating characteristics to individual interface ports.

Inpulse Rule—Determines autonomous processing of incoming network interfaces when a call is requested.

Resource Grouping—Sorts resources by type, and COS (if applicable). Similar resources are placed in a resource group to help the VCO/4K and host keep track of their availability.

Inpulse and Outpulse Rules

Call processing requires various signaling and supervision actions, such as collecting or sending digits. Use inpulse and outpulse rules to define the sequence of these actions for each type of call that the application manages.

The VCO/4K system's inpulse and outpulse rules screens give you the ability to define up to 256 inpulse rules and 256 outpulse rules with individual tokens for each action within a rule.

Like telephony subroutines, rules are *called* in a host command, processed by another rule, or in the case of inpulse rules, executed when a call is detected on an incoming port. Processing overhead decreases for both host computer and host communication interfaces because rule processing occurs on the VCO/4K.

Use inpulse and outpulse rules to condition a network interface to wait for supervision events, to collect MF, MFCR2, dual tone multifrequency (DTMF), or Dial Pulse (DP) digits, and to store received digit strings in an internal VCO/4K call record.

Inpulse Rules

Inpulse rule tokens include the following:

- **Reporting Control**—Determines when event and digit collection reports are sent to the host computer.
- **Signaling Mode**—Indicates whether incoming digits are MF, MFCR2, DTMF, or DP.
- **Digit Collection Set Up**—Defines the conditions under which digit collection is performed.
- **Digit Collection**—Enables the appropriate receiver circuit type (as indicated by the Signaling Mode token), and specifies the call record digit field in which digits are stored.
- **Supervision Control**—Presents in-band or out-of-band signaling to the distant end (i.e., wink, answer, tone, or voice prompt), or waits a specified length of time before continuing rule processing.
- **Processing Control**—Allows construction of rules with more than 16 tokens, and allows processing of outpulse rules.

Special tokens are provided for the processing of calls using TeleRouter and ISDN PRI software.

An administrator's screen showing the inpulse rules table appears in Figure 3-4.

Figure 3-4 Inpulse Rules Table screen

```
                    I N P U L S E     R U L E S    T A B L E

RULE # 1       RULE # 2       RULE # 3       RULE # 4       RULE # 5

MF             MF             ISDN RX   3    NO REPP        REP END
WINK ENAB      WINK ENAB      ISDN TX   4    REP NEXXT      DTMF
IP ANI         IP ANI    7    _________ ___  ISDN RX   9     DIGITS    11
DTMF           _________ ___  _________ ___  _________ ___   REP NEXT
TONE ENAB 3    _________ ___  _________ ___  _________ ___   IP FIELD 1
TONE FDIG 1    _________ ___  _________ ___  _________ ___   WAIT TIME 5
DIGITS    10   _________ ___  _________ ___  _________ ___   ROUTE     A1
IP FIELD 1     _________ ___  _________ ___  _________ ___   _________ ___
_________ ___  _________ ___  _________ ___  _________ ___   _________ ___
_________ ___  _________ ___  _________ ___  _________ ___   _________ ___
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_________ ___  _________ ___  _________ ___  _________ ___   _________ ___
_________ ___  _________ ___  _________ ___  _________ ___   _________ ___
_________ ___  _________ ___  _________ ___  _________ ___   _________ ___
```

48620

Outpulse Rules

Use outpulse rules to condition a network interface to wait for supervision events and outpulse MF, MFCR2, or DTMF digits. Digits can be those collected by an inpulse rule or supplied in a host command. The VCO/4K automatically converts the digits into the specified format, regardless of the format in which they were supplied.

Outpulse Rule tokens are functionally divided into the following five groups:

Reporting Control—Determines if event reports are sent to the host computer.

Signaling Mode—Indicates the type of outpulse signaling required, such as MF digits, MFCR2 digits, DTMF digits, or tones.

Supervision Control—Conditions the network interface to detect and respond to an answer supervision event before continuing with rule processing. Indicates which configurable Answer Supervision template or preconfigured template to use for supervision.

Digit Field—Determines when and what digits or tones are outpulsed.

Processing Control—Allows construction of rules with more than 16 tokens, and allows processing of inpulse rules.

Special tokens are provided for processing ISDN PRI software.

Templates

Templates let you precisely define call handling and are a unique feature of the VCO/4K open architecture. Like rules, templates (similar to If-Then statements) determine the VCO/4K response to specified events. There are three types of templates:

Answer Supervision—Specifies the signaling events to be detected and the VCO/4K response. Answer Supervision templates are called by outpulse rules. Signaling events include true answer, hookflash, wink, and call progress tone events, such as dial tone, busy, reorder, voice cessation, audible ringback, or the cessation of audible ringback.

ISDN Answer Supervision—Determines the VCO/4K response to specific ISDN D-channel messages. The ISDN Answer Supervision templates are called by outpulse rules. These templates are included with the ISDN PRI software.

ISDN Message Templates—Determines the processing, storing, and reporting of specific D-channel messages when called by inpulse rules. When called by outpulse rules, these templates determine the construction and transmission of specific D-channel messages. ISDN Message templates are specific to the ISDN PRI software.

Configure all three types of templates using VCO/4K system administration.

VCO/4K Commands

An extensive and flexible command set enables direct host computer control of the VCO/4K. Additionally, VCO/4K commands enable system maintenance, configuration, and status control. VCO/4K commands include the following:

- **Resource Control**—Provides direct host control of call routing and digit collection, including voice prompting, setting up conferences, and collecting spoken digits. Additionally, Resource Control commands begin inpulse and outpulse rule processing.
- **Configuration Control**—Allows you to control system operating parameters, including the timing source for digital network interfaces, host alarms, and redundant system control.
- **System Status**—Indicates the current operating status and availability of VCO/4K resources.
- **System Diagnostics**—Allows the host to alter normal call processing functions, such as connecting resources and controlling supervision on network interface ports.
- **System Maintenance**—Allows the host to activate or deactivate individual ports on network interface or service circuit cards.

VCO/4K Reports

VCO/4K reports provide the host with precise, consistent information about events and processes. The system rules, templates, and resource definitions determine the content and timing of a report. VCO/4K reports include the following:

- **Resource Control**—Provides the host with information about events related to call processing, including collected DP, DTMF, MF, and MFCR2 digits, port changes of state, rule processing completion, and exception handling.
- **System Status**—Indicates the operating status and availability of VCO/4K resources and alarm conditions.
- **Configuration Control**—Indicates system operating parameters, including host alarms and redundant system control.

Host Interface

The VCO/4K open architecture supports a wide range of host computers, from micros to mainframes.

Optional VCO/4K Ethernet Communications software enables Ethernet TCP/IP communications between the VCO/4K and one or more host computers. The VCO/4K Ethernet Communications software supports a single physical link with up to eight logical connections (sockets), Telnet access to system administration, and NFS capability for system log and trace files. Because of its rate of data transfer, Ethernet is especially suited to applications with heavy call volumes or ISDN applications.

Use VCO/4K system administration utilities to configure host links.

Maintenance and Diagnostics

VCO/4K system administration provides maintenance and diagnostic utilities to track and isolate system fault conditions. Maintenance and diagnostic utilities include

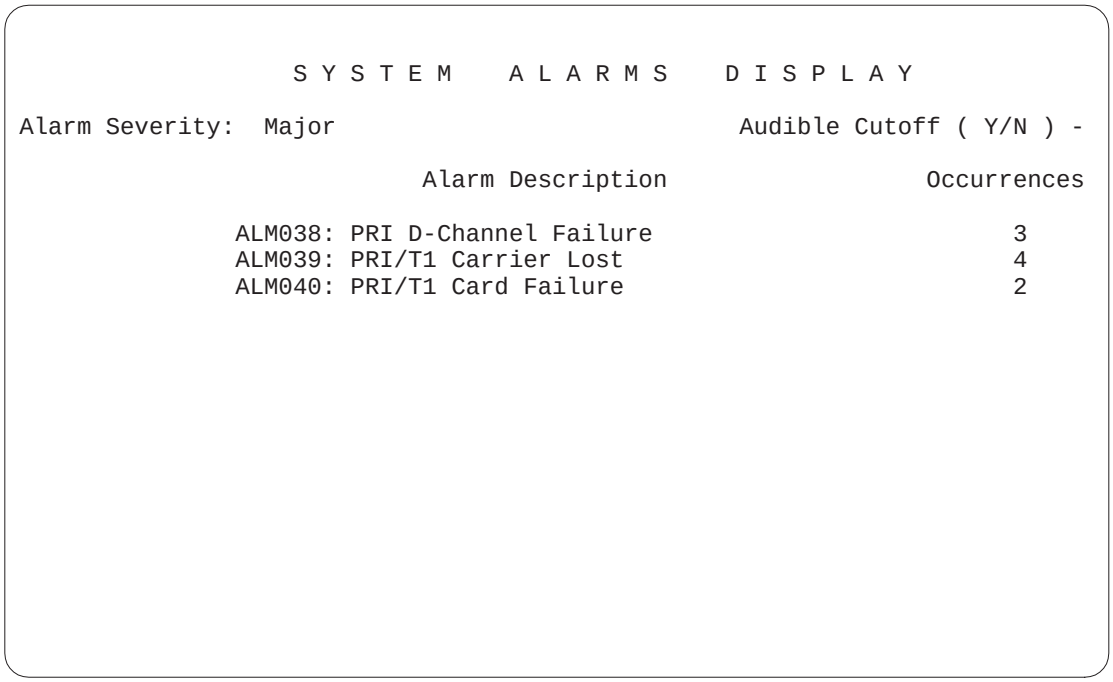
- Menu-driven user-interface
- MS-DOS file system compatibility
- Card and port data display
- Test routines for service circuit cards and network interfaces
- Call progress tone monitoring on network interfaces

The VCO/4K continuously monitors the status of all interfaces and internal components. If a fault is detected, the VCO/4K sends a time-stamped alarm message to the system printer and a logfile to the hard drive and host computer. System alarms include the following:

- Fatal
- Critical
- Major
- Minor
- Aux 1
- Aux 2
- Nonalarmed events

A host command sets and clears Aux 1 and Aux 2 alarms. The VCO/4K tallies the occurrence of each alarm. The alarm count is reset at system initialization. System administration utilities let you view alarms on a system-wide, card, or host-link basis. Figure 3-5 shows a VCO/4K System Alarms Display screen.

Figure 3-5 VCO/4K System Alarms Display



VCO/4K alarm processing is consistent with Bellcore Technical Reference TR-TSY-000474. This reference specifies network maintenance requirements for network elements.

SNMP Network Management

With SNMP agent support, many of the operational functions performed on the system console can be remotely performed with an SNMP network management application.

The VCO/4K SNMP agent conforms to established SNMP Version 1 standards.

CHAPTER 4

Technical Specifications

General System Specifications

This section lists general technical specifications for all VCO/4K systems.

Port Capacity	4,096 maximum
System Call Capacity	Contact the Cisco Systems Technical Assistance Center (TAC) for detailed system capacity information.

Switch Bus Parameters

Voice Encoding Scheme	PCM, -law 255, A-Law, to A and A to conversion A-law with -law to A-law conversion

Measurements of Components

Combined Controller	15.6 in. (39 cm) high 12.1 in. (30.73 cm) deep 1.58 in. (3.95 cm) wide
Power Supply Module	3.0 in. (7.5 cm) high 17.0 in. (42.5 cm) deep 8.0 in. (20 cm) wide
VCO/4K System Enclosure	26.13 in. (67.73 cm) high 22.5 in. (58.57 cm) deep 17.5 in. (45.33 cm) wide Footprint — 22.50 x 17.5 in. (57.15 x 45.33 cm)

Subrack	15.75 in. (40.00 cm) high 13.25 in. (33.70 cm) deep 19.00 in. (48.30 cm) wide
Fan Unit	3.50 in. (8.75 cm) high 7.00 in. (17.50 cm) deep 17.50 in. (43.75 cm) wide

Recommended Clearances

Front — 36.00 in. (90.00 cm)
Rear — 6.00 in. (15.00 cm)
Top — 12.00 in. (30.50 cm)
Side — 12.00 in. (30.00 cm)

Operating Environment

Temperature	40 to 100 F 10 to 40 C
Temperature Gradient	15F (10C) per hour
Relative Humidity	20 to 80 percent (%), noncondensing
Altitude	0 to 10,000 ft 0 to 3,048 m

Shipping Environment

Temperature	–40 to 140F (–40 to 60C)
Temperature Gradient	Below condensing
Relative Humidity	5 to 90%, noncondensing
Altitude	0 to 30,000 ft (0 to 9,144 m)

Storage Environment

Temperature	–4 to 113F (–20 to 45C)
Temperature Gradient	Below condensing
Relative Humidity	5 to 90%, noncondensing
Altitude	0 to 10,000 ft (0 to 3,048 m)

FCC Registration Information

Part 68 Registration Number	B4RUSA-23298-PF-E
Ringer Equivalence	018B

Facility Interface Codes

E+M	TC11M or E	Tie trunk, conventional terminal set, 2-wire, Type I, E+M interface, provides battery on M-lead or ground on M-lead
E+M	TC31M or E	Tie trunk, conventional terminal set, 4-wire, Type I, E+M interface, provides battery on M-lead or ground on M-lead
	TC12M or E	Tie trunk, conventional terminal set, 2-wire, Type II, E+M interface, provides battery on M-lead or ground on M-lead
	TC32M or E	Tie trunk, conventional terminal set, 4-wire, Type II, E+M interface, provides battery on M-lead or ground on M-lead

4xT1	N/A (XD Device)	1.544 Mbps D4F framing format
ICC T1 I/O	04DU9-BN/1SN	1.544 Mbps D4F framing format

Combined Controller Specifications

This section lists specifications for the Combined Controller.

Central Processing Unit Card

Microprocessor	MC68030 (4 MHz)
Memory	16 MB DRAM
Features	Real-time clock with battery backup
	VME bus master
	SCSI bus interface for storage subsystem access/control
Front Panel Switches	RESET — Resets on-board MC68030
	ABORT — Interrupts MC68030
Front Panel Indicators	RUN LED — Normal operation
	FAIL LED — Board failure
	STATUS LED — Microprocessor halt condition
	SCON LED — CPU is system controller
Power Dissipation	20 watts, typical

Switch Interface Card

Memory	64 KB DRAM
DMA Controller	MC68450 (4 MHz)
Power Dissipation	10 watts, typical

Floppy Disk Drive

Formatted Capacity	1.44 megabytes (MB)
Signal Interface	SCSI
Recording Method	MFM
Media Requirement	3.5-in., high-density micro floppy diskettes
Rotational Speed	300 rpm
Read/Write Heads	2 heads
Track Density	135 tracks per in.
Data Transfer Rate	500 kbps
Power Dissipation	15 watts, typical
Form Factor	Half-height

Specifications for Storage/Control I/O Module Assembly

This section lists specifications for the Storage/Control I/O module assembly.

Storage Control I/O Module Interfaces

4 EIA/TIA-232 serial ports (master console and remote maintenance modem)

1 Ethernet transceiver interface

1 Centronics-type parallel interface (system printer)

1 SCSI connector (on CPU-TM front panel–not used)

Hard Disk Drive

Formatted Capacity	270 MB/512 bytes per sector
Signal Interface	SCSI
Recording Method	RLL (2,7)
Spindle Speed	3,600 rpm (0.5%)
Read/Write Heads	6 heads
Disks	3 disks
Track Density	824 tracks per in.
I/O Data Transfer Rate	12 Mbps
Auto Head Park	Yes
Power Dissipation	20 watts, typical
Form Factor	Half-height

Alarm Arbiter Card Specifications

Watchdog Timer Parameters	After reset – 5 to 7 minutes
	Normal operation – 5 to 10 seconds
Alarms:	
Types	Major, Minor, Aux 1, Aux 2 Visual indicators on AAC front panel
External	NO and NC relay contacts provided for each alarm
External Contacts	Type — 2 Form C
	Rating — 0.5A @ 24 VDC, 0.25A @ 120 VAC Resistive load only
Front Panel Switches	A-RESET — Resets left system controller (Side A) B-RESET — Resets right system controller (Side B) SELECT A — Side A system controller always active AUTO — Either system controller can be active SELECT B — Side B system controller always active

Front Panel Indicators	Active A — Side A is active (LED on)
	Active B — Side B is active (LED on)
	ALARMS-MAJOR — Major alarm condition
	ALARMS-MINOR — Minor alarm condition
	ALARMS-AUX1 — Auxiliary alarm 1 condition
	ALARMS-AUX2 — Auxiliary alarm 2 condition
Power Dissipation	24 watts, typical
Form Factor	Eurocard 2

Network Bus Controller (NBC3) Specifications

Microprocessor	MC68360 (25 MHz)
Memory	4 MB DRAM
	256 Kb EPROM
System Synchronization	Clock Input (Ext. or Bus) = 1.544 MHz 75 Hz
External Reference Clock (Bitsclk)	64.0 KHz 3 Hz (Front panel 9-pin male D-sub connector)
Internal Reference Clock	1.544 MHz 50 Hz (complies with Stratum 4 requirements)
Phase Lock Loop	1.544 MHz
Center Frequency	32.768 MHz

Digital Trunk Card Specifications

E1-PRI

Integrated Multipurpose (MP) Processor

Microprocessor	MC68302 (16 MHz)
Memory	64 KB EPROM 256 KB SRAM

Input E1-PRI Stream Specifications:

Format	Common Channel Signaling (CCS) on Time Slot 16 Frame Alignment Signaling on Time Slot 0 Time Slots 1 to 15 and 17 to 31 switchable
Data Transparency	HDB3
Frequency	2.048 MHz 200 Hz
Impedance	75 ohms 10 ohms

Output E1-PRI Stream Specifications:

Format	Common Channel Signaling (CCS) on Time Slot 16 Frame Alignment Signaling on Time Slot 0 Time Slots 1 to 15 and 17 to 31 switchable
Data Transparency	HDB3
Frequency	2.048 MHz 200 Hz
Impedance	75 ohms 10 ohms

E1-CAS

CAS Processor:

Microprocessor	Intel 8032 (12 MHz)
Memory	64 KB EPROM 256 KB SRAM

E1 Stream Specifications:

Format	G.703 & G.732 with CRC framing
Ones Density	HDB3 coding
Frequency	2.048 MHz ± 200 Hz
Impedance	75 ohms 10 ohms unbalanced 120 ohms 10 ohms balanced
Jitter & Wander	Complies with CCITT G.823

T1

Applications	Interface with D3/D4 digital loop carrier systems, including Channel Sender Units (CSUs), digital channel banks and digital switches
I/O Module	15-pin, D-type, male or RJ-45

Packet Processor:

Microprocessor	8031 (12 MHz)
Memory	8 KB EPROM
	2 KB DRAM

Auxiliary Processor:

Microprocessor	8031 (12 MHz)
Memory	8 KB EPROM
Power Dissipation	10 watts, typical
T1 Interfaces Per Card	1
VF Channels Per Card	24 (1 incoming, 1 outgoing stream)

Input Stream Specifications:

Format	Bipolar, D3/D4, DS-1
Drive Capability	0 to 655 ft (0 to 200 m) (22 AWG ABAM cable)
Impedance	100 ohms 10 ohms

Output Stream Specifications:

Format	Bipolar, D3/D4, DS-1
Drive Capability	0 to 655 ft (0 to 200 m) (22 AWG ABAM cable)
Impedance	100 ohms 10 ohms
Line Equalization	Switch selectable pre-emphasis

Programmable Four Span T1

Microprocessor	(4) MC68302, (1) MC68340
Memory	256K per processor SRAM
	64K/68302 EPROM
	128K/68340 EPROM

Input T1 Stream:

Format	D4 or ESF
Data Encoding	Alternate Mark Inversion (AMI)
Data Transparency	Selectable bipolar with 8 zero substitution (B8ZS), Bit 7 zero suppression, or none
Frequency	1.544 MHz 76 Hz
Impedance	100 ohms 10 ohms

Output T1 Stream:

Format	D4 or ESF
Data Encoding	AMI
Data Transparency	B8ZS, Bit 7 zero suppression, or none
Frequency	1.544 MHz 76 Hz
Drive Capability	0 to 655 ft (0 to 200 m) (22AWG ABAM cable)
Impedance	100 ohms 10 ohms
Line Equalization	Switch selectable pre-emphasis

Programmable Four Span E1

Microprocessor	(4) MC68302, (1) MC68340
Memory	256K per processor SRAM
	64K/68302 EPROM
	128K/68340 EPROM
Input E1 Stream:	
Format	CAS/MER CAS/R2 CRC4 CCS/31B
Data Encoding	Alternate Mark Inversion (AMI)
Data Transparency	HDB3
Frequency	2.048 MHz 100 Hz
Impedance	75 ohms 7.5 ohms or 120 ohms 12 ohms
Output E1 Stream:	
Format	CAS/MER CAS/R2 CRC4 CCS/31B
Frequency	2.048 MHz 100 Hz
Impedance	75 ohms 7.5 ohms or 120 ohms 12 ohms
Drive Capability	CCITT Recommendation G.703 for 75 ohm Coax 120 ohm twisted pair

PRI/N Card

Applications	Interface with North American -law Primary Rate (23B+D) stream. Supports D-channel protocol handling of the user side and user side symmetrical. Also supports NFAS. Compatible with Northern Telecom DMS-100 and DMS 250, and AT&T 4ESS and 5ESS implementations.
Microprocessor	MC68032 (16 MHz)
Memory	32KB EPROM 4 MB DRAM
Input Stream Specifications:	
Format	D3/D4 or ESF
Data Transparency	B8ZS
Frequency	1.544 MHz $\pm$ 200 Hz
Impedance	100 ohms $\pm$ 10 ohms
Output Stream Specifications:	
Format	D3/D4 or ESF
Data Transparency	B8ZS
Drive Capability	0 to 655 ft
Impedance	100 ohms $\pm$ 10 ohms

ICC with 16 Span T1 I/O Module

Microprocessor	Power PC, MPC 860, 50 MHz
Memory	16 MB
	8 MB FLASH
Input T1 Stream:	
Format	D4 or ESF
Data Encoding	Alternate Mark Inversion (AMI)
Data Transparency	Selectable bipolar with 8 zero substitution (B8ZS), Bit 7 zero stuff, or none
Frequency	1.544 MHz 76 Hz
Impedance	100 ohms 10 ohms
Output T1 Stream:	
Drive Capability	0 to 655 ft (0 to 200 m) (22 AWG ABAM cable)
Line Equalization	Programmable pre-emphasis

ICC With 16-Span E1 I/O Module

Microprocessor	PowerPC, MPC 860, 50 MHz
Memory	
	16 MB DRAM
	8 MB FLASH
Input E1 Stream:	
Format	CAS/MER CAS/R2 CRC4 CCS/31B Plus Programmable Protocols
Data Encoding	Alternate Mark Inversion (AMI)

Data Transparency	HDB3
Frequency	2.048 MHz 100 Hz
Impedance	120 ohms 12 ohms (75 ohms with optional balun)

Drop and Insert Card

Microprocessor	MC68360
Memory:	1MB DRAM, 72-pin SIMM
	256Kb x 8 EPROM
	2Kb x 8 EEPROM
Data Ports	(Eight identical ports)
	Connector: DB-9 female
	Signals: XMT Clock and Data, RCV Clk and Data
	Levels: EIA/TIA-449/V.35 compatible
Data Options	(Selected per port)
	Speed: Synchronous 56 Kbps or 64 Kbps
	Configuration: DTE or DCE
	Bit Ordering: Normal, Reverse modes
	Test: Loop Back mode
	Operation: Slip and Loss of Clock Detection in DTE mode

Service Circuit Card Specifications

Integrated Prompt and Record Card (IPRC)

Microprocessor	MC68340 (16 MHz)
SCSI Interface	NCR53C94 SCSI Controller
Memory	128 KB EPROM
	2-16 MB DRAM
	7 KB SRAM
Voice Playback/ Record Channels	8 playback/4 record ports 64 playback/32 record ports 128 playback/32 record ports
Max Prompt Time	35 minutes
Voice Encoding Method	64 Kbps Pulse Code Modulation (PCM)

Service Platform Card (SPC)

Microprocessor	PowerPC, MPC 860, 50 MHz
Memory	16 MB DRAM
SRM Location	4
Bandwidth	504 per SRM or 2012 per SPC

Service Resource Module (SRM)

Microprocessor	(8) T1 TMS320C548 (66 MHz)
Memory	(8) 96K SRAM
SRM Location	4
Algorithms	DTMF Detection, Tone Generation, Conferencing, Call Progress Analysis, MF Reception, MFCR2 Processing

Power Supply Module Specifications

Input Voltages	–48 VDC, Dual –48 VDC, 120 VAC, or 240 VAC (50/60 Hz)
Output Voltages	
	+5 VDC
	+15 VDC
	–15 VDC
	+12 VDC
	+24 VDC
	–48 VDC
Spare Fuse Kit	Two replaceable 25-amp fuses for the power supply module Four replaceable 30-amp fuses for the power entry module
Power LED	Power switch off—LED not illuminated Power switch on—LED turns green (normal operation) Power switch on—LED turns red (replace power supply module) Power switch on—LED not illuminated (replace a fuse or the power supply module)

Signaling

The following tables list basic signal and tone information for VCO/4K. For further information, refer to the appropriate country tone feature package for your VCO/4K system or contact your Cisco Systems sales representative.

Table 4-1 Tone Plan for North American Digital Tone Generation

Frequencies	Level[1]	Tone
941 Hz + 1336 Hz	–7 dBm/freq	DTMF 0
697 Hz + 1209 Hz	–7 dBm/freq	DTMF 1
697 Hz + 1336 Hz	–7 dBm/freq	DTMF 2
697 Hz + 1447 Hz	–7 dBm/freq	DTMF 3
770 Hz + 1209 Hz	–7 dBm/freq	DTMF 4
770 Hz + 1336 Hz	–7 dBm/freq	DTMF 5
770 Hz + 1447 Hz	–7 dBm/freq	DTMF 6
852 Hz + 1209 Hz	–7 dBm/freq	DTMF 7
852 Hz + 1336 Hz	–7 dBm/freq	DTMF 8
852 Hz + 1447 Hz	–7 dBm/freq	DTMF 9

Table 4-1 Tone Plan for North American Digital Tone Generation (continued)

Frequencies	Level[1]	Tone
697 Hz + 1633 Hz	–7 dBm/freq	DTMF A
770 Hz + 1633 Hz	–7 dBm/freq	DTMF B
852 Hz + 1633 Hz	–7 dBm/freq	DTMF C
941 Hz + 1633 Hz	–7 dBm/freq	DTMF D
941 Hz + 1209 Hz	–7 dBm/freq	DTMF *
941 Hz + 1477 Hz	–7 dBm/freq	DTMF #
1300 Hz + 1500 Hz	–7 dBM/freq	MF 0
700 Hz + 900 Hz	–7 dBM/freq	MF 1
700 Hz + 1100 Hz	–7 dBM/freq	MF 2
900 Hz + 1100 Hz	–7 dBM/freq	MF 3
700 Hz + 1300 Hz	–7 dBM/freq	MF 4
900 Hz + 1300 Hz	–7 dBM/freq	MF 5
1100 Hz + 1300 Hz	–7 dBM/freq	MF 6
700Hz + 1500 Hz	–7 dBM/freq	MF 7
900 Hz + 1500 Hz	–7 dBM/freq	MF 8
1100 Hz + 1500 Hz	–7 dBM/freq	MF 9
1100 Hz + 1700 Hz	–7 dBM/freq	MF KP
1500 Hz + 1700 Hz	–7 dBM/freq	MF ST
700 Hz + 1700 Hz	–7 dBM/freq	MFSTP3P
900 Hz + 1700 Hz	–7 dBM/freq	MFSTP
1300 Hz + 1700 Hz	–7 dBM/freq	MFST2P
–	–	Quiet
350 Hz + 440 Hz	–19 dBm/freq	Dial tone
440 Hz + 480 Hz	–19 dBm/freq	Ringback (steady)
480 Hz + 620 Hz	–24 dBm/freq	Busy tone
380 Hz	–10 dBm	Digit trip
440 Hz	–13 dBm	
480 Hz	–17 dBm	High tone
920 Hz	–13 dBm	
1400 Hz	–24 dBm	
1760 Hz	–10 dBm	Pay phone trigger tone
1000 Hz	0 dBm	CCITT tone
1000 Hz	Max output	Test tone
404 Hz	0 dBm	Test tone
1004 Hz	0 dBm	Test tone
2804 Hz	0 dBm	Test tone

Table 4-1 Tone Plan for North American Digital Tone Generation (continued)

Frequencies	Level[1]	Tone
440 Hz + 480 Hz	–19 dBm/freq	Ringback (2 sec ON/4 sec OFF)
480 Hz + 620 Hz	–24 dBm/freq	Busy (.5 sec ON/.5 sec OFF)
480 Hz + 620 Hz	–24 dBm/freq	Reorder (.25 sec ON/.25 sec OFF)
380 Hz		NAK (1 sec ON/1 sec OFF)
–	–10 dBm/freq starting level	Cyclic bong tone (repeated every 3.25 sec)
1780 Hz	–12 dBm	ISUP continuity test tones
2010 Hz	–12 dBm	ISUP continuity test tones

1. All levels are relative to system 0 TPL.

Table 4-2 CCITT, Q.441-R2 Signaling Group I Forward Signals

Comb.	Desig.	Frequencies	Meaning[1]	Meaning[2]
1	I-1	1380 + 1500 Hz	Language Digit: French	Digit 1
2	I-2	1380 + 1620 Hz	Language Digit: English	Digit 2
3	I-3	1500 + 1620 Hz	Language Digit: German	Digit 3
4	I-4	1380 + 1740 Hz	Language Digit: Russian	Digit 4
5	I-5	1500 + 1740 Hz	Language Digit: Spanish	Digit 5
6	I-6	1620 + 1740 Hz	Language Digit: (Spare)	Digit 6
7	I-7	1380 + 1860 Hz	Language Digit: (Spare)	Digit 7
8	I-8	1500 + 1860 Hz	Language Digit: (Spare)	Digit 8
9	I-9	1620 + 1860 Hz	Spare: (Discriminating Digit)	Digit 9
10	I-10	1740 + 1860 Hz	Discriminating Digit	Digit 0
11	I-11	1380 + 1980 Hz	Country Code Indicator, outgoing half-echo suppressor required	Access to incoming operator (Code 11).
12	I-12	1500 + 1980 Hz	Country Code Indicator, no echo suppressor required	Access to delay operator (Code 12). Request not accepted.
13	I-13	1620 + 1980 Hz	Test Call Indicator (Call by automatic test equipment)	Access to test equipment (Code 13). Satellite link not included.
14	I-14	1749 + 1980 Hz	Country Code Indicator, outgoing half-echo suppressor required	Incoming half-echo suppressor required. Satellite link included.
15	I-15	1860 + 1980 Hz	Not used	End-of-pulsing (Code 15). End of identification.

1. When the signal is the first transmitted on an international link terminating in the destination country of the call.
2. When the signal is other than the first signal on an international link.

Table 4-3 CCITT, Q.441-R2 Signaling Group II Forward Signals

Comb.	Designation	Frequencies	Meaning	Notes
1	II-1	1380 + 1500 Hz	Subscriber without priority	National Use Only
2	II-2	1380 + 1620 Hz	Subscriber with priority	
3	II-3	1500 + 1620 Hz	Maintenance equipment	
4	II-4	1380 + 1740 Hz	Spare	
5	II-5	1500 + 1740 Hz	Operator	
6	II-6	1620 + 1740 Hz	Data transmission	

Table 4-3 CCITT, Q.441-R2 Signaling Group II Forward Signals (continued)

Comb.	Designation	Frequencies	Meaning	Notes
7	II-7	1380 + 1860 Hz	Subscriber (or operator without forward transfer facility)	International Use Only
8	II-8	1500 + 1860 Hz	Data transmission	
9	II-9	1620 + 1860 Hz	Subscriber without priority	
10	II-10	1740 + 1860 Hz	Operator with forward transfer facility	
11	II-11	1380 + 1980 Hz	Spare for National Use	
12	II-12	1500 + 1980 Hz		
13	II-13	1620 + 1980 Hz		
14	II-14	1749 + 1980 Hz		
15	II-15	1860 + 1980 Hz		

Table 4-4 CCITT, Q.441-R2 Signaling Group A Backward Signals

Comb.	Designation	Frequencies	Meaning
1	A-1	1140 + 1020 Hz	Send next digit (*n*+1)
2	A-2	1140 + 900 Hz	Send last but one digit (*n*-1)
3	A-3	1020 + 900 Hz	Address-complete, change over to reception of Group B signals
4	A-4	1140 + 780 Hz	Congestion in the national network
5	A-5	1020 + 780 Hz	Send calling party's category
6	A-6	900 + 780 Hz	Address-complete, charge, set-up speech conditions
7	A-7	1140 + 660 Hz	Send last but two digit (*n*-2)
8	A-8	1020 + 660 Hz	Send last but three digit (*n*-3)
9	A-9	900 + 660 Hz	Spare (*for national use*)
10	A-10	780 + 660 Hz	Spare (*for national use*)
11	A-11	1140 + 540 Hz	Send country code indicator
12	A-12	1020 + 540 Hz	Send language or discriminating digit
13	A-13	900 + 540 Hz	Send nature of circuit
14	A-14	780 + 540 Hz	Request for information on use of echo suppressor
15	A-15	660 + 540 Hz	Congestion in an international exchange or at its output

Table 4-5 CCITT, Q.441-R2 Signaling Group B Backward Signals

Comb.	Designation	Frequencies	Meaning
1	B-1	1140 + 1020 Hz	Spare (for national use)
2	B-2	1140 + 900 Hz	Send special information tone
3	B-3	1020 + 900 Hz	Subscriber line busy
4	B-4	1140 + 780 Hz	Congestion (encountered after change over from Group A to Group B signals)
5	B-5	1020 + 780 Hz	Unallocated number
6	B-6	900 + 780 Hz	Subscriber’s line free, charge
7	B-7	1140 + 660 Hz	Subscriber’s line free, no charge
8	B-8	1020 + 660 Hz	Subscriber’s line out of order
9	B-9	900 + 600 Hz	Spare (for national use)
10	B-10	780 + 660 Hz	
11	B-11	1140 + 540 Hz	
12	B-12	1020 + 540 Hz	
13	B-13	900 + 540 Hz	
14	B-14	780 + 540 Hz	
15	B-15	660 + 540 Hz	