EXHIBIT 3

Section 2.1033 (c)(3) INSTALLATION AND OPERATING INSTRUCTIONS

A copy of the installation and operating instructions to be furnished the user. A draft copy of the instructions may be submitted if the actual document is not available. The actual document shall be furnished to the FCC when it becomes available.

Response

A copy of the "AUTOPLEX Cellular Telecommunications Systems, System 1000, Series II Cell Site Description, Operation, and Maintenance" manual is attached to this exhibit.

This is the manual for the Series II cell site with EDRU transceivers. Because the SBEDRU is backward compatible to the EDRU, this manual is also applicable to the SBEDRU. Therefore, Lucent Technologies will not issue a new manual. Customers using the SBEDRU will be provided with this current document.

Lucent Technologies
Bell Labs Innovations

AUTOPLEX® Cellular Telecommunications Systems System 1000

Series II Cell Site

Description, Operation, and Maintenance

401-660-100
Issue 11
August 2000

Notice

Every effort was made to ensure that the information in this document was complete and accurate at the time of printing. However, information is subject to change.

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AUTOPLEX Cellular Telecommunications Systems System 1000 Series II Cell Site Description, Operation, and Maintenance

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Introduction

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Contents

Introduction

General

This document has been made current to Executive Cellular Processor (ECP) Release 14.0.

Organization

The contents of each chapter in this document are described in the following list.

- Chapter 2 introduces the user to the Cell Site architecture and its interaction with other parts of the system, the availability and use of bandwidth, the call handling process, and the advantages of Series II hardware and software.
- Chapter 3 is a detailed look as the Time Division Multiple Access (TDMA) system, so that the new-hire, manager, or engineer obtains an in-depth understanding of TDMA technology and why, when, where, and how to implement it.
- Chapter 4 is a detailed look as the Code Division Multiple Access (CDMA) system, so that, again, the new-hire, manager, or engineer obtains an in-depth understanding of CDMA technology and why, when, where, and how to implement it.
- Chapter 5 introduces a new product, the CDMA Adjunct to Small Cells, which is used to add CDMA capability to the Series IIm (Minicell) and Series IImm (Microcell).
- Chapter 6 covers the Cellular Digital Packet Data (CDPD) service, which enables the service provider to offer wireless data services. Several CDPD configurations are offered in this chapter.
- Chapter 7 covers other technology options available for the Series II system. Including the use of fiberoptics and the subdivision of cellular systems into mini or micro systems for situations such as filling in spots missed by the larger cellular system or for the use of cellular systems within a restricted environment, such as an office building.

For those that need equipment specifications for Cell Site engineering, to order equipment, or to obtain a general knowledge of the hardware used in the Series II Cell Site, the following chapters offer a general look at every piece of hardware used at the Cell Site.

- Chapter 8 describes and offers equipment specifications, ordering codes, and interconnections with other equipment, for every piece of hardware (except radios) at the Cell Site.
- Chapter 9 contains detailed technical descriptions of every radio capable of being used in the Cell Site, how each radio operates, and its call-handling capacity. All radios, AMPS, TDMA, and CDMA, are explained.
- Chapter 10 describes antenna configurations and their interaction with Cell Site radios.

- Chapter 11 describes Cell Site hardware at a functional level, the interconnections on each unit, and their interconnectivity with other units.

For operations and maintenance personnel, the following chapters describe the function and operation of all Series II equipment, and different aspects of its maintenance (i.e., test, restore, remove, replace).

- Chapter 12 offers detailed and step-by-step procedures to perform routine and FCC-mandated maintenance tests.
- Chapter 13 describes enhanced maintenance features that have been added to the Series II Cell Site, such as the improved Boot Read-Only-Memory / Non-Volatile Memory Update. This feature enables a radio to identify its hardware type and prevent the downloading of firmware belonging to a different radio hardware type.
- Chapter 14 explains the three major maintenance tools available to the Cell Site Technician, describes and lists all maintenance units, and defines the maintenance states that a unit can take on.
- Chapter 15 has detailed and step-by-step procedures for using the Maintenance Request Administrator (MRA) to perform diagnostic and trouble maintenance.
- Chapter 16 has detailed and step-by-step procedures for using Status Display Pages to perform diagnostic and trouble maintenance.
- Chapter 17 has detailed and step-by-step procedures for using the Executive Cellular Processor (ECP) craft interface to perform diagnostic and trouble maintenance.

The different tools and procedures described in the chapters above allow the technician to choose the maintenance tool he is most comfortable with and, greatly improve both the learning and productivity curve.

- Chapter 18 details all Cell Site alarms, their meaning, and the appropriate response(s) the technician should make.
- Chapter 19 details all Cell Site Light Emitting Diodes (LEDs), their meaning, and the appropriate response(s) the technician should make.
- Chapter 20 is a logical-to-hardware mapping of all maintenance units and is useful in helping the technician find the physical location of any diagnostic or maintenance unit.
- Chapter 21 is dedicated to CDMA-specific maintenance because CDMA units are different enough from the analog/digital units used in AMPS/TDMA that they merit particular attention.
- Chapter 22 is dedicated to the maintenance of the Linear Amplifier Circuit (LAC), a complex and extremely important piece of Cell Site hardware.

Please refer to Lucent Technologies Practice 401-660-125 for a full description of the Modular Linear Amplifier Circuit (MLAC) J-41660CA-3.

We hope that you find this reorganization of the document useful and easy to read.

Introduction to Series II Cell Technology

2

Contents

Introduction

Overview

The Series II platform accommodates three multiple-access methods, one analog and two digital, described below.

- **Frequency Division Multiple Access (FDMA) -**
  Subscribers are separated by frequency. Frequency Division Multiple Access (FDMA) is the implementation of narrowband channels, each carrying one telephone circuit, in a system where any mobile station can access any one of the frequencies. Existing *analog* cellular communications systems use FDMA.

  The Series II FDMA technology is Advanced Mobile Phone Service (AMPS)* which conforms to the Electronic Industries Association (EIA) / Telecommunications Industry Association (TIA) 553 standard. The allocated spectrum is divided into 30-kHz channels, where each channel can carry a single call.

- **Time Division Multiple Access (TDMA) -**
  Subscribers are separated by frequency and time. Time Division Multiple Access (TDMA) is an architecture in which each carrier frequency is divided into a number of timeslots, each of which constitutes an independent telephone circuit. Existing *digital* cellular communications systems use TDMA.

  The Series II TDMA technology conforms to the TIA IS-54 standard. The technology can serve three simultaneous calls on an existing 30-kHz AMPS channel, thereby increasing capacity by threefold.

- **Code Division Multiple Access (CDMA) -**
  Subscribers are separated by digital code. Code Division Multiple Access (CDMA) is a form of multiple access used in spread-spectrum wideband systems. It is based on the principle that each subscriber is assigned a unique code that can be used by the system to distinguish that user from all other users transmitting simultaneously over the same frequency band.

  The Series II CDMA technology conforms to the TIA IS-95 standard. The projection is that CDMA will increase the capacity of the current AMPS system by as much as ten-fold.

* Throughout this document, AMPS will be used to mean analog radios or analog service.

Advanced Mobile Phone Service (AMPS)

With AMPS, the entire allocated cellular frequency spectrum, 825-890 MHz, is divided into a number of 30-kHz channels, each with its specific carrier frequency. These carrier frequencies operate in pairs; each pair is assigned a unique RF channel number. One carrier frequency of the pair is used for transmission from the Cell Site to the mobile station (forward channel), while the other is used for transmission from the mobile station to the Cell Site (reverse channel). The transmit and receive frequencies are separated by 45 MHz.

From the beginning, the FCC has encouraged competition in the cellular radio market by allocating available frequency spectrum to two classes of operators:

- The nonwireline companies (such as radio common carriers) also known as *System A* - is allocated frequencies from spectrum for System A is (known as *block A*, which consists of the A, A', and A" bands
- The local wireline telephone companies, also known as *System B* - is allocated frequencies from the spectrum for System B (known as *block B)*, which consists of the B and B' bands.

Normally, RF channels 313 through 354 are reserved for use as control channels: 21 control channels for System A, and 21 control channels for System B. These channels, also called setup channels, are used to establish calls and to perform control functions. The remaining channels, 395 for System A and 395 for System B, are the voice channels. Each voice channel can carry a single call.

Time Division Multiple Access (TDMA)

TDMA Description

TDMA can accommodate both analog and digital cellular technologies (see Figure 2-1). The digital cellular technology, like Time Division Multiple Access (TDMA) radio technology, provides increased spectral efficiency, system performance improvements (high-quality speech in areas of low signal strength), entirely digital transmission, new and more flexible services, and increased channel privacy compared to analog technology. In the same number of radio slots used by Radio Channel Units (RCUs), half as many Digital Radio Units (DRUs) achieve a 50% increase in the number of radio channels. In addition, if DRUs are replaced with Enhanced DRUs (EDRUs), there are the same number of channels using half as many radio slots on the radio shelf. The EDRU takes up only 1 slot on the radio shelf versus the 2 that the DRU takes up.

TDMA Call Processing

The Telecommunications Industry Association (TIA) has prepared an interim standard (IS-54A) that defines technical requirements for cellular telecommunications systems. This standard provides radio system parameters and call processing procedures for both analog and digital radios to ensure complete compatibility with dual-mode (analog and digital) mobile and single-mode (analog only) mobile stations. The TDMA feature complies with this standard.

In addition, TDMA DCCH complies with EIA/TIA Standard IS-136 *Cellular System Dual-Mode Mobile Station Base Station: Digital Control Channel* that is available from the Electronic Industries Association. DCCH supports IS-136 mobiles that use DCCH to access the system.

The following call processing features are part of the TDMA feature.

- Dual Mode Mobile Station (DMMS) - TDMA works with a DMMS. The TDMA DMMS has allowable-call modes of analog only, TDMA (digital) only, and analog or TDMA. TDMA also supports IS-136 mobiles that access the system over the DCCH.
- Mobile-Assisted HandOff (MAHO) Feature - All TDMA mobile units are designated to assist in the handoff process. The TDMA mobile unit is sent a list of neighbor sectors on which to make signal strength measurements.
- Setup Channels - TDMA uses the same analog setup channels as in the Series II Cell Site. To set up digital channels, TDMA uses the DCCH.
- Locate Function - The locate radios may be analog. TDMA also supports the digital locate function for DRUs and EDRUs.
- Beacon Channel Feature - The beacon channel is a voice radio, analog or digital, which always has its carrier turned on and set at a fixed power level. The beacon channel can be used for voice communications, but the carrier

power level remains fixed. The beacon channel provides a means for the TDMA and TDMA DMMS mobiles to measure signal strength during the handoff process. Series I Cell Sites in a Series II TDMA service area also provide a beacon channel per antenna sector for the benefit of TDMA customers.

Unique software is required for implementation of the TDMA feature. This section briefly addresses the major differences from the analog system in call processing, administration, maintenance, and service measurement software.

All call processing for DRUs is based on logical channels; that is, digital traffic channels rather than physical radio units. The DMMSs communicate with the Cell Site over a 30-kHz analog setup channel. Thus, the mobile station is required to be tuned to an analog setup channel when not in the conversation state. Mobile originations and page response messages are transmitted to and received from the Cell Site over the analog setup channel. Location measurements on digital voice channels will be performed using mobile-assisted handoff (as defined in IS-54A).

The following five handoff scenarios are supported:

1. Analog to analog
2. Analog to digital
3. Digital to digital
4. Digital to analog
5. DCCH InterHyperband handoff

For more information on DCCH InterHyperband Handoff, please see Lucent Technologies Practices Optional Feature document 401-612-118, *DCCH Interhyperband Operation Phase 1 & 2.*

Communication From TDMA Cell Site to TDMA Subscriber Unit

The Time Division Multiplexed (TDM) bus, which should be installed "red stripe up," sends m-law Pulse Code Modulation (PCM) encoded voice to the echo cancelers, and then to the speech coder in the DRU or EDRU. The speech from the TDM bus is coded using the algorithm known as Code Excited Linear Predictive (CELP) Coding. Then the bits are transferred to the associated channel coder.

The encoded speech is further encoded for protection by a three-step process. First, the most significant bits are coded with a Cyclic Redundancy Check (CRC). Then, these bits, with the other class-1 bits, are protected with a convolutional error correction code. Finally, the data is spread within one time slot.

From the channel coder, the signal is sent along with the other two channels to the modulator. Once at the modulator, the bits are modulated using Deferentially Encoded Quadrature Phase Shift Keying (DQPSK) and are sent to the transmitter.

At the transmitter, the digitally modulated RF signals are sent to the antenna and ultimately to the subscriber unit..

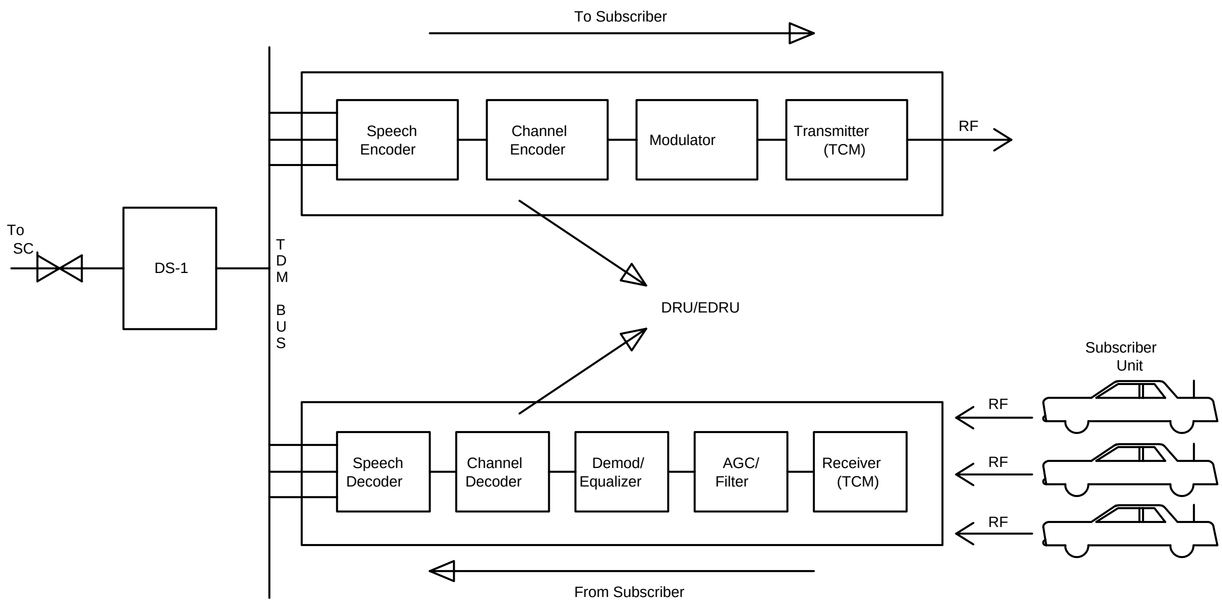

Figure 2-1. TDMA - DRU/ EDRU To/From Subscriber

Communication From TDMA Subscriber Unit to TDMA Cell Site

The receiver in the DRU or EDRU receives digitally modulated RF signals from the subscriber unit and translates them back to baseband frequency. The signals first proceed through a low-pass filter to cut out high frequencies and alias signals, and through an Automatic Gain Control (AGC) to control the signal strength. The waveforms are then sent to the demodulator, where the signals are synchronized and equalized. Then, the demodulated bits are sent to the channel decoder. Upon arriving, data is de-interleaved and decoded. The convoluted encoded bits are CRC-checked for error detection and then transferred to the speech decoder. The speech decoder takes the data and generates the received speech signal, which is transferred to the TDM bus as m-law PCM encoded voice.

Code Division Multiple Access (CDMA)

This section provides an overview of the Series II Cell Site hardware used to support the Code Division Multiple Access (CDMA) application.

CDMA is a method that increases voice traffic on the existing cellular frequency spectrum. CDMA is defined within the IS-95 document, which was produced by the Telecommunications Industry Association (TIA) TR45.5 Subcommittee on Wideband Spectrum Digital Technology.

CDMA uses a direct sequence spread spectrum technology. Within this technology, radio signals are spread across a single 1.23 MHz-wide frequency band. Individual calls are modulated by the three unique Pseudo-random Number (PN) codes during transmission and decoded using those three codes during reception. Signals that do not contain the code matches are treated as noise and ignored. By using this method, a large number of CDMA calls may occupy the same frequency spectrum simultaneously.

One of many benefits of CDMA is that it is virtually impossible to monitor a CDMA call in progress unless all three PN codes are known.

CDMA Cell Site Description

The Series II Cell Sites providing CDMA service (see Figure 2-2) must be equipped with a Global Positioning System (GPS) receiver, associated Synchronized Clock and Tone (SCT) boards, and a Digital Facilities Interface (DFI).

The GPS equipment provides precise timing of data packets between the 5ESS-2000 Switch DCS and the Series II Cell Site. The GPS also provides precise timing for the 20-ms packets transmitted by the CDMA radios. The SCT boards are added to the TDM bus (which should be installed "red stripe up"). The DFI is required for CDMA packet pipes.

All CDMA trunks must be located in the 5ESS-2000 Switch DCS but AMPS and TDMA trunks can still be located in a DEFINITY Switch DCS.

The remaining new circuitry consists of the CDMA Radio Module (CRM), that serves one face. The CRM is located on the CDMA radio shelf. The CRM will be discussed in detail later in this document. The basic RF combiners, Linear Amplifier Frame (LAF) and filter assemblies have not changed from the AMPS/ TDMA Series II Linear Amplifier Circuits (LACs) in existing systems require a Version 6 or higher firmware upgrade.

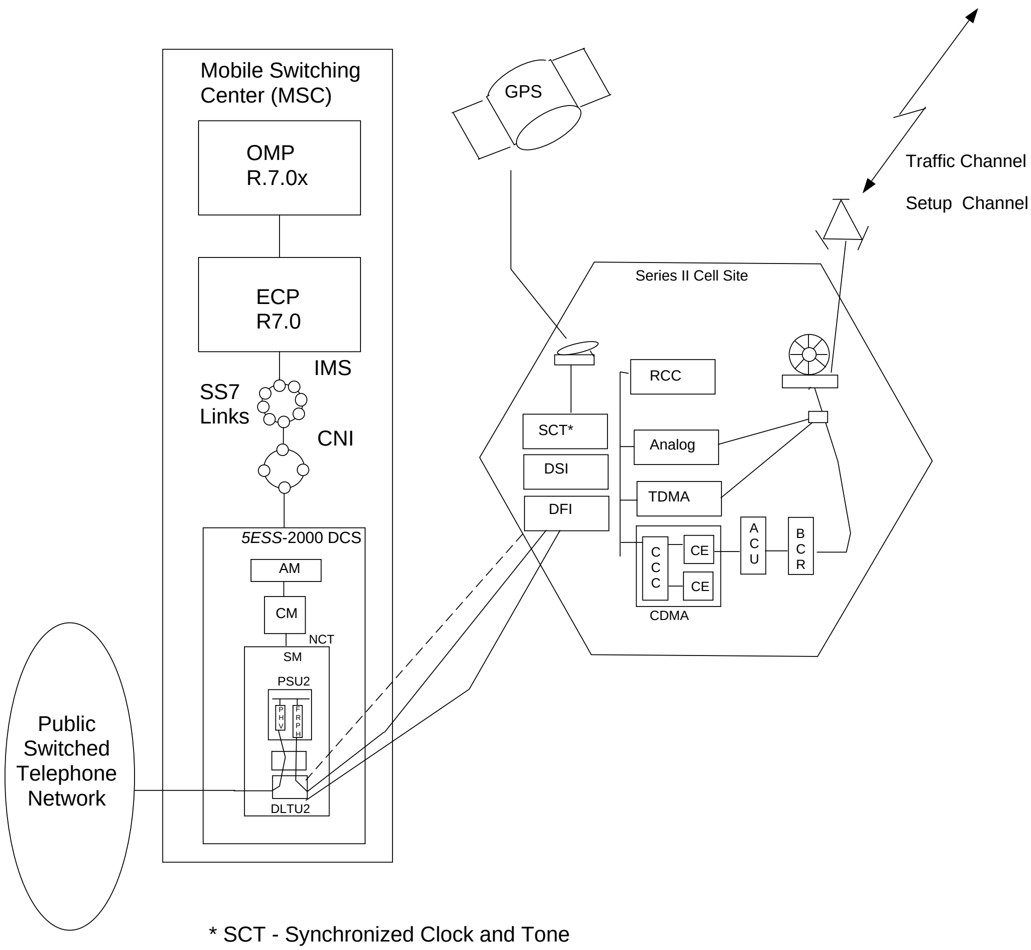

Figure 2-2. CDMA System Components

There are three types of equipment shelves on the CDMA Growth Radio Frame (CGRF). These shelves are listed below.

1. **The interconnect panel** is used to distribute the 15-MHz reference frequency from the Reference Frequency Timing Generation (RFTG) to the radio shelves, and to interconnect CDMA radio equipment to both existing transmit and receive antenna faces.
2. **CDMA radio shelves** (numbered 0 through 5 from top to bottom) which contain the following equipment:
   — Power converters that require +24 volt, 45 amp. feeder and return

— One or two CDMA Cluster Controllers (CCCs) - each CCC contains 7 CDMA Channel Units (CCUs)

— As many as 14 CCUs - each CCU contains two CEs (8-kbps vocoders)

— One or two Baseband, Bus and Analog (BBA) trio circuits

NOTE:
For CDMA 1.0, there is one radio shelf per antenna face. Because CDMA 1.0 supports omni, two-sector, and three-sector cells, there may be one, two, or three CDMA radio shelves. Additional shelves will be supported in future CDMA releases.

Cellular Frequency Spectrum Allocation

The Series II platform can support a hybrid of AMPS, TDMA, and CDMA technologies within the same cellular system. The radio technologies share Cell Site resources and cellular frequency spectrum.

In North America, the Federal Communications Commission (FCC) has allocated a total of 25 MHz for mobile-to-cell-site communication and 25 MHz for cell-site-to-mobile communication for the provision of cellular services. The FCC has divided this allocation equally between two service providers, the wireline (block B) and non-wireline (block A) carriers, in each service area.

To accommodate CDMA, the entire cellular frequency spectrum is divided into ten 1.23-MHz wideband channels.

Each channel is assigned a number, and the channel numbers denote 30-kHz channels. Because of the order in which allocations were made, the 12.5 MHz allocated to each carrier for each direction of the link is further subdivided into two sub-bands. For the wireline carriers (block B), the sub-bands are 10 MHz (B band) and 2.5 MHz (B' band). For the non-wireline carriers (block A), the sub-bands are 11 MHz (A band + A" band) and 1.5 MHz (A' band). A single bandwidth of less than 1.5 MHz could fit into any of the sub-bands, while a bandwidth of less than 2.5 MHz could fit into all but one sub-band.

Thus, in order to preserve maximum flexibility in matching the CDMA technology to the available frequency spectrum, the CDMA digital cellular waveform design must be less than 1.5 MHz in bandwidth.

A set of ten 1.23-MHz bandwidth wideband channels, referred to as *CDMA carriers*, would be used if the entire cellular frequency spectrum were converted over to CDMA. In the interim, only a small number of 1.23-MHz channels need to be removed from the current analog service to provide digital service.

The center RF channel numbers, or center frequencies, of the primary and secondary CDMA carriers are specified in the TIA IS-95 standard. The center RF channel numbers of other CDMA carries are not specified in the TIA IS-95 standard, but are chosen by the individual service providers.

Because some frequency guard band is necessary if there are adjacent high-power cellular (or other) frequencies in use, adding an initial CDMA carrier to an existing AMPS system requires removing 59 adjoining AMPS channels (1.77 MHz of frequency spectrum). Since adjacent CDMA carriers need not employ a guard band, adding a second CDMA carrier would only require removing 43 AMPS channels.

Advantages of Series II Hardware and Software

A number of the advantages of Series II hardware and software are listed below.

- **Channel capacity**. Up to 200 Radio Channel Units (RCUs), including setup, locate, and voice. About 195 can be used for voice.
- **6-Sector configuration**. Single antenna, omni, three- or six-sector configuration. Up to seven transmit antennas, as defined by user, diversity receive antennas, and optional built-in duplexers.
- **Compatible with Series I**. Can be used in the same system with Series I Cell Sites.
- **All digital interfaces**. All data and voice communications between the MSC and Cell Site is by Digital Signal level 1 (DS1) interfaced facilities. The Digital Cross-Connect (DSX-1) interface between the DS1 and cross connect panel provide the radio frame connections and eliminate the need for D4 channel banks.
- **Programmable radio channels**. Programmable radio channels eliminate the need for manual tuning of cavity combiners or the setting of Dual In-line Package (DIP) switches.
- **Combine any channels**. No separation restrictions on channels combined.
- **Downloading of power levels and channel assignments**. Downloading of power levels and channel assignments can be accomplished from a single location, such as the MSC.
- **Less maintenance**. Fewer replaceable parts; most faults are software-detectable. Limited inventory spares needed.
- **Easy update to digital channels**. Series II positions the system to support digital radio technology with minimum cost, effort, and replacement of equipment. RCU slots accommodate both analog and DRUs and EDRUs. Analog and digital radios may be mixed on a slot-by-slot basis.

Cell Site Equipment Functional Overview

Equipment Frames

The equipment frames used in Series II Cell Sites (Figure 2-3) and their dimensions are given below.

- **Radio Channel Frame (RCF) -** 26" wide by 20" deep by 80.5" high, total height = 70" (to top of main bay) + 10" (interconnect panel)

  The Series II radio channel equipment is housed in cabinets. The Radio Channel Frame (RCF) has openings on the side for interframe wiring of the Time Division Multiplexed (TDM) bus, which should be installed "red stripe up". Control and data are transferred over the TDM bus. These frames are installed side by side so that they may be interconnected by one TDM bus, if there are two frames, or two TDM buses, if there are three frames. Cabinet covers are removable for maintenance, allowing easy access to the equipment without requiring the clearance space needed to open hinged doors. The Radio Frame Set (RFS) consists of one, two, or three RCFs. The first RCF is the P-RCF (RCF 0), the other two RCFs are "growth" RCFs (RCF 1 and RCF 2).

- **Linear Amplifier Frame (LAF) -** Same dimensions as RCF. One or two Linear Amplifier Frames (LAFs)are provided per Cell Site.
- **Antenna Interface Frame (AIF) -** 26" wide by 20" deep by 84" high. Antenna interface equipment accommodates up to seven antenna faces, thus permitting implementation of omni-only, three-sector/120-degree, six-sector/60-degree, or other special antenna configurations. One or two Antenna Interface Frames (AIFs) are provided per Cell Site.

The Series II Cell Site equipment frames have greater hardware capacity, are more compact, and allow more flexibility than Series I equipment.

The equipment code for the equipment frames mentioned above are identified below.

- Radio Channel Frame (Primary) J41660A-1 or J41660A-2 (UL* Listed) *
- Radio Channel Frame (Growth) J41660B-1 or J41660A-2 (UL* Listed)
- Linear Amplifier Frame (Primary) J41660C-1 or J41660A-2 (UL* Listed)
- Antenna Interface Frame (Primary) J41660E-1 or J41660A-2 (UL* Listed)
- Antenna Interface Frame (Growth) J41660F-1 or J41660A-2 (UL* Listed)
- Facilities Interface Frame J41660G-1 or J41660A-2 (UL* Listed)

* Registered trademark of Underwriters Laboratories, Inc.

- Optical Interface Frame J41660H-1

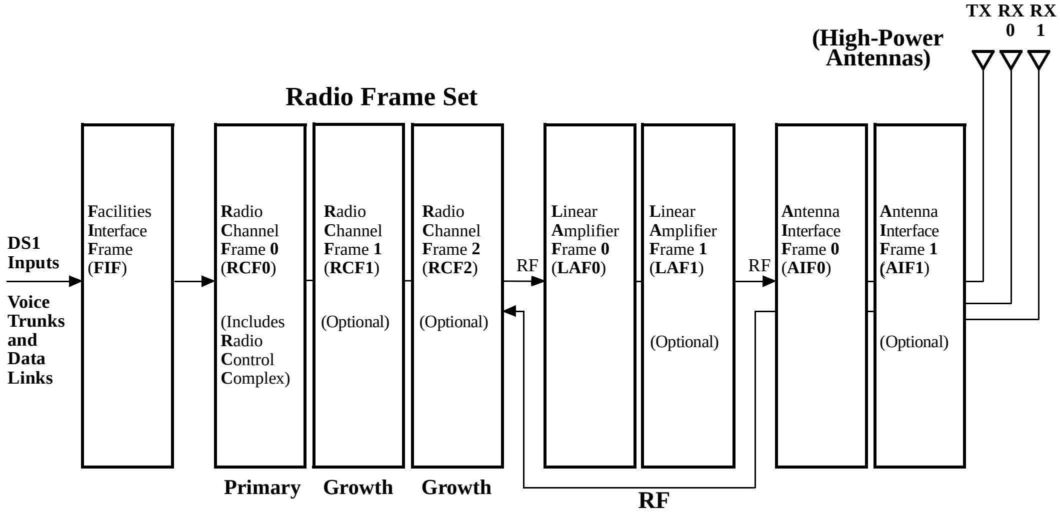

Figure 2-3. Cell Site Architecture

Radio Channel Frames and Radio Equipment Functional Overview

The *radio frame set* (Figure 2-4) consists of a primary RCF and up to two growth RCFs connected by one or two Time-Division Multiplexed (TDM) buses (which should be installed "red stripe up") and controlled by the primary RCF. The primary RCF is unique in that it contains the Cell Site controller (the Radio Control Complex [RCC]) on the uppermost shelf (shelf 0) in addition to five radio shelves below (shelves 1 through 5).

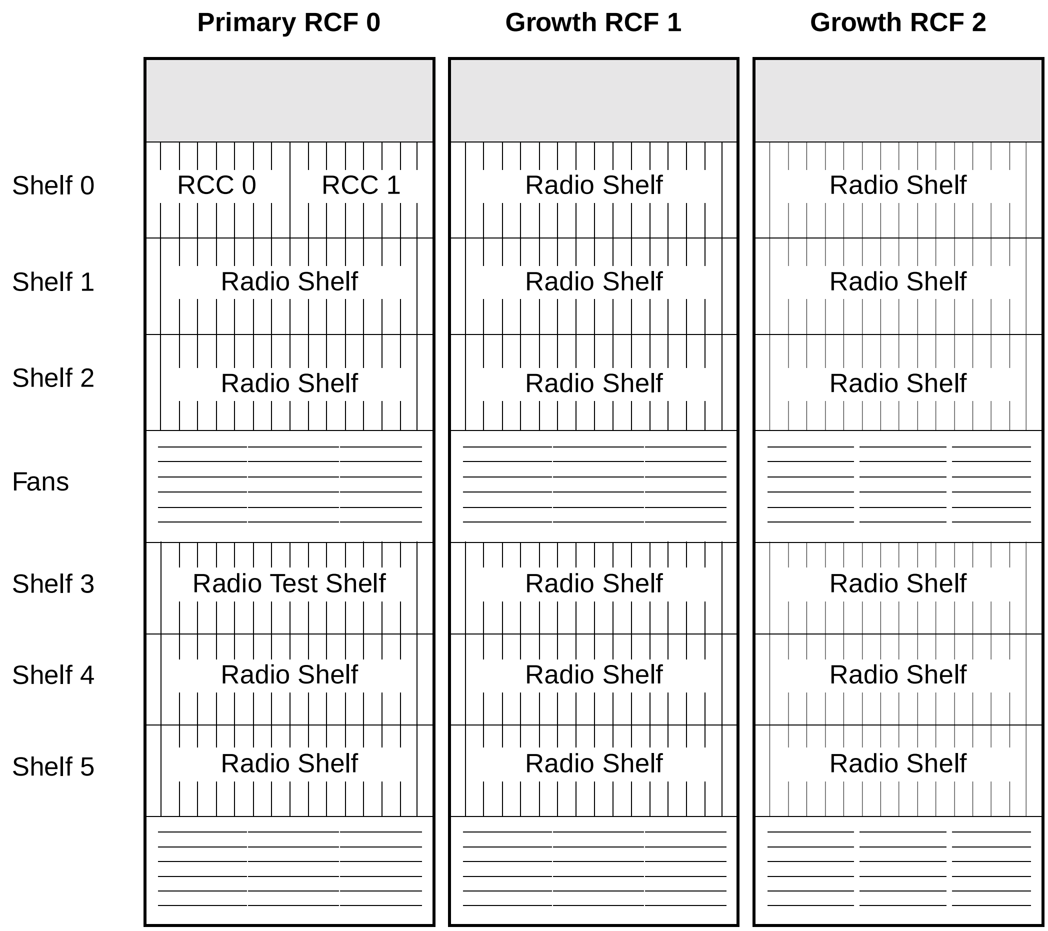

Figure 2-4. Radio Channel Frames

The RCC consists of two identical controllers (redundant controllers). One controller is active (on-line) and one is standby (off-line). The RCC provides intelligent control of the Cell Site equipment and performs call processing in conjunction with the ECP complex.

The primary RCF may contain a combination of AMPS *setup*, *locate*, and *voice* channel radios; setup and locate radios are simply AMPS radios configured to perform setup and locate channel functions. The RCC can configure an RCU or a Single-Board RCU (SBRCU) to perform one of three functions:

- *Setup*—To establish calls with AMPS mobile subscribers

- *Locate*—To assist with handoffs when the established call can be better served by an adjacent sector or cell
- *Voice*—To carry the AMPS over-the-air calls

Setup and locate radios are restricted to shelf 1 and/or shelf 2 of the primary RCF, whereas voice radios may be installed in any of the five radio shelves of the primary RCF or any of the six radio shelves of a growth RCF. Normally, at start-up, there are two setup radios (one active and one standby) and two locate radios (both active).

Up to two Growth RCFs may be added. Each growth RCF contains six radio shelves, housing 72 RCUs in each growth RCF for a maximum capacity of 200 analog radios or 86 digital radios or various combinations. (A minimum of two analog radios are always required for setup and locate functions.).

Twenty-one channels, referred to as setup or control channels, are set aside to accomplish the setup function. That is, 21 channels in each of the cellular frequency spectrums (block A and block B) are not used as voice channels.

Setup radios perform the receive and transmit functions required to set up an AMPS or IS-54 TDMA call, but not a CDMA call. CDMA uses its own control channels to set up a CDMA call.

There are AMPS-only mobiles, IS-54 compliant TDMA/AMPS dual-mode mobiles, IS-136 compliant TDMA/AMPS dual-mode mobiles, and IS-95A and IS-95B compliant CDMA/AMPS dual-mode mobiles. A TDMA/AMPS dual-mode mobile allows the call to be served on either TDMA or AMPS channels, which increases the chances that the call will be served if no TDMA channels are available during setup or handoff. The same holds true for a CDMA/AMPS dual-mode mobile.

If a Cell Site has the TDMA DCCH feature, the DCCH—not the setup radio—is used to set up TDMA calls for IS-136 compliant TDMA/AMPS dual-mode mobiles.

AMPS locate radios (also referred to as analog locate radios), which receive but do not transmit, assist only in the handoff of an AMPS call. As explanation, a handoff decision for an AMPS call is based on Cell Site measurements of signal strengths received from the mobile station. In contrast, the handoff decision for a TDMA or CDMA call is based on mobile measurements of signal strengths received from radios at neighboring sites. This latter type of handoff is referred to as mobile-assisted handoff.

A feature known as the Digital Verification Color Code *(DVCC)* verification feature can ensure a high success rate for the TDMA mobile-assisted handoff procedure. For this feature, there is a digital locate radio available to each physical antenna face, or sector, neighboring the serving face.

Any combination of AMPS radios (RCUs, SBRCUs) and TDMA radios (DRUs, EDRUs) can reside in the primary RCF or in a growth RCF. RCUs, SBRCUs, DRUs, and EDRUs can sit side-by-side in the same radio shelf.*

The DRU occupies two adjoining RCU slots in the shelf, and the EDRU occupies one RCU slot in the shelf; either unit provides a 3-to-1 voice channel capacity advantage over the RCU.

CDMA radios are installed in their own growth RCF (See Figure 2-5), which is designed to house 12 CDMA radios—two (redundant) radios per shelf. (One CDMA radio is active and one is standby).

CDMA radios cannot be installed in the primary RCF, nor can they be intermixed with RCUs, SBRCUs, DRUs, or EDRUs in the same growth RCF. Since there can be up to two growth RCFs in a radio frame set, the Series II Cell Site can accommodate up to 24 CDMA radios.

There are two test radios listed below:

- The Radio Test Unit (RTU)
- TDMA Radio Test Unit (TRTU)

These radios can be used to test AMPS or TDMA radios, respectively, along with their associated RF paths. When installed, the test radios reside in shelf 3 of the primary RCF.

The CDMA Radio Test Unit (CRTU) can be used to test CDMA radios and their associated RF paths. The CRTU consists of two hardware components:

- The CRTU interface (CRTUi)
- The CRTU module (CRTUm)

The CRTUi allows the RCC to communicate with the CDMA/AMPS dual-mode mobile located in the CRTUm. When installed, the CRTUi resides in shelf 0 of the primary RCF, and the CRTUm resides in the FIF or is mounted on a Cell Site wall.

* Due to DC power limitations, it is recommended that no more than five EDRUs, with no other radios, reside in the same radio shelf. This restriction does not apply if the P-RCF is equipped with List N and the G-RCF is equipped with List E.

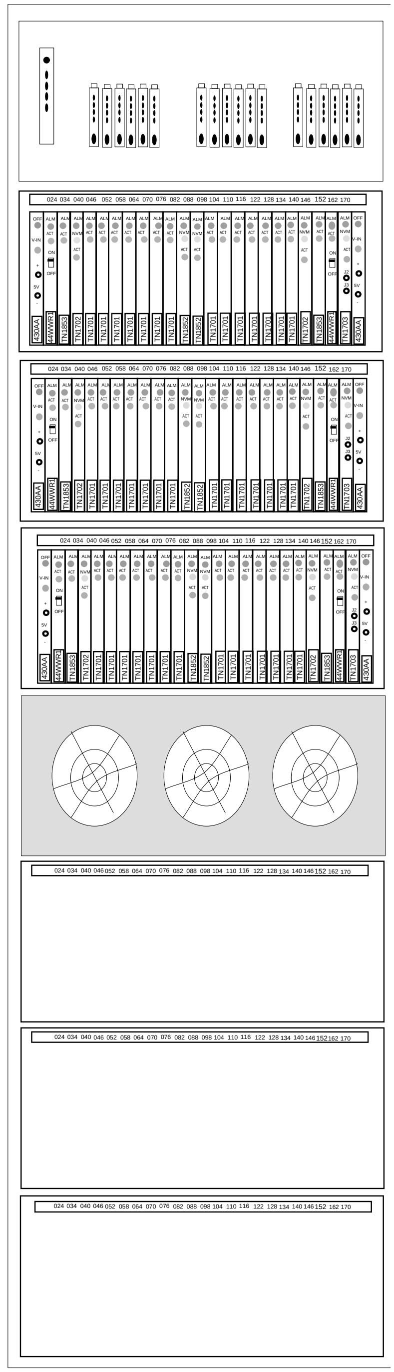

Figure 2-5. Series II CDMA Radio Channel Frame (RCF)

From an RCC perspective, the CRTUi and CRTUm together look like a single maintenance unit, just like the RTU or TRTU.

Facilities Interface Frame (FIF)

The Facilities Interface Frame (FIF) (see Figure 2-3) provides the digital interface between the DCS and radio channel frames via shelf-mounted Data Service Units (DSUs) or Channel Service Units (CSUs). These units perform network interface compliance, format conversion, and network monitoring functions for a T1 or E1 line.

An *alarm control panel*, which is an optional panel mounted in the FIF, can collect up to 18 user-defined alarms.* User-defined alarms are gathered from alarm sensors external to the Cell Site frames; they include miscellaneous alarm conditions, such as fire, forced entry, high temperature, and alarms from ancillary co-located equipment.

* An *Increased Cell Alarms* enhancement available in ECP Release 7.0 added another 12 user-defined alarms and 12 equipment alarms for use in the cell. The Increased Cell Alarms enhancement is described in the *User-Defined Cell Site Alarms (UDA) Optional Feature* document (401-612-057).

Time Division Multiple Access (TDMA)

3

Contents

TDMA Overview

The Series II TDMA technology conforms to the TIA IS-54 standard (sometimes called North American TDMA), which allows the servicing of three digital calls within the same frequency range previously used for one AMPS call. IS-54 TDMA radio transmissions occur in the same frequency bands (System A and System B) as AMPS radio transmissions.

IS-54 TDMA provides a basic modulation efficiency of three calls per 30-kHz of bandwidth. A 30-kHz channel is subdivided into six timeslots for TDMA transmissions. Two timeslots are required for each call when using full-rate voice encoders (vocoders). Timeslots 1 and 4 form user channel 1, timeslots 2 and 5 form user channel 2, and timeslots 3 and 6 form user channel 3.

Each Digital Radio Unit (DRU) or Enhanced Digital Radio Unit (EDRU) is assigned an RF channel number (carrier) using the RC/V Cell Site Trunk Member form (ctm) or Vocoder Relocation feature allows EDRUs to be assigned via the RC/V TDMA Packet Pipe Member form (tpptm), as well as the ctm and dcch forms. The modulated output carries three independent, full-rate channels of information.

Assuming a frequency reuse factor similar to the analog design, the resulting capacity with TDMA is one call per 10 kHz of spectrum or three times that of the AMPS system. However, for TDMA systems, special studies have shown that there is room for placing cells closer together because of TDMA's higher tolerance to interference and/or reducing the frequency re-use factor from the traditional seven to six, five, or even four, further increasing system capacity.

TDMA/AMPS Dual-Mode Operation

The TIA IS-54 standard includes provision for future service additions and expansions of system capabilities. The architecture defined by the TIA IS-54 standard permits such expansion without the loss of backward compatibility with older mobile stations.

A TDMA/AMPS dual-mode mobile complying with the TIA IS-54 standard can obtain service by communicating with either TDMA radios or AMPS radios at the Cell Site. Whether the communication is TDMA or AMPS depends on the availability of either system in the geographic area of the mobile station as well as the preferred call mode of the mobile station. The preferred call mode can be TDMA-only, AMPS-only, or dual-mode TDMA (either TDMA or AMPS).

There are two types of TDMA/AMPS dual-mode mobiles: IS-54 compliant mobiles and IS-136 compliant mobiles. IS-54 compliant mobiles can only access the TDMA system via the analog control channel (ACC)_also known as the setup channel, whereas IS-136 compliant mobiles can access the TDMA system via the ACC or the DCCH.

TDMA System Access

Mobile origination and page response messages are transmitted to/ received from the TDMA Cell Site over the ACC, unless the DCCH feature is in effect at the Cell Site and the accessing mobile is an IS-136 compliant mobile. In the latter case, mobile origination and page response messages may be transmitted to/ received from the TDMA Cell Site over the DCCH.

TDMA Radio Interface

The TDMA radio interface between the serving Cell Site and the mobiles is a three-layered communications architecture. The physical layer is referred to as the air interface, which is a standardized IS-54 TDMA system. The physical layer not only supports the functions required for the transmission of bit streams on the air interface, but also provides access capabilities to the upper layers. The uppermost layer carries messages that are transparent to the Cell Site; the messages convey call control and mobile management information between the MSC and the mobile station.

TDMA transmission is in the form of a series of frames, each of which is divided into a number of timeslots. In IS-54 TDMA, each frame is partitioned into six equally sized, non-overlapping timeslots.

In IS-54 TDMA full-rate operation, individual mobile stations take turns using the reverse channel (mobile ? cell) and may put a burst of data in the assigned timeslots. In the forward channel (cell ? mobile), the Cell Site is usually transmitting continuously with the mobiles listening only during their assigned timeslots. The Cell Site is also repeating a reference burst, and all mobiles synchronize on the reception of that burst.

A mobile station must know not only which two timeslots 1&4, 2&5, or 3&6, to use for transmission, but also which two timeslots to use for reception. In IS-54 TDMA, those timeslots are the same. The TDMA frames used in the forward and reverse directions are staggered by a little more than one timeslot duration to allow the same timeslot pair to be used in both directions, hence avoiding the requirement for the mobile station to transmit and receive simultaneously.

The mapping of assembled DCCH slots into superframes and hyperframes applies only to the forward DCCH (cell ? mobile). There are no superframe or hyperframe structures for the reverse DCCH (mobile ? cell).

Some characteristics of the IS-54 TDMA frame are:

- Frame length = 1944 bits (39.99999 milliseconds)
- Timeslot duration = 324 bits (6.666666 milliseconds)
- Data rate = 20.57613 milliseconds

Radio Channel Types

Each of the repetitive timeslots (1, 2,..., 6) across TDMA frames forms a physical channel. (A physical channel always uses the same timeslot number in every TDMA frame.) Thus, IS-54 TDMA provides six physical channels per RF channel (carrier). As defined in TIA IS-54 and IS-136, there are two overall categories of logical channels that can be mapped onto the physical channels:

a. Digital Control Channels (DCCH) (IS-136 only) - A DCCH is a collection of logical channels used for transmission of control information and short user data messages between the Cell Sites and mobile stations.

b. Digital Traffic Channels (DTC) (IS-54 and IS-136) A digital traffic channel is a collection of logical channels used for transmission of user information and related control messages between the Cell Sites and mobile stations.

A TDMA omni cell or cell sector is allocated a subset of RF channels. One RF channel is assigned to each TDMA radio. The TDMA RF channel is designated as either C0, C1, C2, through C n, where Cn is the last TDMA RF channel provided in the cell. Each TDMA RF channel is divided into 6 timeslots. All but one of the TDMA RF channels can support three digital traffic channels. The exception (i.e., C0) can support up to two digital traffic channels on timeslots 2&5 and 3&6; timeslots 1&4 are dedicated to carrying the digital control channel. Two additional TDMA RF channels, designated C1 and C2, can also be assigned to carry digital control channels via the RC/V dcch form. C0, C1, and C2 need not have the lower RF channel numbers of the allocation; no ordering of RF channel numbers is implied.

Digital Control Channel

The IS-136 DCCH is based on the IS-54 standard. The call control and other features specified in IS-54 are part of IS-136.

The DCCH is used in place of the analog control channel (ACC). The DCCH performs the setup function for mobile subscribers using IS-136 compliant mobiles. The DCCH is carried by a TDMA radio (DRU, EDRU) configured as a DCCH radio, and the ACC is carried by an AMPS radio (RCU, SBRCU) configured as a setup radio. Since a TDMA radio provides a basic modulation efficiency of three user channels (1 - 3) per 30-kHz of bandwidth, the DCCH radio may also carry digital traffic. The DCCH is carried on user channel 1.

Typically, there is one DCCH per physical antenna face, or sector, in a TDMA system. Up to three DCCHs are allowed per sector.

Digital Control Channel (DCCH) Forward Link, or Downlink, Logical Channels

The DCCH provides IS-136 compliant mobiles with a continuous frame-oriented means of communication across the air interface. When not involved in an actual call, the mobile stations monitor RF channel C0. The information sent to all mobile station includes information about the system and how the mobile stations should access the system. If a mobile station is in the process of originating a call, a control channel will be used to notify that mobile station that it should tune to a specified RF channel to complete the call. If a mobile station is idle and a call comes in for it, the mobile station is paged over a paging channel.

The forward DCCH (cell mobile) consists of the following logical channels.

- **Broadcast Control CHannel (BCCH)** - Used to carry generic, system-related information. Broadcast channels are used for such functions as (1) frame synchronization of the mobile station, (2) conveyance of DCCH structure parameters and parameters that are essential for a mobile to access the system, and (3) conveyance of the broadcast short message service (SMS)
- **SMS Point-to-point, Paging, and Access Response Channel (SPACH)**- Used to deliver short messages to a specific mobile station (in the context of SMS services) and carry signaling information necessary for access-management functions. SPACH channels are shared, point-to-point, unidirectional (forward-only) control channels. Broadcast channels are shared, point-to-multipoint, unidirectional (forward-only) channels.
- **DCCH, Shared Channel Feedback (SCF)** - Support for SCF includes support for the encoding of SCF flags.
- **DCCH, Reserved Channel** -The Reserved Channel is for future use, to ensure upward compatibility with first generation mobiles.

The reverse DCCH (mobile ? cell) consists of a random access channel (RACH). The RACH is used by IS-136 compliant mobiles to request access to the system. At any given moment, a mobile station accesses only a limited number of the channels appearing on its radio interface.

DCCH Feature Offerings

Short Message Service (SMS)

Enables users to receive visual messages with the potential for up to 256 alphanumeric characters on their IS-136 compliant mobiles. Transmission of short messages permits a mobile to function as a pager. Projections show SMS will increase the percentage of completed terminations.

Sleep Mode

Extends the battery life of portables, increasing talk time between recharging. Allows subscribers to make longer and more frequent calls.

Private Networks

DCCH development has made it easier for service providers to offer closed wireless systems with customized feature packages for user groups in an office or campus environment.

Channel Organization for Forward DCCH Superframes

The DCCH radio must transmit a burst at a fixed power level in timeslots 1 and 4 of every TDMA frame to allow mobiles to make power measurements. Thus, the DCCH radio must always have its RF carrier turned on and set at a fixed power level. It can be used to carry digital traffic channels, but the carrier power level remains fixed; the DCCH radio is ineligible for dynamic power control.

The reverse DCCH (mobile ? cell) consists of a random access channel (RACH). The RACH is used by IS-136 compliant mobiles to request access to the system.

At any given moment, a mobile station accesses only a limited number of the channels appearing on its radio interface.

Digital Traffic Channels

The digital traffic channel is dedicated to the transport of user and signaling information between the Cell Site and the mobile station, and between the mobile station and the Cell Site. A digital traffic channel implies a forward and reverse pair of communication paths.

Currently, the digital traffic channel only carries encoded speech at a full-rate information rate. In the future, the digital traffic channel will be able to carry either encoded speech or user data. When half-rate speech coding is defined for IS-54 TDMA, the digital traffic channel will be able to carry encoded speech at one of two information rates (i.e., full rate or half rate). The half-rate channel makes use of half as much radio resources as the full-rate channel, which leads to a two-fold increase in spectrum efficiency.

When a Cell Site supports half-rate coding (future), each physical channel on a TDMA radio will be able to carry one half-rate channel, meaning that a TDMA radio will be able to support six user channels (one user channel per physical channel.)

DTC Dedicated Control Channels

There are two separate dedicated control channels associated with a digital traffic channel. These channels are the slow associated control channel (SACCH) and the fast associated control channel (FACCH). Dedicated control channels are point-to-point bidirectional channels used after call establishment for signaling and control.

Table 3-1. Logical Channel Minimum Slots Maximum Slots

Logical Channel	Minimum Slots	Maximum Slots
F-BCCH (F)	3	10
E-BCCH (E)	1	8
S-BCCH (S)	0	15
RESERVED (R)	0	7
SPACH (NOTE)	1	32 - (F + E + S + R)

The digital traffic channel transmits either user information along with SACCH data, or it transmits FACCH data in a blank-and-burst mode. FACCH is transmitted in the data fields normally used for user information (speech data).

FACCH and user information cannot be sent simultaneously.

Digital Verification Color Code Channels

Digital verification color code (DVCC) is the TDMA counterpart of the AMPS supervisory audio tone (SAT). There are 255 DVCC codes as opposed to three SAT codes, which provide greater assurance that a TDMA radio is listening to the right mobile instead of a co-channel interferer. The same 255 DVCC codes are available to each TDMA Cell Site.

DVCC values range from 1 to 255. It is recommended that each Cell Site be assigned one distinct DVCC value, meaning that all of the digital traffic channels for a particular Cell Site will have the same DVCC. A simplistic assignment method is to assign a DVCC value that corresponds to the Cell Site number.

At a TDMA Series II Cell Site, a TDMA radio serving a mobile call continuously transmits a coded DVCC * on the digital traffic channel to the mobile, and the mobile continuously loops back the coded DVCC to the TDMA radio.

- If the TDMA radio receives the correct DVCC, the serving cell knows that continuity exists on the digital and that the call is still active.
- If the TDMA radio receives no DVCC for a translatable timeout interval (ranging from two to 20 seconds, specified using the RC/V ceqface form), the serving cell considers the call to be lost and releases the digital traffic channel and associated trunk member.
- If the TDMA radio receives the wrong DVCC, the serving cell knows that the mobile is in a fade condition and that either the mobile or the TDMA radio is receiving a remote interfering signal. The cell initiates a handoff and temporarily blocks the digital traffic channel experiencing the interference, making the channel unavailable to handle traffic.

The interference level at which the cell blocks a channel is determined by certain translatable values. Interference is considered unacceptable when (1) the signal strength measured on the digital traffic channel falls below a certain translatable signal-level threshold, (2) the frame error rate (FER) detected on the digital traffic channel exceeds a certain translatable FER threshold, or (3) the bit error rate (BER) detected on the digital traffic channel exceeds a certain translatable BER threshold. For digital transmissions, signal quality depends on the accuracy of the received frame and bit sequences.

Handoff and Handoff Types

A handoff is the passing of a call from one traffic channel to another traffic channel to provide better service and higher quality communication to the mobile user. Conditions that can trigger a handoff include poor signal strength and poor signal quality. Handoff is required to maintain a call in progress as the mobile station passes from one Cell Site coverage area to another.

As defined in TIA IS-54, there are three types of handoff:

1. Intra-cell handoff - Handoff within the same Cell Site
2. Inter-cell handoff - Handoff between neighboring Cell Sites within the same MSC

3. Inter-MSC handoff - Handoff between neighboring Cell Sites controlled by two different Cell Sites in two different MSCs

NOTE:
For all three types of handoff, the serving cell initiates the handoff by sending a handoffrequest message to the MSC. Included in the message is a list of optimal Cell Site candidates to which the call may be switched. The MSC selects a candidate from the list and initiates the handoff-related procedure.

There are cases where the MSC will initiate a handoff without direction from the Cell Site, for the purpose of traffic balancing or maintenance, such as to transfer all calls from a particular Cell Site to another so that the Cell Site can be taken off-line for testing.

The Series II platform supports the following additional types of handoff:

- TDMA to TDMA
- TDMA to AMPS
- AMPS to TDMA
- AMPS to AMPS

Mobile-Assisted Handoff Procedure

The TIA IS-54 standard recommends the TDMA mobile-assisted handoff (MAHO) procedure for TDMA/AMPS dual-mode mobiles when they are served on TDMA digital traffic channels. The mobiles measure the signal strength of neighboring antenna faces and report the measurements to the serving cell to determine optimal candidate faces for handoff.

The mobile-assisted handoff is a process where a mobile in TDMA mode, under direction from a Cell Site, measures signal quality of specified RF channels. These measurements are forwarded to the Cell Site upon request to assist in the handoff process.

During initial call setup, the serving cell sends the mobile a Measurement Order Message that contains a list of up to twelve frequencies, called MAHO channels. Each frequency corresponds to a setup channel, DCCH channel, or a beacon channel (an analog voice channel or digital traffic channel kept on at constant power to support MAHO) associated with a physical antenna face that neighbors the serving face.

* A coded DVCC is a 12-bit data field containing the 8-bit DVCC and four protection bits; it is sent in each timeslot of the digital traffic channel.

NOTE:
The beacon radio can also be used for voice communications, but its carrier power level remains fixed. The beacon radio is ineligible for dynamic power control.

When the call is established, the mobile makes signal strength measurements of the twelve (or less) MAHO channels, once per second, and reports the measurements to the serving cell. In addition, and also at a once-per-second rate, the mobile measures both the signal strength and signal quality of the serving cell and reports the measurements to the serving cell. It is from these measurements that the Cell Site selects the most promising handoff candidates.

While the mobile is measuring the received signal strengths of the neighboring MAHO channels and the received signal strength and quality of the serving cell, the serving cell is measuring the received signal strength and quality of the mobile. The serving cell analyzes both the cell-initiated and mobile-initiated measurements to determine if a handoff will provide better service to the mobile user.

HandOff Based on Interference (HOBIT) / INterference Look-Ahead (INLA) Enhancements

For TDMA, interference on a serving channel is detected when any of the following measurements exceeds its threshold:

1. BER Threshold - Uplink Bit Error Rate (cell BER) (cell2 form)
2. FER Threshold - Uplink Frame Error Rate (cell FER) (cell2 form)
3. TDMA BER Avg. Sample - Downlink Bit Error Rate (mobile BER) (fci form)

When excessive cell or mobile BER or excessive cell FER cause a handoff trigger and no better server can be found through the normal handoff process, the Handoff Based on Interference for TDMA (HOBIT) feature allows the call to be handed off to another radio channel on the serving logical antenna face (LAF) in order to escape the interference.

However, the previous implementation of the HOBIT feature allowed a handoff to another channel on the same Logical Antenna Face (LAF) when it detected interference, regardless of whether the interference was caused by a weak signal in a low noise/interference area or whether there truly was high noise/interference in the signal.

This meant that a mobile in a relatively weak serving area could have a BER and/or FER higher than the respective BER and/or FER threshold. In the previous implementation of HOBIT, this would cause a handoff to another channel on the same LAF. However, after the handoff, the mobile would still be in the same weak serving area and the BER and/or FER would not be improved.

The minimum amount of time that can pass before another handoff is allowed is set in:

Min HO int. for TDMA (fci form)

In the previous implementation of HOBIT, the Minimum Handoff Interval for TDMA, also known as hobitime, would expire and the unimproved BER and/or FER would result in yet another handoff to another channel on the same LAF. In this way, HOBIT handoff could continue throughout the duration of the call without improving voice quality. Additionally, this continuous handoff increased the likelihood that calls would be dropped and, thereby, could actually add to the rate of dropped calls.

Enhanced HOBIT was designed to eliminate excessive HOBIT-triggered handoffs that were previously caused by HOBIT’s inability to distinguish between low signal strength in the serving area and actual noise or interference on the signal channel. Eliminating excessive HOBIT-triggered handoffs decreases the number of dropped calls. This, in turn, increases the number of completed calls, which increase both subscriber satisfaction and provider revenue.

The Enhanced HOBIT feature minimizes dropped calls by comparing uplink and downlink signal strength measurements to new, provider-definable uplink and downlink signal strength thresholds to determine whether the serving logical antenna face (LAF) should be added to the handoff candidate list. In this way, the E-HOBIT feature avoids handoffs within the same LAF if the handoff is based on weak signal strength only.

The three new signal strength thresholds used by the E-HOBIT feature are:

1. uhtdm Uplink HOBIT to Dual Mode (Fci form) Range (0-127)
2. dhtdm Downlink HOBIT to Dual Mode (Fci form) Range (0-31)
3. dhta Downlink HOBIT to AMPS (only) (Fci form) Range (0-31)

All three of these thresholds are provider-definable, which gives the Service Provider a great deal of control over HOBIT handoffs to TDMA or AMPS channels. Setting the three parameters above determines the Allowable Handoff Type, which can be either of two values:

1. Dual Mode (HOBIT allowed to either TDMA or AMPS)
2. AMPS (HOBIT allowed to AMPS only).

The Allowable Handoff Type AMPS option will enable a service provider to direct HOBIT handoffs from TDMA radios to AMPS radios, even if a second TDMA radio is available on the same face. This allows providers to deploy their radios more effectively.

NOTE:
These enhancements only affect the handoff criteria for potential candidate channels on the serving LAF. They do not affect handoff criteria to neighbor sectors or cells.

A complementary feature to HOBIT, Interference Look Ahead (INLA), improves the quality of calls by ensuring that a handoff is made only to a channel that has an acceptably low level of interference. INLA does this by taking the signal strength measurements of the candidate channel and comparing them against predefined INLA thresholds for TDMA or AMPS to determine if the level of interference on the candidate channel is acceptable or not. The INLA thresholds are:

INLA threshold - AMPS (RSSI) (ECP form) Range (0-31)

INLA threshold - TDMA (RSSI) (ECP form) Range (0-31)

At most, three searches are made for a clear handoff channel. Previously, the call would be handed off on the last attempt regardless of interference. Enhanced INLA eliminates any HOBIT-initiated handoffs to channels with excessive interference. For all handoff triggers other than HOBIT, INLA actions remain unchanged.

The INLA feature complements the HOBIT feature by ensuring that a HOBIT-initiated handoff is not made to a noisy channel. While Enhanced HOBIT minimizes the number of dropped calls caused by interference, INLA improves the quality of handoffs by preventing a handoff from one channel with an unacceptable interference level to another channel with an equally unacceptable interference level. Lucent strongly recommends that these two features be used together to both minimize the number of dropped calls and improve the quality of calls that are handed off.

Based on these three thresholds, and assuming that the serving LAF is the only potential handoff candidate, the possible results of HOBIT/INLA are: Handoff from TDMA to TDMA or AMPS, handoff from TDMA to AMPS, or the handoff is aborted.

The Enhanced HOBIT/INLA features work with TDMA-compliant mobiles. Other than that, the Enhanced HOBIT feature has no additional, specific hardware requirements.

Enhanced HOBIT/INLA feature require ECP and Cell Release 12.0. Lucent strongly recommends that both Enhanced HOBIT and INLA be used together for maximum effectiveness.

No new FAF or QFAF provisions will be required to support the HOBIT or INLA enhancements.

E-HOBIT and INLA are activated when the fields below are set to "y."

HO INT TDMA (cell2 form)
INLA (cell2 form)

Service Measurements (SM)

HOBIT/INLA introduces the six new Service Measurements below: Series 2 TDMA ECP Logical Antenna Face Counts (ECP-LAF-TDMA)

1. ECP-LAF TDMA Field 11 - HOBIT Request Aborted Due to Interference Series II TDMA Logical Antenna Face Counts (LAF-TDMA)
2. LAF-TDMA Field 46 - HOBIT Request to Dual Mode of Serving Face
3. LAF-TDMA Field 47 - HOBIT Request to AMPS Due to Weak Uplink Signal
4. LAF-TDMA Field 48 - HOBIT Request to AMPS Due to Weak Downlink Signal

5. LAF-TDMA Field 49 - HOBIT Request with Weak Uplink Signal
6. LAF-TDMA Field 50 - HOBIT Request Aborted Due to Weak Downlink Signal

For complete details regarding the Enhanced HOBIT Feature, please refer to Lucent Technologies Practices document 401-612-237, *HandOff Based on Interference (TDMA)*.

Handoffs based on interference will be made only to a TDMA time slot on a different DRU from the serving DRU. If no such time slot is available, the call will be handed off to an analog channel.

Switch-Based TDMA Voice Coder/ Decoder (Vocoder)

Currently, vocoders and echo cancellers used in the Autoplexr TDMA system are located in the Digital Radio Units (DRUs) and the Enhanced DRUs (EDRUs) at the Cell Site (CS). This feature relocates the vocoders and echo cancellers from the EDRUs to the Packet Handler for Voice (PHV3 and/or PHV4) boards at the 5ESS-2000 DCSr (Digital Cellular Switch). Implementation, then, requires PHV3 and/or PHV4 boards at the DCS. This feature does not relocate the vocoders from the DRUs to the DCS. This feature will henceforth be referred to as the "Switch-Based TDMA Vocoder Relocation" feature.

The Switch-Based Vocoder feature is offered to the customer on a per cell basis. The feature is switched on via a Qualified Feature Activation File (QFAF) (i.e., the feature is "QFAF-able"). It does not impact the mobiles and has no external product or OEM dependencies.

The Switch-Based Vocoder feature provides the following benefits:

1. Facilities concentration
2. Vocoder/Echo Canceller pooling
3. Platform for multiple speech coding algorithm support (n>=2)
4. Semi-soft handoff
5. Packet mode transport

The benefits and rationales are discussed below.

Facilities Concentration

Speech carried via TDMA is compressed and digitized (encoded) into an 8Kb/s stream by the voice coder/decoder (vocoder) located inside the mobile unit. The channel coder adds error protection to the 8Kb/s stream, which results in a 13 Kb/s stream that is then broadcast over the air to the Cell Site (CS).

When the CS receives the 13 Kb/s stream, the channel coder strips the error protection bits off and performs error correction which leaves the 8Kb/s stream. The vocoder in an EDRU radio board then decodes the 8Kb/s stream into a 64Kb/s u-law/a-law Pulse Code Modulated (PCM) stream. The 64Kb/s PCM stream is sent to the DCS at the Mobile Switching Center (MSC) via a Digital Switch level 0 (DS0). A DS0 carries a single mobile’s conversation (i.e., 64Kb/s PCM stream) between the CS and the DCS.

It is the 64Kb/s PCM stream (and the overhead bits required for transport) that requires the exclusive use of one DS0 to transmit the stream from the CS to the DCS. If the CS vocoder were relocated at the DCS, then the much smaller 8Kb/s stream would not require the exclusive service of one DS0 to be transmitted from the CS to the DCS. This would free up DS0s to carry more traffic, thereby increasing the number of calls per facility and decreasing the number of facilities required. Therefore, for Release 12.0, vocoders inside the EDRU radio boards at the CS have been relocated to the Packet Handler for Voice (PHV) boards at the DCS.

This feature provides a concentration of at least 3 to 1 TDMA calls on the facilities between the DCS and the Series II CSs. As the system evolves, this concentration will increase. However, this feature will not impact pre-existing system performance or call setup times.

Vocoder / Echo Canceller Pooling

Each radio time slot requires one vocoder and one echo canceller. That is, each time slot requires a vocoder/echo-canceller pair. Relocating the vocoders to the DCS centralizes them and lets the provider pool them, which reduces the number of vocoders required. The number of vocoders needed can be set by the technician depending on the expected traffic and service grade (i.e. blocking rate) instead of depending on the number of radios needed to physically cover a service area.

Because the echo cancellers are included with the vocoders in the Packet Handler for Voice (PHV) boards they are also centralized and pooled. These echo cancellers are part of the standard feature package. Customers who do not want to use the standard echo cancellers or who want to install third party echo canceller boards, can use the RCV mechanism, which is also provided, to bypass the PHV echo cancellers.

Platform for Multiple Speech Coding Algorithm Support

The EDRU previously supported a maximum of two speech coding algorithms which could be switched on a per call basis. Relocating the vocoders to a centralized platform allows the EDRU to support multiple (two or more) speech coding algorithms. In the 5ESS-2000 DCS Switch, each PHV board can support one type of algorithm. As new algorithms are standardized, this feature makes it easier to implement and support these future speech coders. Additional PHV boards can be added or existing PHV boards can be downloaded with the new algorithms. Then, calls can be assigned to a particular vocoder based on the algorithm requested by the mobile.

* This architecture supports packet mode transport. In packet mode transport, overhead/control bits are added to the 8 Kb/s stream.

Semi-soft Handoff (intra-DCS, inter-DCS)

The definition of a TDMA semi-soft handoff is:

- Different Frequency (hard handoff at the CS)
- Same Vocoder / Echo Canceller (soft handoff at the DCS)

The Switch-Based Vocoder feature improves the voice quality of a call during handoff in two ways:

1. It reduces the amount of processing needed for handoff because reassignment and switching of some components is not necessary.
2. Because the same vocoder/echo-canceller pair are used throughout, you do not have the degradation of voice quality observed whenever a new vocoder and echo canceller pair is needed for a handoff.

The reason for the degradation of voice quality observed when a new vocoder/echo-canceller pair is needed is that algorithms for echo cancellers require an initial training period to adjust to the particular characteristics of the voices in each conversation. If a new vocoder and echo canceller is not needed for a handoff, then any degradation of voice quality observed in the past will no longer occur with semi-soft handoff.

Intra-DCS Semi-soft Handoff

A Semi-soft handoff within the DCS (Intra-DCS) forces the same vocoder/echo canceller pair to be used when the mobile switches from one frequency to another, as long as the new frequency is provided by the same CS (intra-cell) or by the same sector (intra-sector). Intra-DCS Semi-soft Handoff is also used when the mobile switches from one frequency to another and the new frequency is provided by a different CS (inter-cell) but where that CS terminates on the same DCS (intra-switch). For this functionality to work in a DCS with more than one Packet Switching Unit (PSU), all the PSUs within the DCS have to be interconnected via Packet Handler for Asynchronous Transfer Mode (ATM) boards (PHA boards). The Switch-Based Vocoder feature supports Intra-DCS semi-soft handoff.

Inter-DCS Semi-soft Handoff

Currently, the Switch-Based Vocoder feature does not support Inter-DCS semi-soft handoff. However, we will define it here to complete the discussion of handoff types. Inter-DCS semi-soft handoff forces the same vocoder/echo canceller pair to be used when the mobile switches from one frequency to another and the new frequency is provided by a CS that terminates on another switch (inter-DCS). The interconnection of a collection of PSUs from a group of switches can be used to create a large, virtual vocoder pool across a large coverage area (e.g. nationwide).

Packet Mode Transport

The Switch-Based Vocoder feature implements a packet mode transport Link Access Protocol on D-channel (LAP-D/Frame Relay variant) to transmit voice frames between the CS and the DCS. Packet mode transport is implemented as a step towards evolving to an architecture based on a packet mode backbone using packet mode standards such as ATM or Frame Relay (FR). In the future, this architecture will allow system components (i.e. Cell Sites, Switches, etc.) to hook into established ATM/FR wide area networks and to achieve connectivity with each other.

Packet Pipe (PP) Implementation

In the Series II CSs, the PP transport software is implemented in the EDRU. One of the six Digital Signal Processors (DSPs) that previously processed the vocoder and echo canceller algorithms has been reused to support the PP transport protocol. Installing this feature in field-deployed CSs only requires a download of new software to the DSP. The CS does not require any hardware changes to support this feature.

The FRPH and PHV packet handler boards are not supported on the Classic Switch Modules (SMs). Therefore, at least one SM-2000 per DCS is required to implement this feature. Pre-existing trunk terminations on the Classic SMs, however, do not need to be changed to implement this feature. Changes can be made within the 5ESS-2000 DCS switch to re-route the DS0s coming into the Classic SMs out to an SM-2000. Today, those DS0s are sent to outgoing PSTN trunks.

The Switch-Based Vocoder feature is supported on T1 and E1 voice/data trunks. T1 voice/data trunks are four-wire voice/data trunks that carry 24 duplex channels via 64Kb/s time slices. E1 voice/data trunks are four-wire voice/data trunks that carry 30 duplex channels via 56Kb/s time slices.

Cell Sites Supported by the Switch-Based Vocoder feature

The Switch-Based Vocoder feature supports Cell Sites (CSs) with some or all of the following configurations:

- All EDRUs and DRUs with vocoders in the CS
- All EDRUs with vocoders in the DCS
- Mixed configuration of all EDRUs with vocoders in the DCS and all DRUs with vocoders in the CS

Use of DS1 and/or DFI boards at the cell

For TDMA Cells, the following applies:

Switch-based vocoder packet pipe (PP) has been successfully implemented on Series II TDMA cell sites that have traditional DS1 boards installed. However, the traditional DS1 board only supports a 56Kb packet pipe rate. Also, the DS1 board is manufacturer discontinued and is being replaced by the 3500B DFI board. That means that switch-based vocoder packet pipe can also be implemented on the new TDMA PCS minicells, which have the 3500B DFI boards installed. Additionally, the 3500B DFI board supports both the 56Kb and the 64Kb packet pipe rates.

For CDMA Cells, the following applies:

Switch-based vocoder packet pipe (PP) implementation on CDMA cell sites requires that DFI boards be installed at the cell.

Operation, Administration, and Maintenance (OA&M)

To facilitate Operation, Administration, and Maintenance (OA&M), the Switch-Based Vocoder feature uses new and/or modified:

1. Recent Change (RC/V) screens
2. Technician Interface (TI) input commands and output reports
3. Status Display Pages (SDP). These forms allow the technician to:
   - Designate each cell as being configured with the vocoder in the cell or the vocoder in the DCS
   - Assign a vocoder algorithm to each PHV board at the DCS
   - Assign radio timeslots to Packet Pipes (PPs)
   - Assign DS0s to PPs
   - Bypass the echo cancellers in the PHV boards at the DCS

To facilitate Packet Pipe (PP) maintenance, Man-Machine Language (MML) commands are also provided with the Switch-Based Vocoder feature.

Existing input and output commands and status display pages used for maintenance of TDMA PPs on the Executive Cell Processor Complex (ECPC), the cell, and the 5ESS-2000 DCS Switch have been updated to reflect that PP maintenance does not apply specifically to CDMA technology.

Cell Site OA&M

Implementing the PP protocol changes the structure of CS trunks from full rate 64Kb/s DS0s that can handle only one call, to groups of DS0s that support a parameterized number of multiplexed calls. This impacts trunk maintenance, as described below.

Maintenance actions (such as remove, restore, diagnostics) that were previously performed on a trunk (DS0) basis are now also performed on a PP trunk basis, if the Switch-Based Vocoder feature is implemented. The difference is that when a maintenance action is performed on a DS0 it affects only one call, whereas when a maintenance action is performed on a PP, it can affect more than one call.

The Maintenance Request Administrator (MRA) at the Radio Control Complex (RCC) continues to handle all such maintenance requests (i.e., remove, restore, diagnostics). Those translations in the RCC have been updated to check and report the status of PP trunks, in addition to the status of pre-existing trunks. Maintaining PP status allows the RCC to take appropriate action for any maintenance requested on a PP.

Therefore, a CS with a mixture of DRUs and EDRUs, and with the Switch-Based Vocoder feature implemented, continues to support all the OA&M of pre-existing trunks as well as that of the new PPs. The RCC also supports both technician-initiated and autonomous maintenance actions requested for a PP.

Additionally, the RCC/EDRU detects and reports any PP failure(s) back to the ECPC (i.e. transmit identification [XID] packets are not received in time, voice packets do not arrive when expected, etc.). The CS receives, recognizes, and acts on PP status messages received from the ECPC.

For CS EDRUs for which the vocoder has been relocated at the DCS, vocoder-specific OA&M has been disabled and all other OA&M functionality remains. EDRU testing that requires a vocoder has been re-implemented to be independent of the need to have a vocoder at the CS.

The following radio-related OA&M subsystems that reside in the Radio Control Complex (RCC) have been redesigned:

Configuration Utilities (CFUT)
Diagnostics (DN)
Measurement (MEAS)

These subsystems, which operate within the CS, have been redesigned because certain functions performed by the Vocoder no longer exist in every EDRU.

In particular, for those EDRUs whose vocoders have been moved to the DCS, there are:

- No Vocoder MUTE/UNMUTE settings
- No Vocoder Tx/Rx Gain settings
- No Vocoder Tx Tones generated

The only EDRU-specific Diagnostic test impacted by the Switch-Based Vocoder feature is the Baseband Transmission Level test. Voice-band tests include the Baseband Transmission Level Test of the DN subsystem and Audio Level Measurements of the MEAS subsystem. The MEAS subsystem performs Audio Level Measurements in both Transmit (Tx) and Receive (Rx) directions. Voice-band tests use a Clock And Tone (CAT) board to generate and detect a tone, and a TDMA Radio Test Unit (TRTU) to emulate a mobile phone.

Because the voice encoding/decoding (vocoding) functions are still necessary to carry out voice-band tests, Vector Sum Excited Linear Predictive (VSELP) vocoding is provided by an EDRU's Packet Pipe Digital Signal Processor (PP DSP) that talks only to Time Slot 2. The RCC changes the operating mode of an EDRU's PP DSP to VSELP vocoding mode before conducting any voice-band test. When the PP DSP operates as a VSELP vocoder, the muting functions default to off and the Tx/Rx Gains default to 0x4000 (i.e., there is no Vocoder Gain setting, no MUTE/UNMUTE setting, and no Tx Tone). The RX/TX Audio Level Measurements are not affected by the Network Transmission Level (NTL).

To perform the DN, MEAS and CFUT test functions, the RCC directly controls the DSPs of the EDRU via the TDM message "RMRCC2DSP". This message is relayed by the Maintenance Handler (MH) subsystem of the EDRU to an appropriate DSP while the EDRU is in the maintenance mode.

Below is a summary of the radio-related OA&M subsystems that reside in the RCC, and how they are affected by the Switch-Based Vocoder feature.

Diagnostic subsystem (DN)

- The Baseband Transmission Level Test is performed only on Time Slot 2, without any Vocoder Gain settings based on NTL.
- The Diagnostics are not affected by the absence of the MUTE/UNMUTE settings.
- The pre-existing Diagnostics continue to function, without the Tx Tones from the EDRU and the Test Radio.
- The system performs a PP DSP version check.

Measurement subsystem (MEAS)

- Tx/Rx Audio Level Measurements are no longer affected by NTL because the Vocoder Gain settings are no longer supported.
- Audio Level Measurements are only performed on Time Slot 2.
- The other measurements made by the Technician Interface (TI) "MEAS" remain unchanged.

Configuration Utilities subsystem (CFUT)

- The CAT Tone can only be connected to Time Slot 2.
- There are no MUTE/UNMUTE settings.

ECPC OA&M Support of the Cell Site

In the Switch-Based Vocoder feature, the RC/V DB for the ECPC Subsystem allows the technician to specify a group of contiguous DS0s (1 to 8) on one DS-1 to make up one Packet Pipe (PP). The RC/V DB restricts the width of a PP to 1 DS0 for Series II CSs.

The ECPC Subsystem supports the Cell Site(s) as follows:

- Provides the maintenance commands for PPs and notifies the CS of PP status changes
- Handles PP failure messages from the CS
- Supports OA&M of trunks and PPs
- Supports audits for pre-existing CS trunks and for the new CS PPs

Feature Activation and Installation

The Switch-Based Vocoder feature is offered to the customer on a per cell basis. Therefore, customers may opt to have some cells with vocoders at the DCS and some cells with vocoders in the CS mixed within the same system. The feature is switched on via a Qualified Feature Activation File (QFAF) (i.e., the feature is "QFAF-able"). It does not impact the mobiles and has no external product or OEM dependencies.

Feature activation data is downloadable to the cell sites via translations. The ECPC RC/ V DB software and the RCV interface allow the customer to assign this feature to particular CSs and specifies which CSs have the feature implemented, so that the correct images can be downloaded and activated at the cell sites.

At the cell site, a new NVM image is downloaded into those EDRUs for which the Switch-Based Vocoder Feature is activated, to support the Packet Pipe (PP) protocol at both the DSP and the EDRU main controller.

Call processing and OA&M software execute properly for either state of an EDRU, with this feature activated or without.

Separate Access Thresholds for DCCHs and DTCs (SEPA)

This section describes the feature called "Separate Access Thresholds for DCCHs and DTCs"(SEPA), developed in response to AMUG 36-12. The SEPA feature is a standard feature which does not require activation. It is being introduced in Cell Software Release R12.0 and ECP Release 12.0 for the Time Division Multiple Access (TDMA) Cellular (850 MHz) and PCS (1.8 GHz) Series II product family. The SEPA feature interfaces and functions with the TDMA R12.0 cell site and the ECP R12.0 (MSC) in both the Cellular and PCS configurations.

Let us begin our discussion of the (SEPA) feature, with some definitions and background information.

To begin, let us look at the Digital Control Channel (DCCH). The DCCH transmits the control information needed to set-up and handle a digital call between a Cell Site and an IS-136-compliant digital mobile station. For the purpose of discussing the SEPA feature, the DCCH carries:

- Page Response messages that the mobile sends to the cell site in response to a paging messages that the cell site has sent to the mobile
- Mobile-Origination messages that the mobile sends to the cell site to alert the cell site that the mobile is initiating a call. The DCCH is carried on user channel 1 of a TDMA Digital Radio Unit (DRU) or Enhanced DRU (EDRU). Because the DRU and the EDRU carry three channels, a DCCH DRU or EDRU can carry two Digital Traffic Channels (DTCs) in addition to the DCCH. A DTC transmits the actual content, the digitally-encoded speech, of a call.

The DCCH sends messages from the cell site "down to" the mobile on its downlink (aka forward link) over three logical channels:

1. SPACH (SMS Point-to-point, Paging, and Access Response Channel)
2. BCCH (Broadcast Control Channel)
3. SCF (Shared Channel Feedback)

The SMS point-to-point, Paging, and Access Response Channel (SPACH) carries messages from the cell site to the mobile. SPACH is itself divided into the three following subchannels according to the type of message carried:

1. SMS Channel: Delivers short messages to a specific mobile unit when the SMS feature is active
2. Paging Channel: Delivers pages and orders
3. Access Response Channel (ARCH): Conveys call handling information in response to a mobile unit attempt to access the system

To access a digital cellular network, an IS-136 mobile must first access a DCCH. The "Access Threshold"of a cell site is a parameter that is used to determine whether a mobile will be granted access to the cell site. Starting with Cell Release 8.0, the determination is made by comparing the Mobile Power Class (MPC) of the mobile to the Access Threshold of the cell site. MPCs are recognized for Class-I, Class-II, Class-III, and Class-IV mobiles. Class I and Class II mobile are higher-powered; Class III and Class IV mobiles are lower-powered and often used in buildings and cars. A service provider can lower the Access Threshold parameter to make it easier for Class III and IV mobiles to access the cell site. In any event, the determination is left completely up to the Service Provider.

The SEPA feature allows the Service Provider to set the currently existing minimum received signal strength required to access the DCCH, the RSS_ACC_MIN threshold, to a relatively low value. This way, if a mobile requests access to a DCCH but the DCCH is busy, the mobile can "camp on" the SMS Channel (defined above) of the DCCH. For the mobile to "camp on" the DCCH, means that the mobile will continue monitoring the busy/idle status of the DCCH until the DCCH is free to service the mobile or until a timeout occurs.

Once a mobile has successfully accessed a DCCH and acquired synchronization, it decodes the data sent "down" to it by the cell site over the Broadcast Control Channel (BCCH) of the DCCH.

BCCH data is sent from the cell site "down to" the mobile on its downlink (aka forward link).

The BCCH logical channel is used to send system-related overhead and control information, such as system identification, neighbor lists of other DCCHs, and the DCCH frame structure of the cell, to the mobiles. The BCCH transmits this information to the mobile over three BCCH subchannels:

1. Fast Broadcast Control Channel (F-BCCH)
2. Extended Broadcast Control Channel (E-BCCH)
3. Short Message Service Broadcast Control Channel (S-BCCH)

The Fast BCCH sends time-critical data from the cell site to the mobile. The Extended BCCH (E-BCCH) broadcasts information that is less time-critical than F-BCCH information, such as Neighbor Cell Lists and Signal Strength Measurements, to the mobiles. The E-BCCH channel also plays a major role in Mobile-Assisted Channel Allocation (MACA).

Mobile-Assisted Channel Allocation (MACA) requires an IS-136-compatible mobile with MACA capability. MACA is the process by which a cell site asks a mobile that has accessed one of its DCCHs to measure and report the downlink signal strength of the serving DCCH and of the idle channels at the cell site. The cell site uses these measurements to determine which of the available channels offers the best downlink channel quality.

The MACA_TYPE parameter, which is in the MACA message sent by the E_BCCH from the cell site to the mobile, tells the mobile when to generate a MACA report. In the SEPA feature, the MACA_TYPE parameter is fixed to Report MACA at Page Responses and Origination. Therefore, every time the IS-136 mobile sends an Origination or Page Response to the cell site, it also sends a MACA report.

The MACA_STATUS parameter, that is in the MACA message sent by the E_BCCH from the cell site to the mobile, tells the mobile which MACA function(s) to perform and to report back to the cell site. In the SEPA feature, the MACA_STATUS parameter is fixed at MACA STM enabled, indicating that the IS-136 mobile will perform and send a Short Term Received Signal Strength (ST_RSS) measurement for the current DCCH. The ST_RSS value reported by the mobile is an average of at least four measurements of the serving DCCH’s signal strength. How is this measurement used? Let us return to the subject "Access Threshold."

The Separate Access Thresholds for DCCH and DTC (SEPA) feature introduces an additional cell site Access Threshold- the DCCH_SETUP_ACCESS parameter. When the cell site receives an Origination or Page Response from an IS-136 mobile camped on the SMS Channel of a DCCH, it also receives the MACA report of the serving DCCH’s signal strength (ST_RSS).

The cell compares the DCCH’s signal strength (ST_RSS) to the DCCH_SETUP_ACCESS parameter. The call is set up only if the signal strength of the serving DCCH (ST_RSS) is greater than or equal to the DCCH_SETUP_ACCESS threshold. This SEPA feature is only applicable for mobiles with MACA capability. For mobiles without MACA capability, the additional cell site Access Threshold check is not made and the call proceeds as usual.

The DCCH_SETUP_ACCESS parameter is a per-sector, translatable parameter for which there is an RC/V change to the ceqface form.

The SEPA feature introduces a second additional cell site Access Threshold, the ISS_DR_DCCH parameter. The ISS_DR_DCCH parameter indicates whether the Insufficient Signal Strength Directed Retry feature is enabled for the serving DCCH/ sector. By setting the ISS_DR_DCCH parameter, the service provider controls the conditions under which a Directed Retry will occur.

A call will be given directed retry when all of the following conditions are met:

- The ST_RSS measurement is below the cell site’s DCCH_SETUP_ACCESS threshold.
- The ISS_DR_DCCH Directed Retry feature is enabled for the serving DCCH/ sector.
- In the last ISS_DR_DCCH received by the cell site, the Directed Retry bit is not set.

For either of the two combinations of conditions below:

- The ST_RSS measurement is below the DCCH_SETUP_ACCESS threshold.
- The ISS_DR_DCCH's Directed Retry bit is set for the serving sector.

- or -

- The ST_RSS measurement is below the DCCH_SETUP_ACCESS threshold.
- In the last ISS_DR_DCCH received by the cell site, the Directed Retry bit is not set.

The following two actions will be taken:

A Reorder message will be sent from the cell to the mobile to allow the mobile to attempt an Origination.

- and -

A Release message will be sent to the mobile to allow it to attempt a Page Response.

The ISS_DR_DCCH parameter is a per-sector, translatable parameter for which there is an RC/V change to the ceqface form.

The SEPA feature also has two new Service Measurement Counters as follows:

TEDRTORIGINS is a count of the Directed Retries on DCCH Origination, which are caused by the ST_RSS measurement being below the cell site's DCCH_SETUP_ACCESS threshold. TEDRTORIGINS is measured at the Cell and pegged (i.e., counted) per Physical Antenna Face (PAF).

TEDRTRTERMINS is a count of the Directed Retries on DCCH Termination, which are caused by the ST_RSS measurement being below the cell site's DCCH_SETUP_ACCESS threshold. TEDRTRTERMINS is measured at the Cell and pegged (i.e., counted) per PAF.

Two-Branch Intelligent Anntenna (TBIA)

EDRU and DRM implementation of TBIA

The Two-Branch Intelligent Anntenna (TBIA) feature is implemented in the Enhanced Digital Radio Unit (EDRU) and the Dual Radio Module (DRM), which are both digital radios. The TBIA feature does not apply to analog equipment or to analog signals on digital equipment.

The EDRU is in the Time Division Multiple Access (TDMA) family of products and is used in the Series II Classic, Series IIe, Series IIm, Series IImm, and Personal Communications Systems (PCS) TDMA Minicell products. The DRM is in Lucent's Flexent family of products. The TBIA feature does not have or add a separate EDRU or DRM Non-Volatile Memory (NVM) image. Both the existing EDRU NVM images (packet pipe & non-packet pipe) incorporate the new software. The TBIA feature requires TDMA R13 software.

The TBIA feature is implemented via software modifications in the Digital Signal Processors (DSPs) in the EDRU and the DRM. No changes need to be made to *any* Cell Site hardware. Therefore, the TBIA feature does not impact an existing base station's RF footprint, antennas, size, or power. The TBIA feature does not require any external products and has no OEM dependencies. The TBIA feature has no impact on mobiles. Therefore, no particular mobile types are required.

For both the EDRU and the DRM, the TBIA feature is applied to the:

- Digital Traffic Channel (DTC)
- Digital Control Channel (DCCH)

TBIA Performance

The critical aspect of the TBIA feature is that in an interference dominated environment, it provides better voice quality on the reverse link (Mobile to Base Station) by reducing the perceived Bit-Error Ratio (BER) on the order of 3 dB, in the presence of co-channel interference. That is, on average, BER decreases by a nominal 3 dB when compared to the Maximal Ratio Combining (MRC) technique previously used by the EDRU and the DRM to combine receive diversities.

The level of improvement depends on the distribution of co-channel users in neighboring cells. Using software processing, The TBIA feature allows each 30 kHz TDMA channel, to reduce or eliminate the effects of co-channel interference within the EDRU's or DRM's field of view using baseband processing that combines the spatially separated diversities and applies the adaptive interference rejection. The TBIA feature's baseband processing is able to steer a spatial null at one co-channel interferer.

In a noise limited environment, the TBIA feature equals the performance of the existing maximal ratio combining technique used and does not significantly degrade the performance (received SINR or lost call rate) of the EDRU or DMR.

Therefore, while the TBIA feature does not improve Carrier-to-Noise (C/N) performance it does not degrade it.

NOTE:
When the TBIA feature is turned on, the service provider may witness lower average C/I measurements derived from PLM data. This does not mean that the interference levels have worsened; rather, it is due to improved BER performance in the presence of the interference.

Finally, while the TBIA feature does not increase the existing capacity or range of a base station in a noise limited environment, it can be used with a tower top Low Noise Amplifier (LNA) to provide interference rejection and range extension on the reverse link in a noise limited environment.

TBIA Availability

To expedite the TBIA feature to customers in the field, Lucent is releasing it in two phases. Phase one incorporates the adaptive interference rejection technique, versus the previously used Maximal Ratio Combining technique, into the differential path of the DSPs in the EDRU and the DRM. Phase two of the feature will add the adaptive interference rejection technique into the trellis equalization path.

TBIA Activation

The TBIA feature is *activated* by a Qualified Feature Activation File (QFAF) on a per Cell Site basis. There are no QFAF activation translations for selecting the differential detection path versus the equalization path in the EDRU or the DRM.

The TBIA feature is *enabled* (or disabled) from the Mobile Switching Center (MSC) by translations which select adaptive interference rejection mode, or maximal ratio combining mode, on a logical face by face basis for the DTC and a sector by sector basis for the DCCH.

Code Division Multiple Access (CDMA)

4

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CDMA Overview

CDMA is a method that increases voice traffic on the existing cellular frequency spectrum. CDMA is defined within the IS-95 document, which was produced by the Telecommunications Industry Association (TIA) TR45.5 Subcommittee on Wideband Spectrum Digital Technology.

CDMA promises to increase the capacity of current AMPS cellular networks by as much as ten-fold, as well as provide for new user applications and improved quality of service. The Series II CDMA technology conforms to the TIA IS-95 standard.

CDMA uses a direct sequence spread spectrum technology. In this technology radio signals are spread across a single 1.23 MHz-wide frequency band. Individual calls are modulated by the three unique Pseudo-random Number (PN) codes during transmission and decoded using those three codes during reception. Signals that do not contain the code matches are treated as noise and ignored. By using this method, a large number of CDMA calls may occupy the same frequency spectrum simultaneously. Two or more users communicate simultaneously over the same wide frequency band. (The wide frequency band is referred to as the *CDMA carrier.*) To distinguish between users, the system assigns each user a distinct binary code.

The system spreads the transmitted power over a wide frequency band so that the power per unit bandwidth (watts per hertz) is very small. Then, at the receiver, the signal is compressed into its original narrow band while leaving the power of other (interfering) signals scattered over that same extremely wide transmission band.

With CDMA, the bandwidth of a user's data is spread over a larger bandwidth (1.23 MHz) by multiplying it by a binary code (sequence). The same code is used by the receiver to undo the spreading and recover the original data—accomplished by multiplying the received signal by the known code and filtering through a low-pass filter. The other users' data, whose codes do not match, are not despread in bandwidth; they contribute only to the noise and represent a self-interference generated by the system. *There is no hard limit on the number of system users.*

Transition to CDMA

CDMA, TDMA, and AMPS can coexist in the same cellular system. Initially, CDMA will be assigned to 1.23 MHz of the cellular frequency spectrum, which is the minimum practical spectrum that CDMA can use.

A set of Cell Sites capable of covering the entire geographic area will be identified and equipped with CDMA radio equipment. (The number of Cell Sites will be far fewer than required by AMPS, as clarified in the following section, *Advantages Compared with AMPS and TDMA.*) Although only the selected Cell Sites are equipped with CDMA radio equipment, the 1.23-MHz segment of spectrum for the

CDMA carrier is set aside in all Cell Sites in the local area (that is, the area of coverage), to prevent mutual interference between AMPS and CDMA transmissions.

The CDMA technology can be added to the Series II Cell Site by (1) adding one or two CDMA growth radio channel frames (RCFs), (2) replacing the reference frequency generator with a reference frequency and timing generator (RFTG) to support timing based on a Global Positioning System (GPS), and (3) adding a GPS antenna.

AMPS and TDMA technologies can be supported in other RCFs, if desired. A typical technology integrated configuration will consist of a primary RCF for AMPS and a CDMA growth RCF for CDMA.

CDMA Advantages Compared with AMPS and TDMA

The real advantage of CDMA is the way it exploits the sporadic nature of conversation. People speak only about 35% of the time during a typical telephone conversation. When users assigned to the CDMA carrier are not talking, all others on the carrier benefit with less interference. The voice activity factor reduces mutual interference by 65%, increasing the actual carrier capacity by three times.

Other advantages include:

- One radio per site - Only one radio is needed at each omnidirectional Cell Site or at each sector of a multi-sector Cell Site
- Frequency reuse factor of 1 - Unlike current AMPS and TDMA access technologies, which require frequency engineering to avoid co-channel (same channel) interference in nearby cells, the same block of CDMA spectrum may be reused in every cell or sector. CDMA, by its very design, can decode the proper signal in the presence of high interference.

  In AMPS and TDMA, frequency management is both a critical and difficult task to carry out. Since the frequency reuse factor is 1 for CDMA, no frequency management is needed for CDMA.
- No hard capacity limit - The number of users that can use the same CDMA carrier and still have acceptable performance is determined by the total interference power that all of the users generate in the receiver.

  The question is NOT, “Is there a conflict that will produce interference?”, but “Do enough conflicts occur often enough to degrade the quality to an unacceptable level?” Spread spectrum takes advantage of the fact that at any given time, there will be enough open holes in the spectrum for enough information to get through.

  The odds of a conflict depend only on the likelihood of two or more users landing on the same frequency at the same time. The more users, the more collisions. Signal quality is measured as a bit error rate (BER). For voice, a BER of 10^{-3} or better (10^{-4} is better) is considered acceptable. (A BER of 10^{-3} means that one out of a thousand bits is faulty.)

- Low RF power - CDMA requires less RF power than AMPS or TDMA to transmit and receive over the same distance with comparable quality. Thus, mobile subscribers with portable equipment will require lower RF power levels to obtain acceptable call quality, thereby lengthening portable battery life and talk times.

  The reduced RF power requirement also provides the ability to transmit over greater distances with the same power level used for existing technologies. The reduced RF power requirement is, in part, due to the presence of multipath RF signals.

- Multipath exploitation - Whereas AMPS and TDMA suffer losses and interference due to naturally occurring multipath RF signals, CDMA signal quality actually improves under such conditions. This characteristic greatly improves in-building RF penetration.

  CDMA receivers (called *rake receivers*) use three or four parallel correlators to receive and track separately the strongest of signals in multiple paths. The receiver then combines the signals constructively (in-phase) and uses the result to demodulate the signal. While there is fading on each arrival, the fades are usually independent of one another. A loss in performance occurs only when all correlators experience fades at the same time.

  The multiplicity of correlators is also the basis for *soft handoff.*

- Soft handoff - Soft handoff permits a call to be carried by two or more cells or two or more sectors at the same time while the mobile station is traveling through a handoff zone. The difference in arrival time of signals from the cells or sectors is treated just as multipathing—the mobile receiver combines the signals constructively.

  A handoff in AMPS or TDMA, referred to as a *hard handoff*, is performed on a “break before make” basis: the old link is dropped before the new link is established. In contrast, a soft handoff in CDMA is performed on a “make before break” basis: the old link is dropped only after the mobile chooses the new link—the one carrying the best quality signal.

  A soft handoff virtually eliminates the interference, clipping, and clicks commonly associated with a hard handoff. Since every cell uses the same CDMA carrier, the only difference in transmission is the binary codes (sequences); there is no handoff from one frequency to another frequency. The probability that a CDMA call will be discontinued if the handoff command is received in error is substantially reduced.

- High level of security - Should a spread-spectrum signal be intercepted, the data cannot be decoded without the knowledge of the appropriate binary code.
- Spread-spectrum transmission is not totally secure, but it is private. A casual listener will not be able to intercept the message.For microcell and in-building systems - CDMA is a natural waveform suitable for microcell and in-building wireless systems because of its tolerance to noise and interference.

Capacity

The major system factors determining the capacity of the CDMA system are as follows:

- Voice duty cycle (@ 3.5)
- Frequency reuse factor (1)
- Number of sectors in the cell (1 to 6)
- Processing gain
- Required E_c/I_o

The processing gain of the CDMA system is given by the ratio of the binary code rate (1.2288 Mbit/s) to the baseband data rate (9.6 or 14.4 kbit/s). For a baseband data rate of 9.6 kbit/s, the processing gain is approximately 21 dB.

E_c/I_o is a signal-quality measurement, where E_c is the energy per bit, and I_o is the interference power per hertz. (E_c/I_o at the baseband is closely related to the carrier-to-interference [C/I] ratio received at the RF.) The higher E_c/I_o, the better the signal quality.

CDMA/AMPS Dual-Mode Operation

The GPS equipment provides precise timing of data packets between the 5ESS-2000 Switch DCS and the Series II Cell Site. The GPS also provides precise timing for the 20-ms packets transmitted by the Code Division Multiple Access (CDMA) radios. The SCT boards are added to the TDM bus (which should be installed "red stripe up"). The DFI is REQUIRED for CDMA packet pipes.

A CDMA/AMPS dual-mode mobile station complying with the TIA IS-95 standard can obtain service by communicating with either CDMA radios or AMPS radios at the Cell Site. Whether the communication is CDMA or AMPS depends on the availability of either system in the geographic area of the mobile station as well as the preferred call mode of the mobile station. The preferred call mode can be *CDMA-only*, *AMPS-only*, or *dual-mode CDMA* (either CDMA or AMPS).

There are two types of CDMA/AMPS dual-mode mobiles:

- IS-95A compliant mobiles
- IS-95B compliant mobiles

IS-95A compliant mobiles can only access the CDMA system via 8-kbit/s vocoders, whereas IS-95B compliant mobiles can access the CDMA system via 8-kbit/s *or* 13-kbit/s vocoders. A 13-kbit/s vocoder, as compared to an 8-kbit/s vocoder, provides better sound fidelity.

Lucent Technologies CDMA Architecture

The Lucent Technologies CDMA architecture (see Figure 4-1) is built on the current Series II platform, consisting of the Series II Cell Site, the 5ESS®-2000 Switch DCS, and the ECP complex (See). CDMA requires new speech-handling equipment at the switch and new radio equipment at the Cell Site.

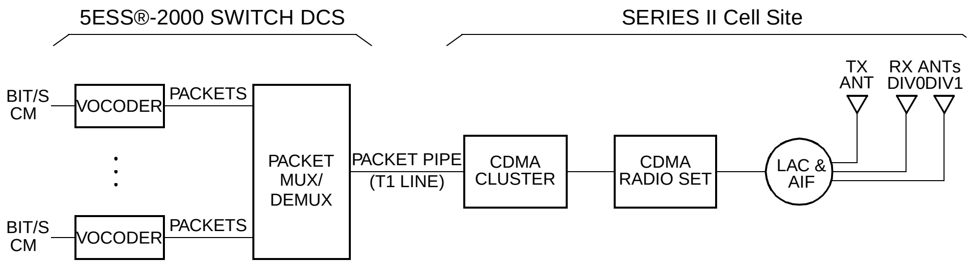


Figure 4-1. High-Level View of the Lucent Technologies CDMA Architecture

Hardware Requirements

New hardware required to implement Code Division Multiple Access (CDMA) in a Series II Cell Site. Series II Cell Sites must be equipped with the following CDMA equipment:

- **One CDMA growth radio cabinet**, which includes one shelf of CDMA radio equipment per antenna face
- **Global Positioning System Receiver (GPS)**, Reference Frequency and Timing Generator (RFTG), and associated Synchronized Clock and Tone (SCT) boards
- **Digital Facilities Interface (DFI)** supporting two T1 or E1 and providing two physical DS1 (Digital Signal - Level 1) interfaces.
- **Radio Control Complex (RCC**) shelf, which requires 8 Mbytes of RAM (Random Access Memory) for Cell Release 6.0
- **Optional test equipmen**t

To support CDMA, the DCS must have a 5ESS-2000 Switch DCS as one of its switch elements. As an alternative, existing DCSs can be used as hub switches for CDMA Cell Sites. That is, CDMA traffic can be routed through the Definity DCS to a 5ESS-2000 Switch for processing.

With R12.0, vocoders have been relocated to the switch. This feature is referred to as “Switch-Based Vocoder." To know more about this feature and the benefits it provides, refer to Chapter 3.

Transmission trunking for CDMA traffic between the MSC and the Cell Site is known as a *packet pipe*. A CDMA packet pipe, which has a variable bandwidth from two to eight DS0s, saves T1 (or E1) facilities by concentrating conversations approximately 3.5 to 1. For example, assuming 8-kbit/s vocoders and 64-kbit/s T1 channels, two-, four-, and eight-DS0 wide packet pipes can handle respectively 6, 14, and 30 simultaneous CDMA calls. (One vocoder is required for each CDMA call.) Each packet pipe is dedicated to one and only one CDMA cluster at the Cell Site. Switch-based vocoder packet pipe (PP) implementation on CDMA cell sites requires that DFI boards be installed at the cell.

All CDMA trunks must be located in the 5ESS-2000 Switch DCS, but AMPS and TDMA trunks can still be located in a DEFINITY Switch DCS.

NOTE:
Currently, a CDMA cluster can support up to 14 traffic channels (one user per channel), requiring a 4-DS0 wide packet pipe for 8-kbit/s vocoders or a 6-DS0 wide packet pipe for 13-kbit/s vocoders. (Packet pipes configured for wider bandwidth are reserved for future, higher capacity CDMA clusters.) You can use the variable width packet pipe feature to set or change the size of packet pipes.

Up to 90 simultaneous CDMA calls can be carried on a single T1 facility. A T1 (or E1) facility can carry any combination of AMPS, TDMA, and CDMA traffic, as well as Cell Site data links (signaling channels).

The remaining new circuitry consists of the CDMA Radio Module (CRM) that serves one face. The CRM is located on the CDMA radio shelf. The CRM will be discussed in detail later in this chapter. The basic Radio Frequency (RF) combiners, Linear Amplifier Frame (LAF), and filter assemblies have not changed from the AMPS/TDMA. Series II Linear Amplifier Circuits (LACs) in existing systems require a Version 12 firmware upgrade.

Speech-Handling Equipment at the DCS

To process CDMA calls, the 5ESS-2000 Switch DCS must be equipped with a packet switching unit (PSU) cabinet. The interface to the PSU is through the switching module (SM) of the 5ESS-2000 Switch; an SM can interface with only one PSU.

The PSU handles CDMA traffic to and from the mobile station through the Cell Site. The following types of plug-in units within the PSU perform the CDMA voice processing:

- Protocol Handler for Voice (PHV) - The PHV contains 12 CDMA vocoder circuits and, therefore, can support up to 12 CDMA calls. The PHV transmits packets to and receives packets from the mobile station through the Cell Site.

  In the forward direction (toward the mobile station), the vocoder compresses 64-kbit/s pulse-code modulation (PCM) digital voice to produce a much lower data rate, and then assembles the compressed data into packets. In the reverse direction (from the mobile station), the vocoder reverses the operation.

Two different types of vocoders are available: one that compresses data to 8 kbit/s and one that compresses data to 13 kbit/s. (The 8 kbit/s vocoders are located on PHV-1s, and the 13-kbit/s vocoders are located on PHV-2s.) The higher the compression rate (13 kbit/s is higher), the better the sound fidelity in terms of both frequency response and inherent noise.

The vocoder generates data at one of four variable rates depending upon the speech activity of the user. The data rate may be full rate, half rate, quarter rate, or eighth rate. Variable rate signal coding permits “bandwidth on demand” for data transmission, thereby raising capacity.

NOTE:
Currently, a 5ESS-2000 Switch DCS can have either all 8-kbit/s vocoders or all 13-kbit/s vocoders but not a mixture of both. In addition, an entire cellular geographic service area (CGSA) must operate at the same vocoder rate: the mixing of 8-kbit/s and 13-kbit/s vocoders in a CGSA is not supported.

- Frame Relay Protocol Handler (FRPH) - The FRPH provides the interface between the packet pipes (Refer to Table 4-1) and the frame relay packet switching platform.

Table 4-1. Packet Pipe Capacity

No. of DS0s	8-kbit/s Service		13-kbit/s Service	
	56-kbit/s Channels (No. Of DS0s x 4 - 3)	64-kbit/s Channels (No. Of DS0s x 4 - 2)	56-kbit/s Channels (No. Of DS0s x 3 - 3)	64-kbit/s Channels (No. Of DS0s x 3 - 2)
2	5	6	3	4
3	9	10	6	7
4	13	14	9	10
5	17	18	12	13
6	21	22	15	16
7	25	26	18	19
8	29	30	21	22

- A single FRPH can handle 46 CDMA calls when 8-kbit/s vocoders are employed, or 42 CDMA calls when 13-kbit/s vocoders are employed. Accordingly, a single FRPH can terminate three packet pipes, assuming that the packet pipes connect to CDMA clusters each having a 14 traffic channel capacity. For lower capacity CDMA clusters, a single FRPH can terminate considerably more packet pipes.

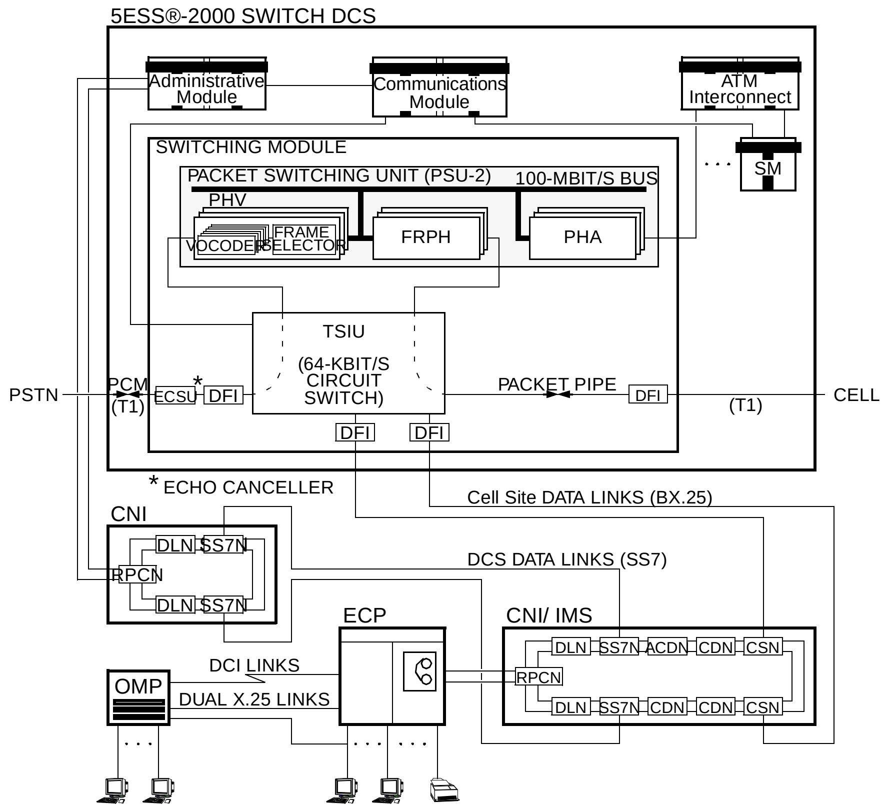
Each FRHP is dedicated to certain packet pipes and therefore certain CDMA clusters. A packet pipe is a static (dedicated) connection path from the FRPH to the CDMA cluster. All hardware, DS0s, and TDM bus timeslots in the path are assigned statically (“nailed up”) in accordance with the translations.

- Protocol Handler for Asynchronous Transfer Mode (ATM) (PHA) - The PHA provides the ability to interconnect to other PSUs. This allows packet pipes terminating at the FRPH in one PSU to communicate with a PHV residing in another PSU. PHAs may be connected directly using a point-to-point connection, or can be connected through an ATM center stage for larger offices.

Call Setup

A CDMA traffic-channel path is static except for the connections between the FRPH and the PHV, and the PHV and the PSTN. Those connections are set up and torn down dynamically by the call processing and data base node (CDN). The CDN receives a call setup message from one of the following: the PSTN or Cell Site via a DCS or Cell Site data link. The CDN, working with the 5ESS-2000 Switch DCS, decides how to complete the call.

The 5ESS-2000 Switch DCS chooses a PHV to handle the call and then sends the PHV identification to the CDN. The CDN, in turn, sends the PHV identification to the Cell Site. (The Cell Site includes the PHV identification in the address portion of the packets so that the FRPH knows how to route the packets through the switch.) The CDN also sends the trunk group and member associated with the packet pipe to the 5ESS-2000 Switch DCS so that the switch knows which FRPH to use to complete the traffic-channel path (see Figure 4-2).



DEFINITIONS PERTAINING TO CDMA HARDWARE:

ATM	Asynchronous Transfer Mode	PHA	Protocol Handler For ATM
FRPH	Frame Relay Protocol Handler	PHV	Protocol Handler For Voice

Figure 4-2. Series II Cell Site Code Division Multiple Access (CDMA) Communications Path

Mobile-to-Mobile Calls

Because the voice processing is performed at the switch, vocoders are bypassed for mobile-to-mobile calls, which improves call quality. Packet exchange at the switch involves only the two FRPHs participating in the mobile-to-mobile call. (It could involve only one FRPH if both mobiles are communicating through the same CDMA cluster.)

Radio Equipment

Radio Control Complex (RCC)

The Central Processing Units (CPUs) of the fully redundant Radio Control Complexes, RCC 0 and RCC 1, communicate over the update bus (See Figure). The active RCC updates the standby RCC memory over the update bus. Each RCC uses its own system bus to communicate with the:

- Alarm/FITS (Factory Installation Test Set) interface, which monitors up to 18 user-assignable external alarms
- Network Control Interface (NCI), which provides communications between the active RCC and the Time Division Multiplex (TDM) bus (which should be installed "red stripe up"); one NCI is required per TDM bus
- Communications Processor Interface (CPI) to send and receive data link messages
- Random Access Memory (RAM)
- CDMA Radio Test Unit (CRTU) Interface Board (CRTUi) -
- Peripheral units, such as Clock And Tone (CAT), Radio Channel Unit (RCU), etc., over the TDM bus.

The CDMA equipment connects directly to the TDM bus. A CDMA growth frame may be added to an existing system by either extending the current TDM bus, or by adding a new NCI in each RCC and connecting the CDMA growth frame to the new TDM bus. A TDM bus should always be installed "red stripe up."

CDMA Series II Cell Site Radio Control Complex (RCC) Shelf Changes

CDMA uses the traditional RCC shelf (see Figure 4-3). However, there are several changes to the RCC memory. When the RCC is used with Cell Release 5 and earlier, only four Mbytes of RAM memory is required (TN169). However when the RCC is used with Cell Release 6 and later, the CDMA software requires more than 4 Mbytes of memory; 8 Mbytes of RAM is required. This applies when any Radio Frame Set (RFS) is equipped with CDMA radios. Within a single RCC, 2 4-Mbyte boards could be placed on each side of the RCC, or a new 8-Mbyte board (TN1710) could be used to replace the 4-Mbyte boards in slots 072 and 102.

The CRTUi, which resides in RCC Slot 15, acts as an interface between the RCC (via the TDM bus) and the CRTU Mobile (via RS-422). The CRTUi controls all CRTU functions that are needed to support functional and diagnostic processes.

Although the CRTUi sits in the RCC shelf, it is not considered part of the RCC maintenance object at the MSC. In addition, the CRTUi is accessible from either side of the RCC regardless of which RCC side is active as long as there is power to the side on which the CRTUi resides.

The heart of the CDMA system is the CDMA radio shelf, which consists of both CDMA modem equipment and RF equipment. Only a single RF transmitter/ receiver is required for each antenna.

Each of the two CDMA clusters in a CDMA radio shelf holds multiple CDMA modems referred to as *channel elements*. A channel element can be configured as an overhead channel or voice (traffic) channel. The main function of a channel element configured as a traffic channel is to spread the narrowband signal coming from the MSC and despread the wideband signal coming from the air interface.

In the forward direction, each CDMA cluster merges its multiple channel-element output into a serial digital stream for input to the CDMA radio set. The CDMA radio set combines the serial digital streams from the CDMA clusters, converts the serial digital baseband data to analog baseband signals, and up-converts the analog baseband signals to RF. The RF passes through a high-power amplifier (LAC) and a transmit filter to the transmit antenna. In the reverse direction, the received RF passes through the receive antennas, receive filters, and low-noise amplifiers to the CDMA radio set. The CDMA radio set down-converts the RF to analog baseband signals, converts the analog baseband signals to serial digital baseband data, and passes the data to the CDMA clusters for processing.

The timing to the CDMA system is provided by a GPS receiver in the RFTG. The original application of the satellite-based GPS was to precisely locate a ship or airplane in latitude, longitude, and altitude. The satellite-based GPS has grown to have other applications such as establishing precise worldwide time that could aid in synchronizing digital communications. In a CDMA system, the importance of the combined synchronization process between transmitter and receiver cannot be overstated; if synchronization is not both achieved and maintained, the desired signal cannot be detected by the receiver.

The GPS antenna, which is approximately one foot high, can be placed anywhere near the Cell Site that is appropriate for the best reception of the required number of GPS satellites. The GPS antenna is usually mounted on the outside of a building, not on a tower.

NOTE:
For GPS antenna installation procedures, refer to the *CDMA GPS Antenna Installation Guidelines* (401-610-160).

Cabinet Configurations

A typical Series II CDMA configuration (see Figure 4-3) contains a CDMA growth frame attached to one existing FDMA/TDMA frame. Initially, only two radio cabinet configurations are supported. Future configurations will support up to three CDMA radio frames, including a CDMA-equipped RCC frame. This configuration will yield a total of 15 CDMA radio shelves, three in the first frame and six in the remaining two frames.

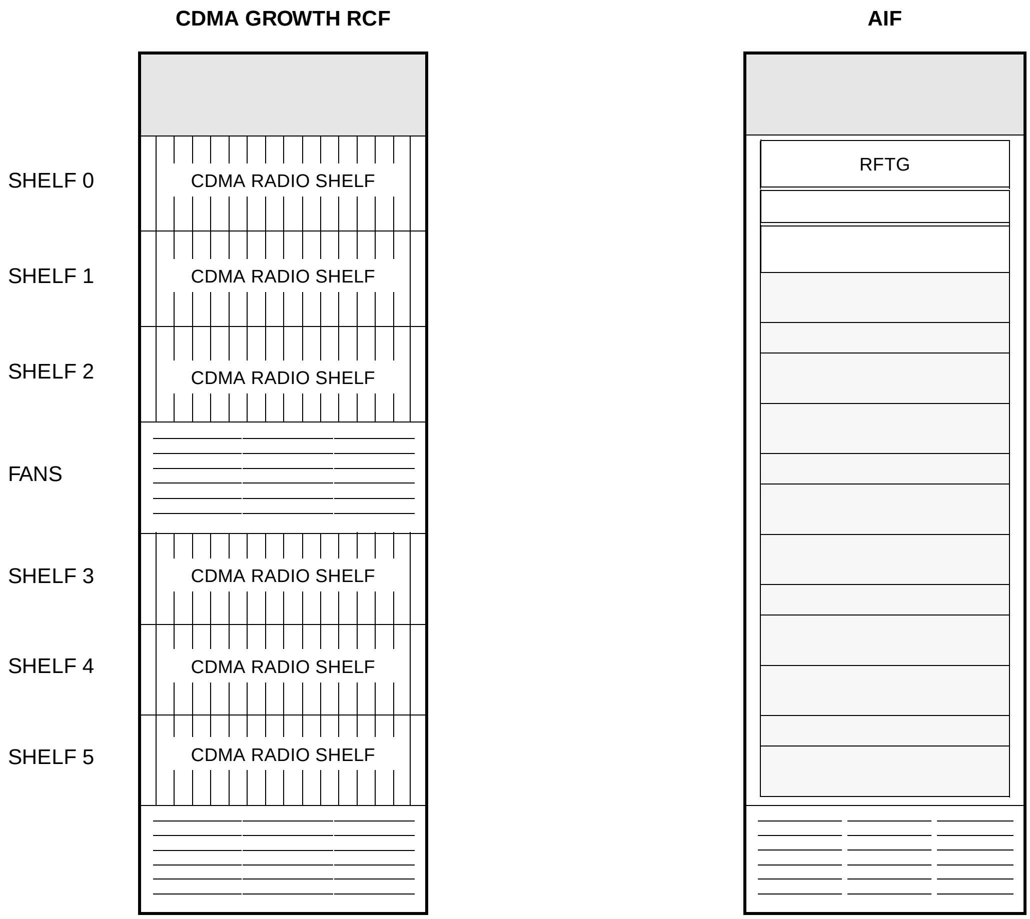


Figure 4-3. CDMA Cell Site Equipment

There are certain Series II cabinet configuration rules that apply to how CDMA and FDMA/TDMA radio equipment are configured:

1. The FDMA/TDMA radio shelves may not occupy the same radio cabinet as CRMs.
2. If both FDMA/TDMA and CDMA are required, a minimum of two RCF frames is required.
3. There is a maximum of one CDMA shelf for omni, and three CDMA shelves for a three-sector configuration, (i.e., one per face). The CDMA shelves must be located within the same RCF frame.

An all-CDMA system has a maximum of 15 CDMA shelves: three in RCF0, six in RCF1, and six in RCF2 (see Figure 4-4).

There are three types of equipment shelves on the CDMA Growth Radio Frame. These shelves are listed below:

1. **The interconnect panel** which is used to distribute the 15.00-MHz reference frequency from the RFTG to the radio shelves and to interconnect Code Division Multiple Access (CDMA) radio equipment to both existing transmit and receive antenna faces
2. **CDMA radio shelves (numbered 0 through 5** from top to bottom) which contain the following equipment:
   - Power converters that require +24 volt, 45 amp. feeder and return
   - One or two CCCs - each CCC contains 7 CCUs
   - As many as 14 CCUs (CDMA Channel Units) - each CCU contains two CEs (8-kbps vocoders)
   - One or two Baseband, Bus and Analog (BBA) trio circuits

   For CDMA 1.0, there is one radio shelf per antenna face. Because CDMA 1.0 supports omni, two-sector, and three-sector cells, there may be 1, 2, or 3 CDMA radio shelves. Additional shelves will be supported in future CDMA releases.
3. **Fan units** - Provide cooling to both upper and lower equipment shelves.

The Code Division Multiple Access (CDMA) shelf contains the circuit packs needed to perform the spread spectrum processing on CDMA channels. A CDMA channel consists of the following equipment:

- A CDMA Channel Unit (CCU)
- CDMA Channel Elements (CEs)

CDMA radios are installed in their own growth RCF, which is designed to house 12 CDMA radios—two (redundant) radios per shelf. (One CDMA radio is active and one is standby). CDMA radios cannot be installed in the primary RCF, nor can they be intermixed with RCUs, SBRCUs, DRUs, or EDRUs in the same growth RCF. Since there can be up to two growth RCFs in a radio frame set, the Series II Cell Site can accommodate up to 24 CDMA radios.

The TDM buses interconnect the RCC with the other units in the primary and growth RCFs. TDM buses are installed "red stripe up." The interconnections are accomplished as follows:

- On the primary RCF, the TDM bus interconnections are accomplished via AYD4 and AYD12 paddleboards (circuit boards) that mount onto the wiring side of certain backplane pinfields. Each of these paddleboards has a connector that provides termination to flat ribbon cable, thus providing the means to complete the necessary interconnections.

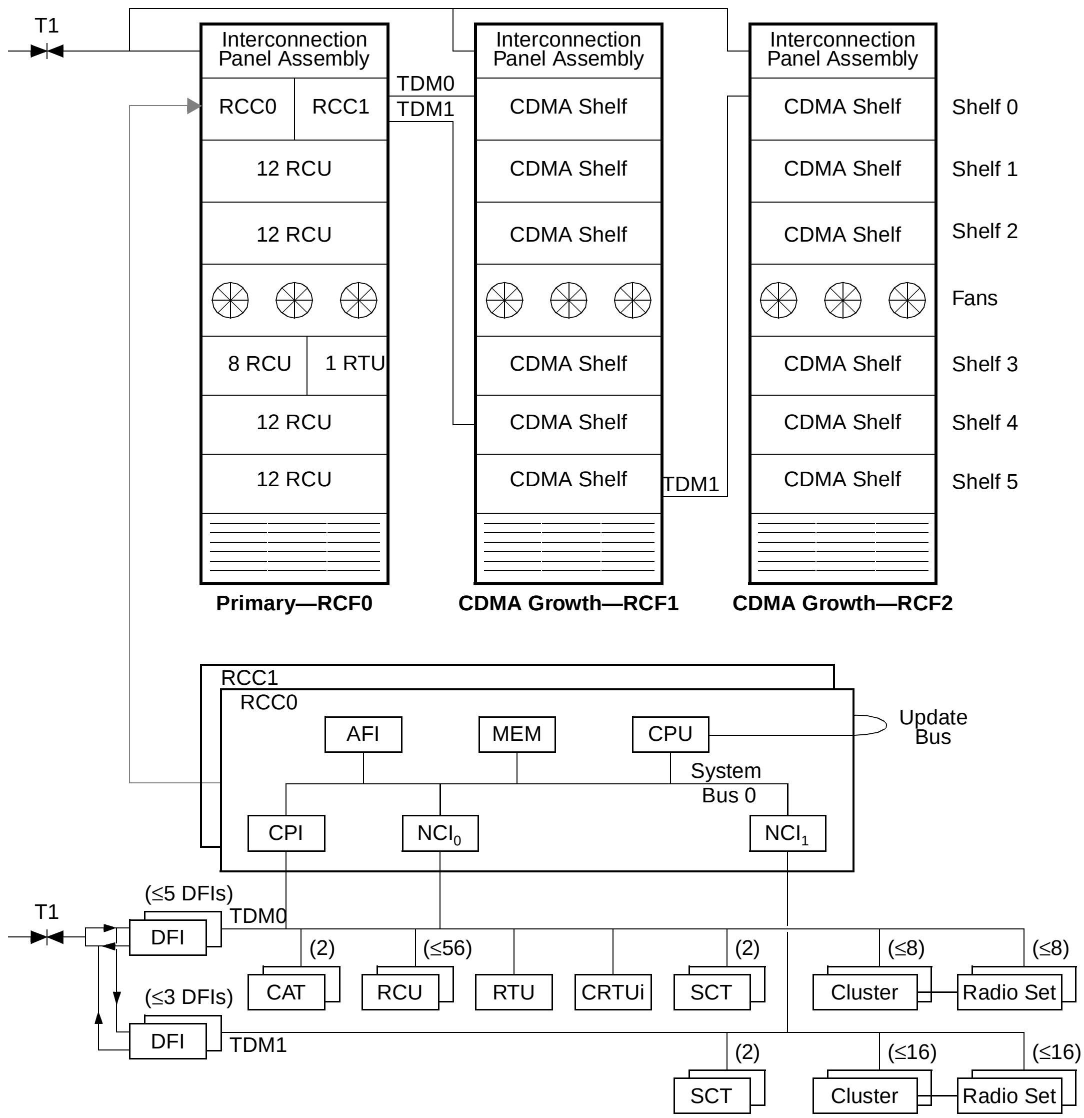


Figure 4-4. Radio Frame Set Having Two CDMA Growth RCFs (TDMs install "red stripe up")

- On the CDMA growth RCFs, the TDM bus interconnections (see Figure 4-5) are accomplished via P3 and P30 connectors located on the wiring side of each of the backplanes. Each connector provides termination to flat ribbon cable, thus providing the means to complete the necessary interconnections.

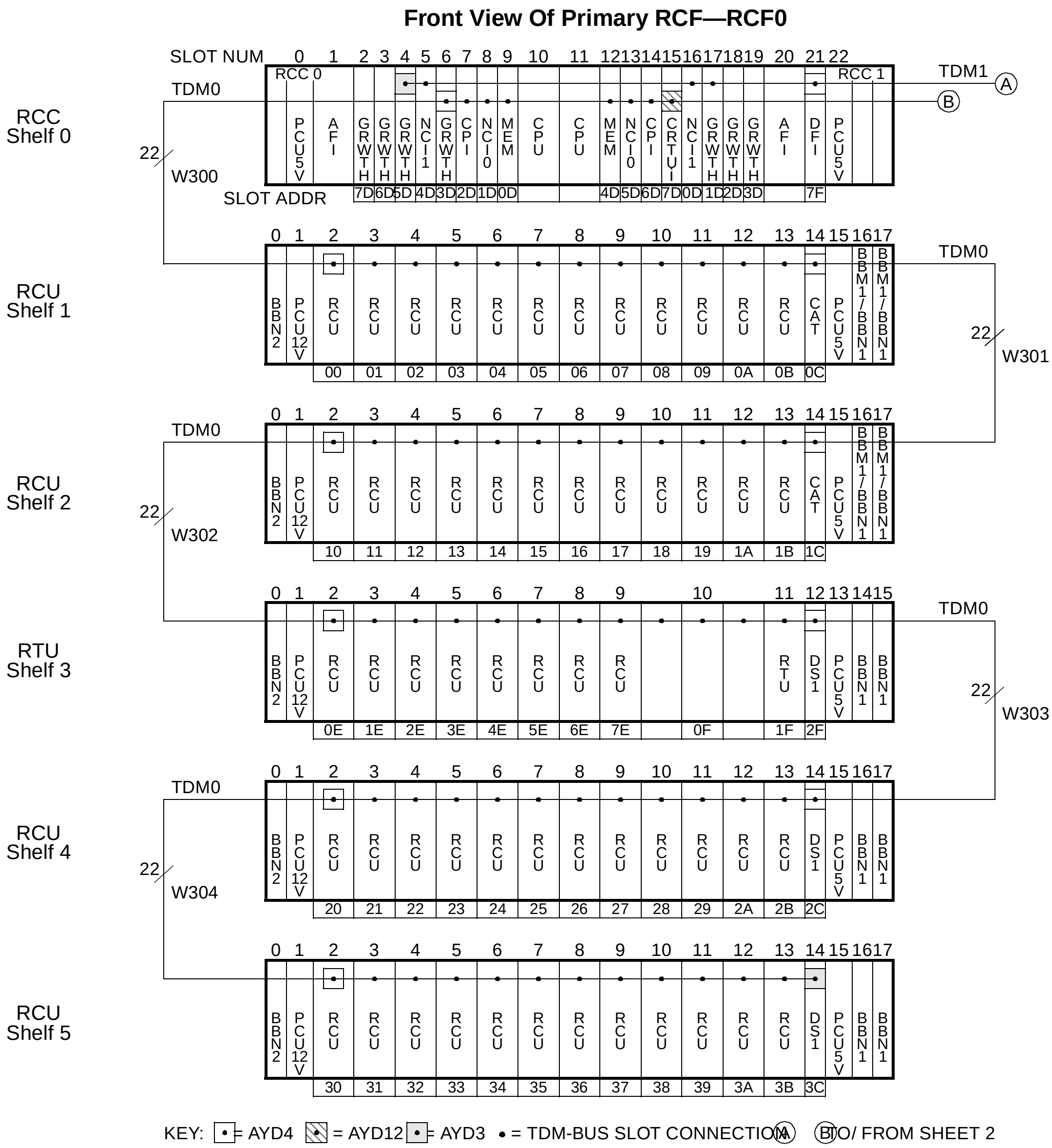


Figure 4-5. Physical View of TDM Buses at the CDMA Series II Cell Site (TDMs install "red stripe up") (Sheet 1 of 3)

Front View Of First CDMA Growth RCF (GRCF1)

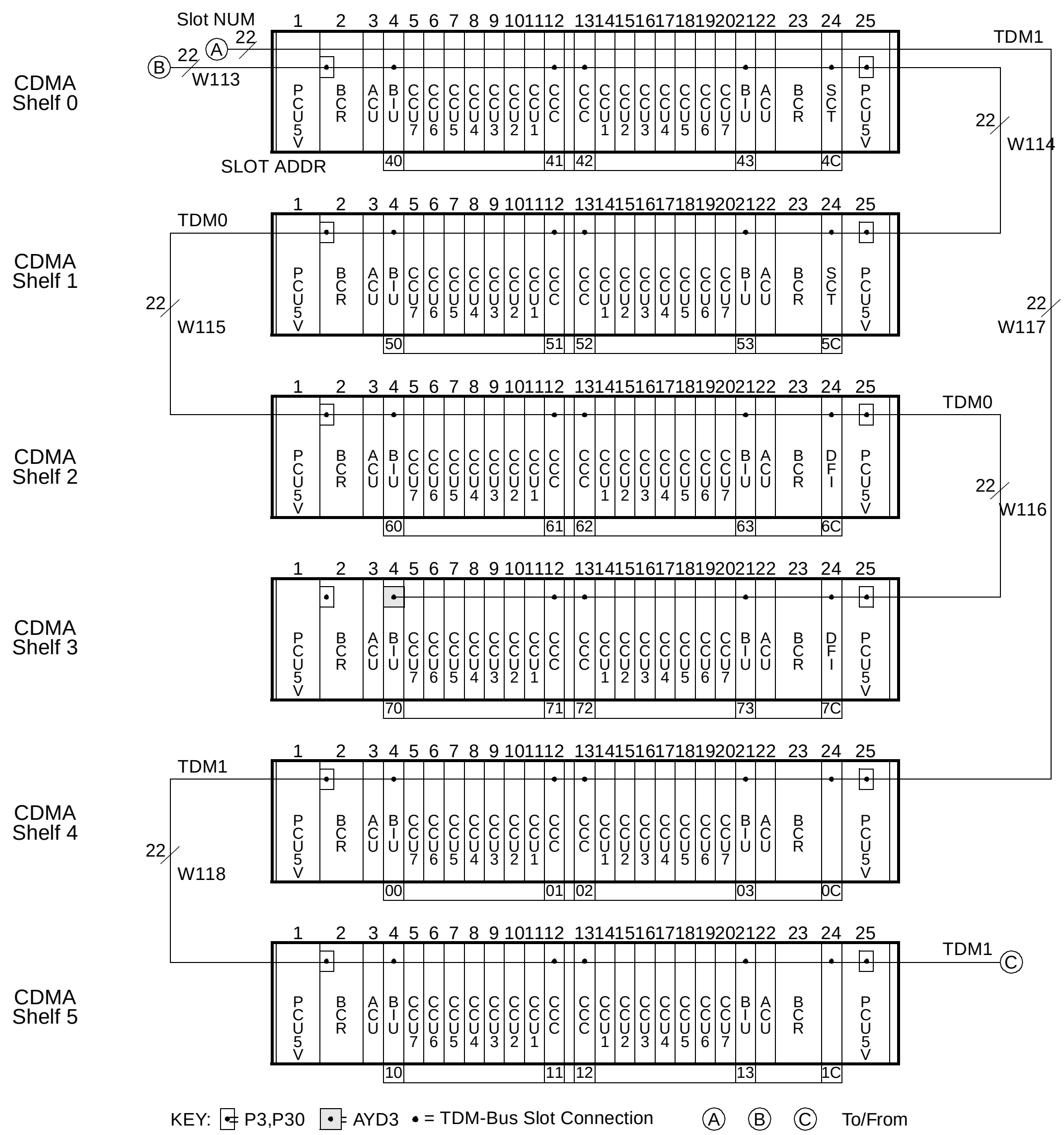


Figure 4-6. Physical View of TDM Buses at the CDMA Series II Cell Site (TDMs install "red stripe up") (Sheet 2 of 3)

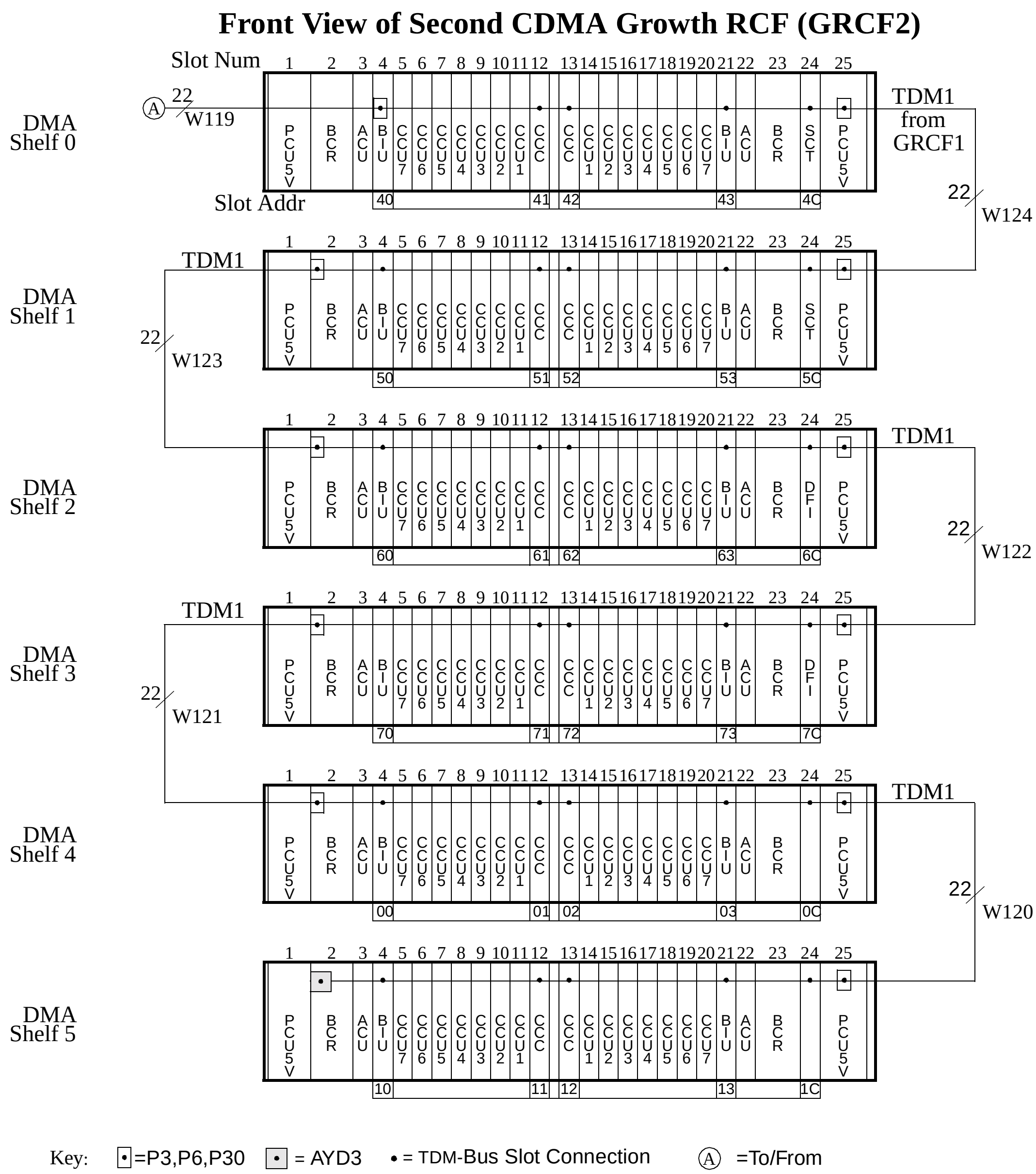


Figure 4-7. Physical View of TDM Buses at the CDMA Series II Cell Site (TDMs install "red stripe up") (Sheet 3 of 3)

In addition, all TDM buses are terminated via AYD3 termination paddleboards that mount onto the wiring side of certain backplane pinfields. (TDMs install "red stripe up").

If the radio frame set consists of only the primary RCF and a CDMA growth RCF and assuming that shelf 4 and/or shelf 5 of RCF1 is populated with CDMA equipment, an AYD3 termination paddleboard is installed on the wiring side of RCF1 shelf 5, slot 24. In addition, to generate clock signals for TDM1, redundant CAT units are installed in RCF1 shelf 4, slot 24, and RCF1 shelf 5, slot 24.

NOTE:
The CDMA radio test unit interface (CRTUi) board installed in shelf 0, slot 15, of the primary RCF allows the RCC to communicate with the IS-95B compliant mobile station located in the CRTU module (CRTUm).

Radio Shelf

The CDMA radio shelves use a new backplane that is not compatible with FDMA/TDMA radio frames or shelves.

There is a maximum of one CDMA shelf for omni configuration, and one CDMA shelf per face for three-sector configuration. Figure 4-8 shows the CDMA radio shelf.

CDMA radio shelves may be configured per face. However, cabinet configurations may allow the CCUs on a shelf to service any of three associated faces. CDMA radio shelves may be configured per face (A dual shelf arrangement will be available in the future)..

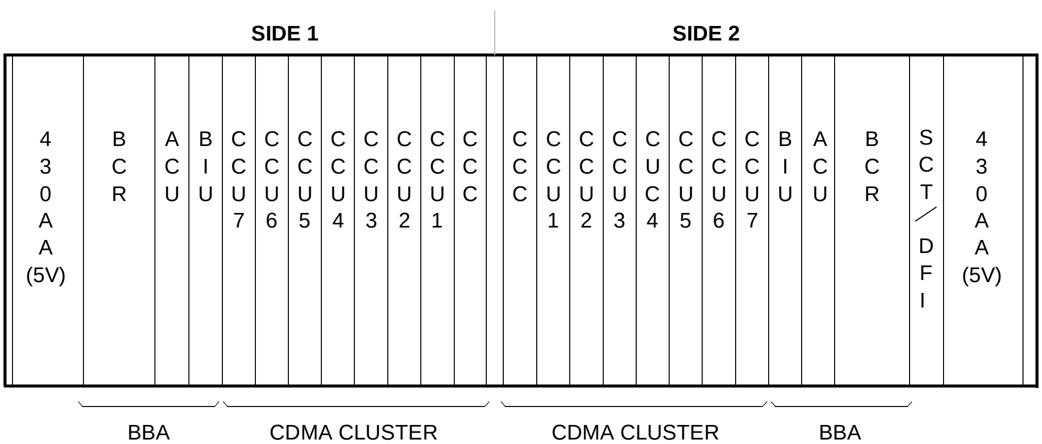


Figure 4-8. Fully Loaded CDMA Radio Shelf With BBA Redundancy

A single shelf connects to one input of a 4:1 combiner located in the interconnection panel assembly (IPA). The output connects to the appropriate LAC. A dual shelf connects to two inputs of a 4:1 combiner in the IPA. The output connects to the appropriate LAC. This configuration allows more radios on an antenna face.

CDMA radio shelves may be configured nonredundant with only side 2 (right) equipped or redundant where both sides are equipped.

Each CDMA radio shelf (See Figure 4-8 on page 22) contains:

- One or two CDMA Channel Unit Clusters (CUCs). A CUC consists of the following equipment types:
  - One CCC
  - CCUs, TCUs, or ECUs

  The use of 8-kbps speech vocoders or 13-kbps vocoders must be uniform within an MSC. An MSC is will support either 8-kbps speech vocoders or 13-kbps vocoder, but not both.
- One or two Baseband Combiner and Radio (BCR), Bus Interface Unit (BIU) and Analog Conversion Unit (ACU) trios. One (right side) is always active; the other (left side) is optionally redundant.

  The BCR, BIU, and ACU are known collectively as the BBA.
- Either a SCT board or DFI board - The SCTs provide timing to all CDMA circuits in the frame, while DFIs terminate the T1 facilities between the Cell Site and the Mobile Switching Center (MSC). Later versions will support Nonvolatile Memory (NVM)updating.

TDM Bus Addresses

TDM bus cables are installed "red stripe up." There are TDM bus addresses for the following slot positions in the CDMA shelf: slots 4, 12, 13, 21, and 24. Sheets 2 and 3 of the figure identify the TDM bus addresses—in hexadecimal format—for the various slot positions within the CDMA RCF1 and RCF2.

The pin designations for the slot address are BA0 (LSB) through BA6 (MSB). The logic values for BA0 through BA6 are unique for each of the slot positions connected to the TDM bus. The 7-bit address for a slot position is established by grounding an address pin for a logic 0, and leaving an address pin unconnected for a logic 1. The 7-pin address for a slot position is realized only when a unit is installed in that slot position: each of the seven address pins is connected to a pull-up resistor on the installed unit.

The backplanes for the CDMA shelves are identical; therefore, each CDMA shelf has an associated, four-pole switch used to select unique logic values for the upper slot-address bits BA4, BA5, and BA6. The switches, identified as SW1

SHLF ADR, are soldered to 8-pin paddleboard connectors that mount onto the wiring side (rear side) of the backplane. Refer to the following tables for the default switch settings in the primary RCF, first CDMA growth RCF, and second CDMA growth RCF.

TDM bus cables are installed "red stripe up." The TDM1 cabling in the CDMA RCF2 starts at the top of the frame, whereas the TDM1 cabling in the AMPS/TDMA RCF2 starts at the bottom of the frame. The cabling arrangement allows the redundant SCT boards to be installed in shelves 0 and 1 of CDMA RCF2 instead of shelves 4 and 5, which allows the SCT boards to be accessed at TDM bus addresses 2C and 3C instead of 6C and 7C*.* (SCT units configured for TDM bus timing—also applies to CAT units— must be located near the center of the TDM bus to achieve similar clock delays throughout the bus.) The relocation of SCT boards in CDMA RCF2 compensates for the following software limitation: software cannot access the SCT board at TDM bus address 7C (shelf 5) because address 7C is too high—address 78 is the uppermost limit.

Circuit Pack Light-Emitting Diodes (LEDs) and Connectors

The Light Emitting Diodes (LEDs) on the Code Division Multiple Access (CDMA) radio shelf are almost identical to the existing Series II equipment. There are three LEDs; one red, one yellow, and one green. The red LED indicates that an alarm has occurred on the circuit pack. The yellow LED indicates that NVM is in the process of being updated into this circuit pack from the MSC. The Green LED indicates that the circuit pack is active.

The BCRs, SCT, and 430AA 5-volt power converters each have ON/OFF switches to manually control the circuit pack.

Each BCR has an output adjustment screw that can be used to set its output power.

The SCT has two SMA (subminiature A) connectors that can be used to connect to external test equipment, such as the HP8921A.

The 430AA 5-volt power converters have + and - 5 volt test access points. These jacks provide a test point for VOM (volt-ohm-meter) test access.

The inputs and outputs to the IPA function the same as FDMA/TDMA signals.

Radios and Radio Equipment

The following paragraphs provide a description of the CDMA radio architecture. Refer to Figure 4-9 while reading the following discussion.

CDMA Channel Constituents

A CDMA Channel Element (CE) contains the circuitry necessary to perform forward and reverse link CDMA spread spectrum processing. CDMA CEs are held in circuit packs called:

1.)CDMA Channel Unit (CCU) - CDMA Release 1
2.)Thirteen-kbps Channel Unit (TCU) - CDMA Release 2
3.)Enhanced CDMA Channel Unit (ECU-3V(Q)) - CDMA Release 5
4.)Enhanced CDMA Channel Unit (ECU-3V(L)) - CDMA Release 7

CDMA Channel Unit (CCU) - CDMA Release 1

CDMA Release 1 introduced a CDMA Channel Element (CE) that is comprised of one CDMA modulator/demodulator (modem) that supports one 8-kbps voice coder/decoder (vocoder) (i.e., one CDMA channel).

The CDMA Channel Unit (CCU) is a circuit pack that holds two 8-kbps CEs.

The CDMA Channel Unit Cluster (CUC) can contain up to 7 CCUs = 14 8-kbps CEs.

The CDMA radio shelf can support two CUCs = 14 CCUs = 28 8-kbps CEs.

Thirteen-kbps Channel Unit (TCU) - CDMA Release 2

CDMA Release 2.0 introduced a CDMA Channel Element (CE) that is an Application Specific Integrated Circuit (ASIC) modem that supports either 8-kbps or 13-kbps vocoding, but not a combination of both.

A Thirteen-kbps Channel Unit (TCU) is a circuit pack that holds two of these 8-kbps or 13-kbps CEs.

The CDMA Channel Unit Cluster (CUC) can contain up to 7 CCUs = 14 8-kbps or 13-kbps CEs.

The CDMA radio shelf can support two CUCs = 14 CCUs = 28 8-kbps or 13-kbps CEs.

Mobile Switching Center (MSC)

The use of either 8-kbps vocoders or 13-kbps vocoders must be uniform within an MSC. An MSC is restricted to support either 8-kbps vocoders or 13-kbps vocoders, but not both.

Enhanced CDMA Channel Unit (ECU-3V(Q)) - CDMA Release 5

CDMA Release 5.0 introduced the Enhanced CDMA Channel Unit (ECU-3V(Q)); a circuit pack that holds ten 8-kbps or 13-kbps CEs.

A CDMA Channel Unit Cluster (CUC) can contain up to 4 ECUs = 40 8-kbps or 13-kbps CEs.

Enhanced CDMA Channel Unit (ECU-3V(L)) - CDMA Release 7

CDMA Release 7.0, introduced the ECU-3V(L); a form, fit and function replacement to the ECU-3V(Q). Initially, the ECU-3V(L) circuit pack holds ten 8-kbps or 13-kbps CEs.

Also, like the ECU-3V(Q), the CDMA Channel Unit Cluster (CUC) can contain up to 4 ECUs = 40 8-kbps or 13-kbps CEs.

The software for the ECU-3V(L) is released in two phases.

In **Phase 1,** the ECU-3V(L) operates identically to the ECU-3V(Q) introduced in Release 5.0. That is, the Phase 1 software allows the ECU-3V(L) to support 10 CEs. Additionally, its maintenance is the same as that for the ECU-3V(Q) and there are no changes to the Recent Change/Verify (RC/V) screen or the Status Display Pages (SDP).

The **Phase 2** software implements the major difference between the ECU-3V(L) and the ECU-3V(Q), which is that the ECU-3V(L) will support 16 CEs instead of 10 CEs. In addition to supporting 8 kbps and 13 kbps for voice applications, the ECU-3V(L) also supports 9.6 kbps and 14.4 kbps full duplex, or raw, data rates.

From a maintenance interface perspective (Technician Interface(TI),RC/V,SDP, etc.), this pack can continue to be called a “CCU”. However, the increased number of channel elements in Phase 2 need to be reflected in the RCV screen. The RCV screen at the MSC must be updated to reflect that a ECU-3V(L) has been installed.

The ECU-3V(L) is slot-compatible with the ECU-3V(Q), TCU, and CCU.

The ECU-3V(L) can be mixed with the ECU-3V(Q) in the same cluster. However, the ECU-3V(L) and/or the ECU-3V(Q) cannot be mixed with TCUs or CCUs in a single CDMA cluster.

The ECU-3V(L) provides Joint Test Action Group (JTAG) support for the Cell Site Modem (CSM) ASIC chips and the digital combiner .

The ECU works with mobiles that conform to ANSI-J008 and EIA/TIA/IS-95A standards.

CDMA Cluster Controller (CCC)

Provides a control and data interface between the TDM bus and up to seven CDMA channel units (CCUs). The CCC manages the CCUs.

A CCC and its CCUs form a CDMA cluster; there may be up to two CDMA clusters on a shelf. Both CDMA clusters may be active.

Each CCC terminates the dedicated packet pipe associated with its CDMA cluster. The CCC extracts the voice data from the incoming packets and distributes the data to the appropriate CCUs for processing. In the reverse direction, the CCC receives voice data from its CCUs, assembles the data into packets, and then multiplexes the packets onto the packet pipe.

CDMA Channel Unit (CCU)

A CCU is a circuit pack that hold the CEs. A CE contains the necessary circuitry to support one CDMA channel. It can be configured as an overhead channel (pilot/sync/access or page) or a traffic (voice) channel.

The CCU performs the digital baseband signal processing, including spreading and despreading. Currently, four types of CCUs are supported, as follows:

1. CDMA Channel Unit (CCU) contains two 8-kbps CEs
2. Thirteen-kbps Channel Unit (TCU) contains two 8-kbps or 13-kbps CEs
3. Enhanced CDMA Channel Unit (ECU-3V(Q))contains ten 8-kbps or 13-kbps CEs
4. Enhanced CDMA Channel Unit (ECU-3V(L)) contains ten to sixteen 8-kbps or 13-kbps CEs

NOTE:
Each CE can be configured to interface with either an 8-kbit/s or 13-kbit/s vocoder

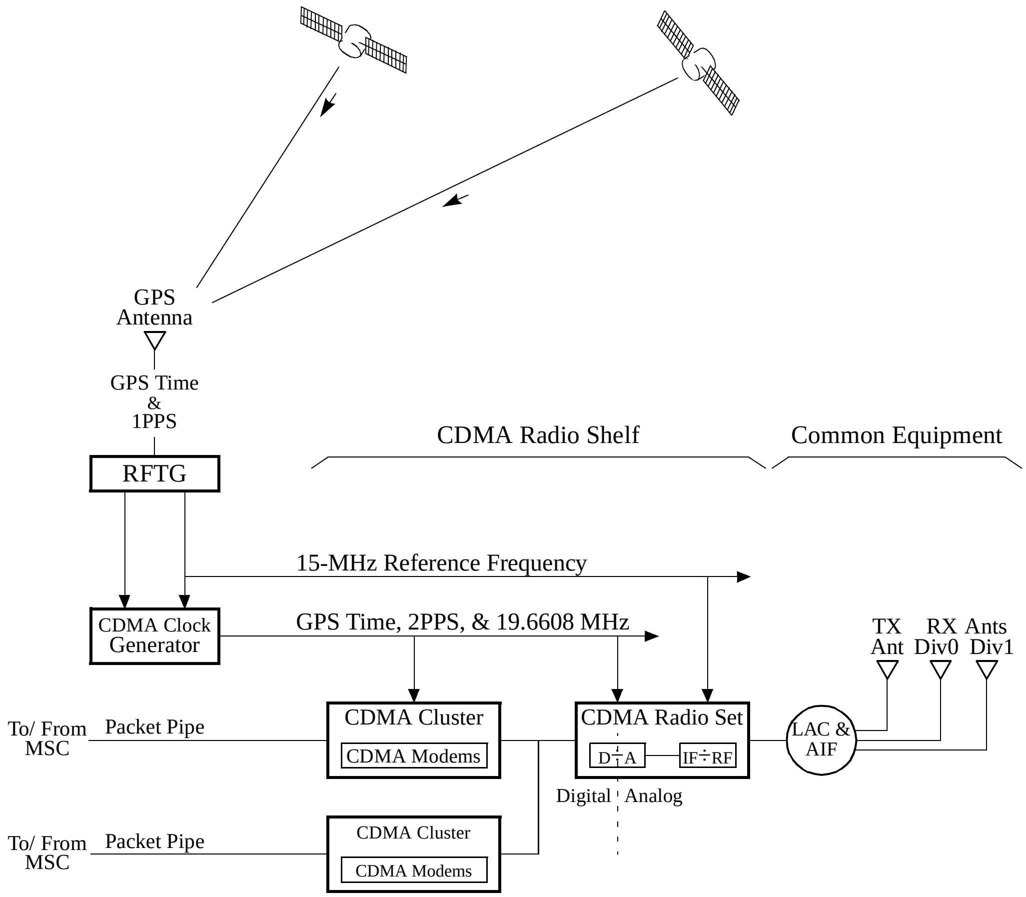
Table 4-2 List shelf number and switch position settings.

Table 4-2. Shelf Number and Switch Position Settings

	Switch Position Settings*			
Shelf Number	**1**	**2**	**3**	**4**
1	Don’t Care	ON	ON	ON
2	Don’t Care	ON	ON	OFF
4	Don’t Care	ON	OFF	ON
5	Don’t Care	ON	OFF	OFF

* ON = Logic 0, OFF = Logic 1

The CDMA radio shelf can contain up to 14 CCUs and each CCU can be configured with either 2, 10, or 16 CEs.



Definitions:

1PPS	One **P**ulse **P**er **S**econd (1.0 Hz) Strobe	IF	**I**ntermediate **F**requency
2PPS	One-half **P**ulse **P**er **S**econd (0.5 Hz) Strobe (Also Known As 2-second Tic)	RF	**R**adio **F**requency

Figure 4-9. CDMA Radio Architecture

Groups of CCUs are logically connected to form clusters. Each cluster is controlled by a single CDMA Cluster Controller (CCC). The CDMA Radio Channel Frame shelf can hold two CCCs, and therefore, two CDMA Clusters.

The CCC provides the interface between the CCUs and the RCC. The CCC supports the call processing functions for each of the channel elements.

Table 4-3. Shelf Number and Switch Position Settings

Shelf Number	Switch Position Settings* 1	2	3	4
0	Don't Care	OFF	ON	ON
1	Don't Care	OFF	ON	OFF
2	Don't Care	OFF	OFF	ON
3	Don't Care	OFF	OFF	OFF
4	Don't Care	ON	ON	ON
5	Don't Care	ON	ON	OFF
* ON = Logic 0, OFF = Logic 1				

Table 4-4. Shelf Number and Switch Position Settings

Shelf Number	Switch Position Settings* 1	2	3	4
0	Don't Care	ON	OFF	ON
1	Don't Care	ON	OFF	OFF
2	Don't Care	OFF	ON	ON
3	Don't Care	OFF	ON	OFF
4	Don't Care	OFF	OFF	ON
5	Don't Care	OFF	OFF	OFF
* ON = Logic 0, OFF = Logic 1				

NOTE:
Currently, an entire cellular geographic service area (CGSA) must operate at the same vocoder rate; the mixing of 8-kbit/s and 13-kbit/s vocoders in a CGSA is not supported.

In addition, each CDMA shelf contains a BIU/BCR/ACU, known as a BBA trio and an optional redundant BBA trio. The BBA contains the Bus Interface Unit (BIU) (TN1702), the Analog Conversion Unit (ACU) (TN1853), and the Baseband Combiner and Radio (BCR) (44WRI)

Bus Interface Unit (BIU)

The Bus Interface Unit (BIU) provides the interface between the BCR, ACU and the TDM bus (which is installed "red stripe up"). It provides power conversion and alarm control functions. The BIU provides a control bus interface between the TDM bus and its associated analog conversion unit (ACU) and baseband combiner and radio (BCR). It also provides power conversion for its associated ACU and BCR.T

The BIU has an on-board converter circuit that converts +24 Vdc to a precise +5 Vdc, +5.2 Vdc and +12 Vdc. The ACU sources the + 5 Vdc and +5.2 Vdc, while the BCR sources all three voltages.

Analog Conversion Unit (ACU)

The ACU performs baseband combining from the CEs, digital/analog and analog/digital conversion, filtering, and IF mixing. The output is a 1.2288 Mbps to the BCR associated with the particular face for CDMA 1.0, and to the BCR associated with any equipped face for CDMA 2.0 and later. The ACU also combines the digital transmit signals from the two CDMA clusters and then converts the signals to analog for input to the BCR. The Analog Conversion Unit (ACU) digitally combines signals form the CCUs, performs a Digital-to-Analog conversion, and limits the signal with a low-pass filter. Each ACU has six analog outputs, which represent the I and Q signals to each of three sectors. In the reverse direction, the baseband signals from up to three (in the cross-connected configuration) BCRs are ' sampled and sent to each CE.

In the reverse direction, the ACU converts the analog receive signals from the BCR to digital and then distributes the digital signals to the two CDMA clusters.

Baseband Combiner and Radio (BCR)

The BCR is a wideband Code Division Multiple Access (CDMA) RF transceiver, that combines the 1 (inband) and Q (Quadrature) signals form the ACU and converts them to RF with an RF upconverter. In the reverse path, the BCR receives RF signals and down-converts them to baseband for the ACU. The BCR is always associated with one face.

Accepts analog signals from and sends analog signals to its associated ACU. The BCR is responsible for RF transmission and reception. The Baseband Combiner Radio (BCR) combines (sums) the I and Q signals from each of the ACUs and converts the signals to RF with an RF up-converter. In the reverse path, it receives RF signals and down-convert to Baseband.

A BCR and its associated BIU and ACU form a CDMA radio set—the BBA (for BCR-BIU-ACU). Since the BBA is a single point failure for a sector, redundant BBAs—one active and the other in standby mode—may be installed for increased reliability. (A BBA pair is redundant.) For OA&M purposes, the BBA is treated as a single maintenance unit.

Synchronized Clock and Tone (SCT)

Generates the CDMA clock signals for the entire CDMA growth RCF. In addition, if so configured, the SCT can perform the following TDM bus functions: bus clock generation and monitoring for the TDM bus, maintenance tone generation, and maintenance tone detection.

Usually, redundant SCTs are installed in a CDMA growth RCF, in shelves 0 and 1.

Each CDMA radio shelf has a TDM enable switch (SW2) on the wiring side (rear side) of its backplane. The TDM enable switch only has meaning for a shelf if an SCT is installed in that shelf. When the switch is in the DISABLE position (switch arm on DISABLE side pressed in), the SCT provides only CDMA clock signals. When the switch is in the ENABLE position (switch arm on ENABLE side pressed in), the SCT provides both CDMA clock signals and TDM bus functions. The TDM bus functions include all functions performed by the CAT: bus clock generation and monitoring for the TDM bus, maintenance tone generation, and maintenance tone detection and measurement. TDM bus cables are installed "red stripe up."

Digital Facilities Interface (DFI)

Provides serial-to-parallel and parallel-to-serial data conversion between the T1 or E1 lines and the TDM buses internal to an RCF. The DFI provides two physical carrier line interface ports; currently, only one port is supported.

The Series II platform uses TDM timeslots to “nail up” the logical connection between a packet pipe on the T1 or E1 line and the associated CDMA cluster.

Usually, one or two DFIs are installed in a CDMA growth RCF, depending upon how many CCUs are installed in the frame. DFIs may be installed in shelf 2 and/or shelf 3 of a CDMA growth RCF.

NOTE:
The DFI is not dedicated to the CDMA radio architecture; it can also interface with RCUs, SBRCUs, DRUs, and EDRUs. A DFI may reside in any slot previously reserved for the DS1 plug-in unit.

The CDMA clusters and radio sets are controlled through the RCC. The RCC consults with resident translations data base to set up the logical connections between the packet pipes on the T1 or E1 lines and the associated CDMA clusters in the cell

CRTU Components

The CRTU consists of two hardware components(see Figure 4-10); The CRTU interface (CRTUi), and the CRTU module (CRTUm). The CRTUi is a plug-in board installed in the primary RCF through which the RCC communicates with an IS-95B compliant mobile station in the CRTUm. From an RCC perspective, the CRTUi and CRTUm together look like a single maintenance unit, just like the RTU or TRTU.

The term *CRTU* will be used in this document except when it is necessary to distinguish between the CRTUi and CRTUm components.

NOTE:
The term *CRTU* will be used in this document except when it is necessary to distinguish between the CRTUi and CRTUm components.

NOTE:
Be aware that the port designations *J1* and *J2* on the PCS CDMA Minicell RSP map to port designations *J2* and *J1* on the Series II Cell Site RSP or Cellular CDMA Minicell RSP—the port designations are reversed. As clarification, J1 on the PCS CDMA Minicell RSP allows access to the transmit filter panels, whereas J1 on the Series II Cell Site RSP allows access to the receive filter panels.

CRTU interface (CRTUi)

The CRTUi provides a transparent communication interface between the RCC and the CRTUm, and between the RCC and the RSP. The CRTUi plugs into TDM bus 0 (TDM0) at shelf 0, slot 15 of the primary RCF, and has a translation indicating its installation. The CRTUi apparatus code is TN1854.

The CRTUi contains the firmware needed to run the CDMA functional tests. In response to functional test messages from the RCC, the CRTUi carries out the specified actions and returns the test information to the RCC. The message exchange is through TDM0. TDM bus cables are installed "red stripe up."

The CRTUi faceplate has three light-emitting diode (LED) indicators: one red, one yellow, and one green. Their meanings are as follows.

Red LED

Controlled by the CRTUi; lighted during the self-test initiated upon powerup or after a reset and goes off after successful completion of the self-test; lighted during normal operation if the CRTUi has a board error or is insane.

Yellow LED

Controlled by Cell Site system software; lighted during non-volatile memory (NVM) update.

Green LED

Controlled by the CRTUi; lighted when a CDMA functional test is executing.

CRTU mobile (CRTUm)

The CRTUm consists of an IS-95B compliant CDMA/AMPS dual-mode mobile, a duplexer containing a three-port RF circulator, an EIA-422 to TTL signal converter, and a 24-Vdc to 12-Vdc power converter. The duplexer provides separate RF transmit and receive paths for the single-ported, CDMA/AMPs dual-mode mobile.

The CRTUm has RF connections through the RCB-associated RF switches and RSP to the directional couplers of the transmit and receive filter panels at the antennas. The CRTUm is mounted in the facilities interface frame (FIF) or on a Cell Site wall, and uses standard 24-Vdc power.

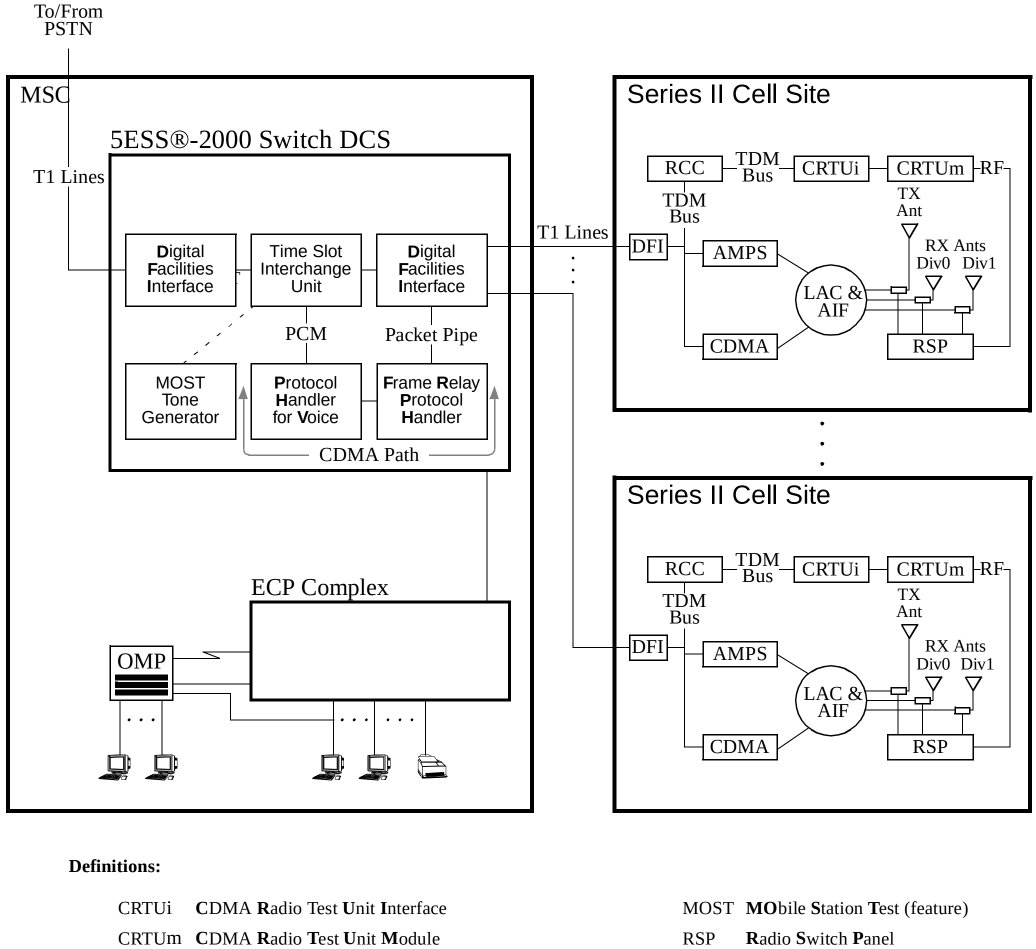


Figure 4-10. High-Level View of the CRTU Test System

The CRTUm in the Series II Cell Site or Cellular CDMA Minicell is identified as KS-24237 L1 (407537018). The CRTUm in the PCS CDMA Minicell is identified as KS-24237 L2 (407537026).

The CRTUm in the Series II Cell Site is used to test CDMA radio equipment but not AMPS radio equipment; the RTU is used to test AMPS radio equipment.

NOTE:
The CRTUm in the Series II Cell Site or Cellular CDMA Minicell is identified as KS-24237 L1 (407537018). The CRTUm in the PCS CDMA Minicell is identified as KS-24237 L2 (407537026).

The CRTUm in the Series II Cell Site is used to test CDMA radio equipment but not AMPS radio equipment; the RTU is used to test AMPS radio equipment.

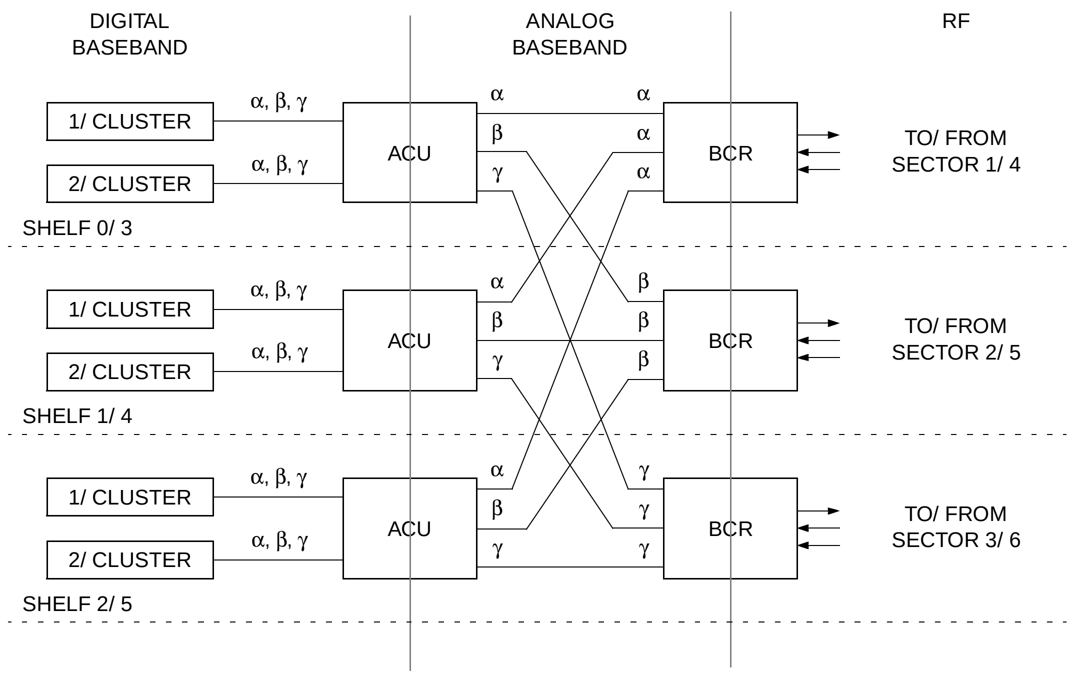


Figure 4-11. CDMA Subcell Configuration—BBA Interconnections Shown Only For One Side (Side 1, Side 2)

CDMA Series II Configuration Options

CDMA Subcell Configuration

In the CDMA growth RCF, two sets of three consecutive shelves may be interconnected to form two *subcells see* Figure 4-11. The top three shelves form one subcell, and the bottom three shelves form the second subcell. Any CE within a subcell is available to any of the three sectors formed by the subcell.

The electrical interconnections between the side-1 BBAs or the side-2 BBAs of a subcell are accomplished via backplane cabling. However, the actual enabling of the

interconnections is controlled via translations, specifically, via the Sub Memb field on screen 13 of the RC/V Series II Cell Equipage Common form (ceqcom2). The following configurations are possible using the Sub Memb field:

- All three CDMA shelves interconnected to form a subcell
- Any two of the three CDMA shelves interconnected to form a subcell
- No CDMA shelves interconnected and hence no subcell configuration—each CDMA shelf operates independently.

The CDMA subcell configuration is required for the softer handoff feature.

Typical Configurations

Finally, Table 4-7 below contains different configurations available for the Series II Cell Site with CDMA. Note that each row represents a different set of configurations options. The table does not represent all possible combinations. Because AMPS and TDMA may be combined within a single RCF, listing all possible configurations would produce a very large table. The table reflects combinations of RCFs where AMPS and TDMA are NOT mixed within a frame. Combinations of AMPS and TDMA may be derived from the data specified in the table.

Timing Requirements

15-MHz Reference Frequency

The RTU and each Radio Channel Unit (RCU) require a stable 15-MHz reference frequency signal. This signal is supplied by the RFG in the AIF and is applied to a 1:6 RF power divider in the Interconnection Assembly. The reference signal is distributed to the RTU shelf and four RCU shelves by a 1:12 RF power divider located on each shelf.

The sixth port on the 1:6 power divider in the Interconnection Assembly is not used and must be terminated into a 50-ohm resistive load. The 1:12 power divider on the RTU also has unused ports that must be terminated into 50-ohm resistive loads.

However, due to the requirement that CDMA components at neighboring sites be synchronized, the Reference Frequency Generator (RFG), used for AMPS and TDMA is not adequate. Instead, a Reference Frequency and Time Generators (RFTG) and a Global Positioning System (GPS) antenna is required to synchronize the Cell Sites, and the MSC to Universal Coordinated Time (UCT).

Reference Frequency and Timing Generator

The RFTG is similar to the standard reference frequency generator in that it provides a precise and stable 15-MHz reference frequency signal to all of the Cell Site radios.

The RFTG is different from the standard reference frequency generator in that it has an internal GPS receiver, which is used to synchronize CDMA transmission and reception. The reference frequency generators, themselves, are disciplined (synchronized) by GPS timing.

For Code Division Multiple Access (CDMA) to work within the stringent timing requirements, synchronization must be maintained between neighboring Cell Sites and between the Cell Sites and the Mobile Switching Center (MSC). The Global Positioning System (GPS) is used in performing this function by providing pulses to synchronize the Cell Sites and the MSC to Universal Coordinated Time (UCT). The GPS received signal is used to distribute a universal synchronized reference clock to the CDMA components. If the GPS signal is lost or the GPS receiver fails, the system clock at the Cell Site will drift. This does not immediately affect system performance since back-up timing is provided by a rubidium oscillator, which will maintain synchronization with the other Cell Sites to within +/-10 us for 24 hours. Synchronization can be assumed for no more than 24 hours without relocking on to the GPS signal. If that time period elapses without resynchronizing, all CDMA radiation will stop. If the rubidium oscillator also fails, there is a backup oscillator which may be either an ovenized crystal or another rubidium oscillator. The ovenized crystal can maintain synchronization to within the +/-10 us for 4 hours after loss of the GPS signal (provided Cell Site temperature remains constant to within 2 degrees Celsius); the backup rubidium oscillator can maintain synchronization for up to eight hours after loss of GPS signal.

Installing an RFTG

The RFTG, KS24019 L1, mounts in the Series II AIF J41660E-2. To mount the RFTG, remove the existing RFG shelf ED-2R849-31, and replace it with the RFTG shelf. To mount the RFTG, you need a field mounted GPS Antenna kit 847683349. You also need a GPS surge protector kit 847780475 to protect the GPS antenna input. You need one surge protector kit per GPS antenna.

Field Upgrade of an RFTG

Cells equipped with a 50dB gain antenna may include the installation of a 24dB in-line attenuator instead of replacing the 50dB antenna with a 26dB gain antenna. Otherwise, a 10dB in-line attenuator may be installed instead of replacing the 50dB antenna with a 40dB gain antenna.

RFTG KS24019, L1 (407 163 500) is field upgradeable to KS24019, LIB (407 658 269) using the field upgrade kit 847 849 866 in Table 4-5 below.

Table 4-5. Field Upgrade Kit

Field Upgrade Kit 847 849 866			
Item	Description	Part Number	Qty
1	Rubidium Controlled Oscillator	KS 24019 L102A	1
2	Crystal Controlled Oscillator	KS 24019 L104B	1
3	Label	KS 24019 LIB	1

RFTG KS24019, L1A (407 529 132) is field upgradeable to KS24019, LIB (407 658 269) using the field upgrade kit 847 849 874 in the Table 4-5 below.

Table 4-6. Field Upgrade Kit

Field Upgrade Kit 847 849 874			
Item	Description	Part Number	Qty
1	Crystal Controlled Oscillator	KS 24019 L104B	1
2	Label	KS 24019 LIB	1

KS24019, LIB is the replacement for both KS24019, L1 and KS24019, LIA.

To remove and replace the RFTG modules without disrupting CDMA service, the Cell software must be R7.1 Beta 02 build (APX07.10), or later. For Cells not equipped with R7.1 or later, removal and replacement of the RFTG modules should be done during those hours when traffic is light. The RFTG module remove/replace procedure is not disruptive to AMPS/TDMA service regardless of cell software. Traffic, transmission, AC and DC power drain, service, maintenance, and reliability are not adversely affected. To remove/replace RFTG modules:

1. Remove a all CDMA sectors from service.
2. Perform the in-field change of modules as per the ECP.
3. Return cells to service.

.

Table 4-7. Examples of CDMA (with Series II) Configurations

Primary (RCF0)		**Growth (RCF1)**		**Growth (RCF2)**	
Traffic Channels		Traffic Channels		Traffic Channels	
Config	Physical	Config	Physical	Config	Physical
TDMA	28 DRU	TDMA	36 DRU	CDMA	168 2-*CE/CCU
	56 EDRU		72 EDRU		360 8-CE/CCU
Analog	56 RCU	TDMA	36 DRU	CDMA	168 2-CE/CCU
			72 EDRU		360 8-CE/CCU
TDMA	28 DRU	Analog	72 RCU	CDMA	168 2-CE/CCU
	56 EDRU				360 8-CE/CCU
Analog	56 RCU	Analog	72 RCU	CDMA	168 2-CE/CCU
					360 8-CE/CCU
TDMA	28 DRU	CDMA	168 2-CE/CCU	CDMA	168 2-CE/CCU
	56 EDRU		360 8-CE/CCU		360 8-CE/CCU
Analog	56 RCU	CDMA	168 2-CE/CCU	CDMA	168 2-CE/CCU
			360 8-CE/CCU		360 8-CE/CCU
CDMA	84 2-CE/CCU	CDMA	168 2-CE/CCU	CDMA	168 2-CE/CCU
	180 8-CE/CCU		360 8-CE/CCU		360 8-CE/CCU
CDMA	84 2-CE/CCU	CDMA	168 2-CE/CCU	TDMA	36 DRU
	180 8-CE/CCU		360 8-CE/CCU		72 EDRU
CDMA	84 2-CE/CCU	CDMA	168 2-CE/CCU	Analog	72 RCU
	180 8-CE/CCU		360 8-CE/CCU		
CDMA	84 2-CE/CCU	CDMA	168 2-CE/CCU	None	
	180 8-CE/CCU		360 8-CE/CCU		
CDMA	84 2-CE/CCU	TDMA	36 DRU	TDMA	36 DRU
	180 8-CE/CCU		72 EDRU		72 EDRU
CDMA	84 2-CE/CCU	Analog	72 RCU	TDMA	36 DRU
	180 8-CE/CCU				72 EDRU
CDMA	84 2-CE/CCU	TDMA	36 DRU	Analog	72 RCU
	180 8-CE/CCU		72 EDRU		
CDMA	84 2-CE/CCU	Analog	72 RCU	Analog	72 RCU
	180 8-CE/CCU				
CDMA	84 2-CE/CCU	None		None	
	180 8-CE/CCU				

CDMA Series II Cell Site Generator Input

In Figure 4-12 the leftmost divider is used for the 15.00-MHz reference generator input, just like the standard Series II Cell Sites. The topmost SMA connector on the divider, (J7), is used for the 15.00-MHz input from the RTFG in the AIF. The six other SMA connectors (J1 through J6) are outputs. There is one output for each CDMA shelf used. Each output connects to a 1:3 divider on the CDMA radio shelf. One output from the 1:3 divider provides timing to Base Band Combiner and Radio 1 (BCR1), a second output provides timing to BCR2, and a third output provides timing to the SCT (if an SCT is on the shelf).

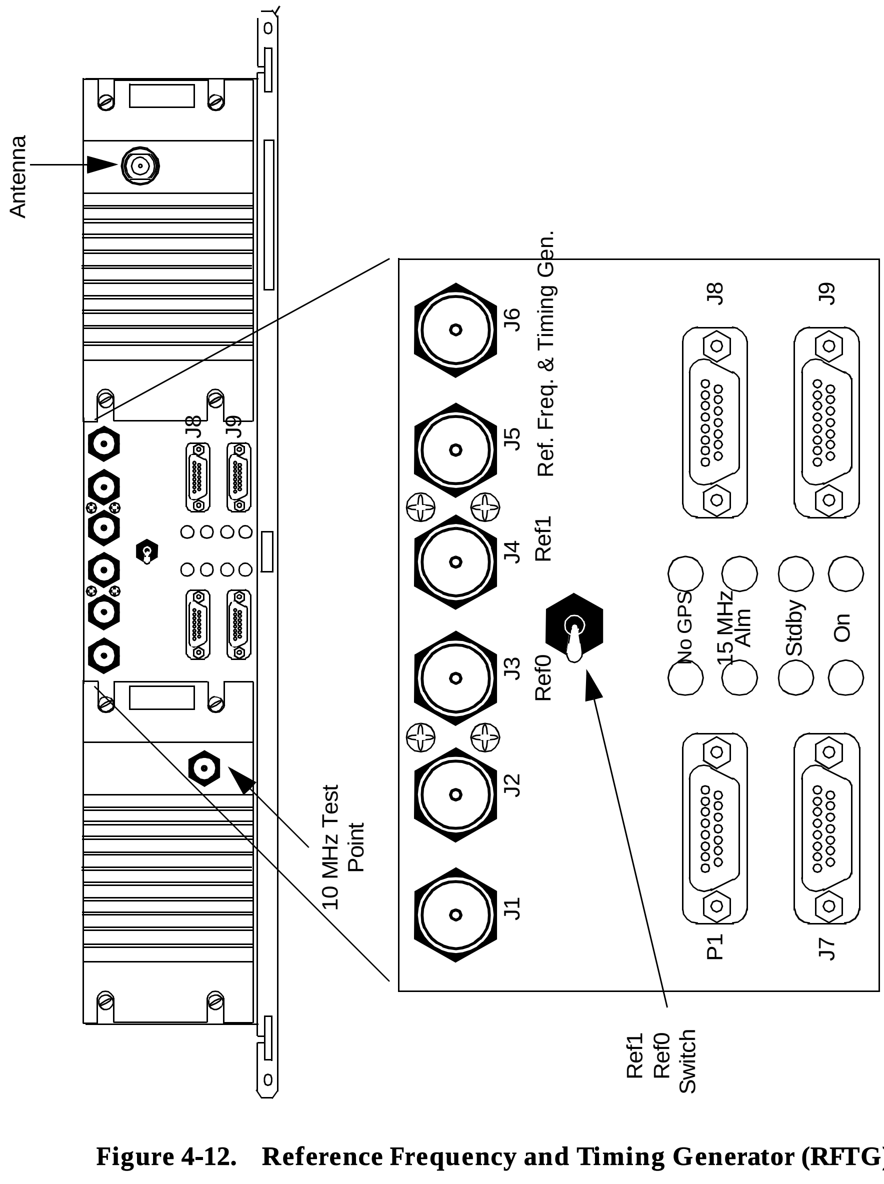


Figure 4-12. Reference Frequency and Timing Generator (RFTG)

New Features and Upgrades

Cell Site Synchronization Failure Warning & Correction: Phase 1

This section covers the Phase 1 implementation of Cell Site Synchronization Warning and Failure Correction for the Reference Frequency and Timing Generator (RFTG) and its associated base station Global Positioning System (GPS) antenna.

The Reference Frequency Timing Generator (RFTG) consists of two redundant plug-in modules interconnected by a housing frame. The left module is referred to as REF0 and the right module is referred to as REF1. Hardware errors from these two modules are now treated separately and generate a new status display icon on Status Display Page (SDP) 2138. Therefore, there are now two icons on SDP 2138: one for each RFTG module, REF0 and REF1.

There is also a third icon, labelled “Cell_Sync”, on SDP 2138. The Cell_Sync icon warns against a possible synchronization problem. Cell_Sync status is sent to the Read-Only Printer (ROP) and is displayed as MINOR, MAJOR, or CRITICAL, based on combinations of errors from the:

- RFTG modules
- Synchronized Clock and Tone (SCT) board
- CDMA Cluster Controller (CCC)

Additionally, GPS Status has also been modified to display only hardware errors directly related to the GPS hardware (i.e., the GPS Receiver and the GPS Antenna).

This feature does not require File Activation File (FAF) execution.

New CDMA Cluster Controller (CCC) Board with Increased SRAM

CDMA R7.0 introduces new hardware: a new CDMA Cluster Control (CCC) board with increased Static Random Access Memory (SRAM). SRAM is a type of memory which requires electrical power to maintain its contents but does not require constant refreshing. This new CCC board was designed with larger SRAM to ensure that it would accommodate the growth in software loads beyond Cell/ECP R12 and CDMA R7.0, with their ever increasing growth of features and capabilities.

Although the new CCC board is not required in Cell/ECP R12.0 or in existing CDMA systems, its implementation is strongly recommended because its need will increase substantially when software load sizes increase after R12.0. Additionally, all new CDMA Cell Site systems produced after CDMA R7.0 will use the new CCC board.

Whether used exclusively or in combination with existing CCC boards, the new CCC boards perform all existing OA&M and Call Processing functions using PCS, traditional Cells, or analog radios. While the new CCC board (TN1852B) is not compatible with cell loads prior to G50Y11.00 (CDMA R6.0), it is compatible with G50Y11.00 and subsequent cell loads.

Code Division Multiple Access (CDMA) Double Density Growth Frame (DDGF)

CDMA DDGF Description

The Code Division Multiple Access (CDMA) Double Density Growth Frame (DDGF) is a new product designed in response to customer requests for higher CDMA channel capacity, with full-power amplification, made available at the lowest cost possible. In particular, the DDGF increases CDMA channel capacity in a Series II Analog Cell Site. When used with a full-power SII MLAC amplifier, the DDGF supports up to 12 CDMA carriers partitioned into two-six-sector configurations.

DDGF Architecture

Frame Architecture

Figure 4-13 shows how the DDGF frame is partitioned into four quadrants: two quadrants in the top of the frame, two quadrants at the bottom of the frame, and the fan shelf in between. The two quadrants on the top left and bottom left of the frame are numbered 1 and 2. The 2 quadrants on the top right and bottom right of the frame are numbered 3 and 4.

Each of the four quadrants in the DDGF contains an independent, triple-height (i.e., containing three rows of shelves) CDMA Radio Complex (CRC). Each CRC contains three CDMA half-shelves arranged one on top of the other in a vertical stack. There are a total of 12 half-shelves in the DDGF. The six half-shelves from the top left to the bottom left of the frame are numbered 0 to 5. The six half-shelves from the top right to the bottom right of the frame are numbered 6 to 11. Figure 4-14 shows the half-shelves.

Each half-shelf of the DDGF contains 10 circuit pack slots, numbered 1 to 10 beginning with the left-most slot and proceeding to the right. An example is shown in Figure 4-14, which illustrates the circuit packs and where they are placed in shelves 6, 7, and 8 of the DDGF.

CDMA Radio Complex (CRC) Circuit Packs

In the following discussion regarding the DDGF circuit packs, the term *CDMA Channel Unit (CCU)* will apply to either, or both of, the Two-Channel Element CCU or the enhanced Ten-Channel Element CCU. In addition, a grouping of one to four CCUs is called a "cluster." Each cluster is supported by a CDMA Cluster Controller (CCC).

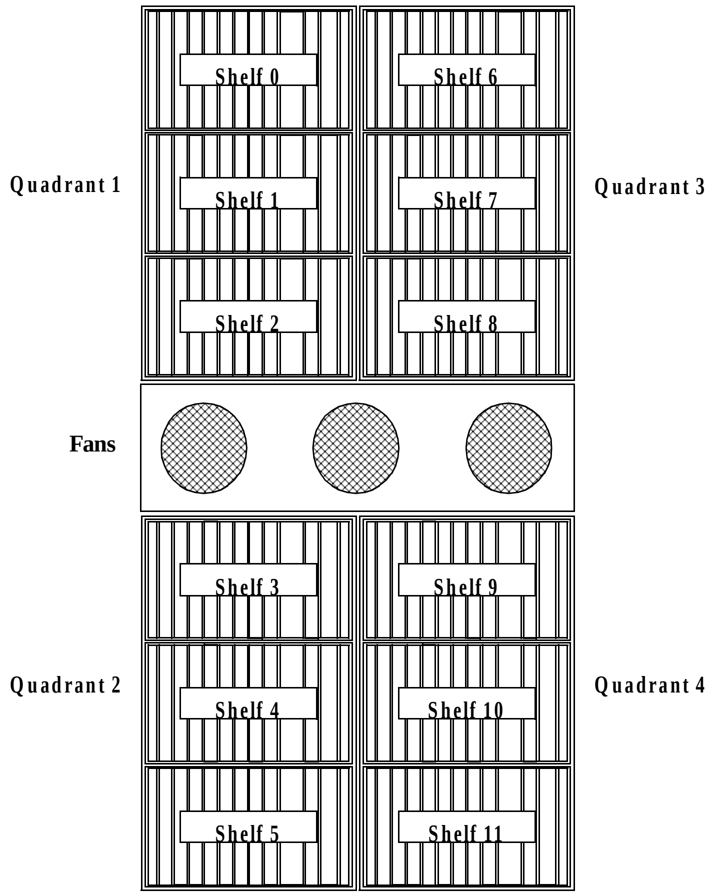
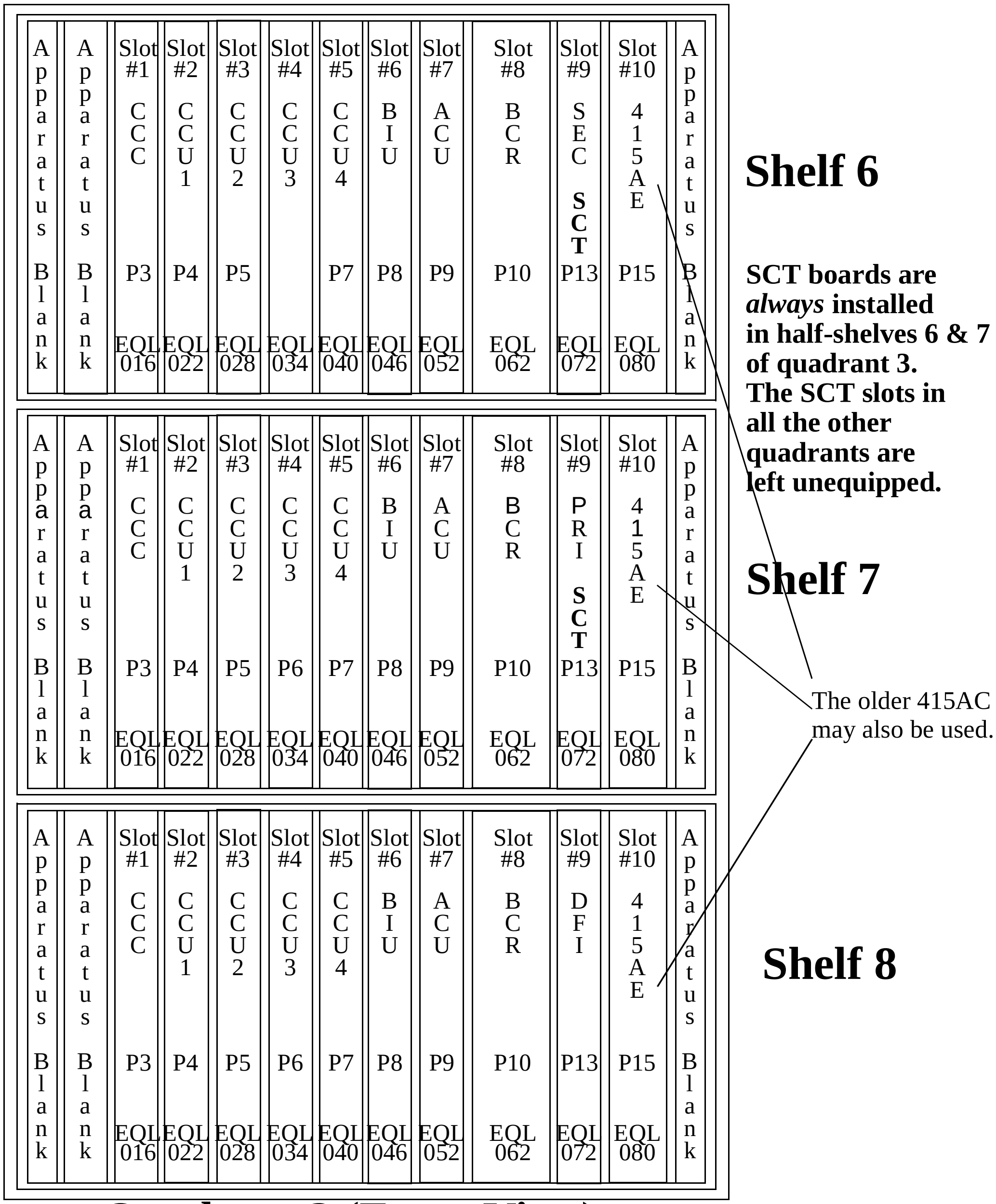


Figure 4-13. Quadrant and Half-shelf Numbering of DDGF (Front View)



Quadrant 3 (Front View)

Figure 4-14. Illustration of Circuit Packs Populating the CRC

CRC circuit packs are enumerated below and Table 4-C lists the Circuit Pack apparatus code, half-shelf location, slot location, and function of all circuit packs. The circuit packs that populate the CRC are:

1. One to Four CDMA Channel Units (CCU), or a "cluster"
2. One CDMA Cluster Controller (CCC)
3. One Baseband Combiner/Radio (BCR)
4. One Bus Interface Unit (BIU)
5. One Analog Conversion Unit (ACU)

There are no redundant BCRs, ACUs, or BIUs in each CRC quadrant.

The BIU contains the:

1. TDM bus interface to support the BCR and ACU
2. DC-DC converters required to supply voltages of +5V, -5.2V, and ±12V

Together, the BCR, BIU, and ACU are commonly known as the BBA. For each quadrant, if the BBA and the CDMA cluster are not interconnected, any handoff will be a soft hadoff. The BBA and the CDMA cluster can also be interconnected for softer handoff. Interconnection is controlled by a translation.

6. Two Synchronized Clock and Tone Units (SCTs) and one Digital Facilities Unit (DFI)

The two Synchronized Clock and Tone (SCT) circuit packs in the CRC are always installed in the two uppermost, front-right half-shelves, numbered 6 and 7, of quadrant 3. The SCTs generate 19.6608 MHz and the TDM bus clocks. The TDM SCT switches must be enabled on the backplane of shelves 6 and 7.

The Digital Facilities Interface (DFI) for each CRC is located in the lowest half-shelf. The DFI provides the software interface between the TDM bus and one T1 or E1 digital transmission line. Each DS1 can carry 24 Digital Level 0 signals (DS0s time slots in the domestic DS1 mode). The T1/E1 line links the DDGF site to the Mobile Switching Center (MSC).

7. One Power Converter Unit (PCU)

Lastly, each half-shelf has one 415AE DC-to-DC power converter to convert the +24 VDC main power to +5 VDC. (The older 415AC may also be used.)

NOTE:
There is no difference between one CRC quadrant and another except that the SCT boards are always installed in the two uppermost, right-most half-shelves, numbered 6 and 7, of quadrant 3. The SCT slots in the other CRC quadrants are left empty.

Table 4-8. Table of CRC Circuit Packs Apparatus, Slot Installation, and Function

Slot(s) Installed In	Circuit Packs	Apparatus Code	Eql	Shelves Installed In	Board Function
01	CCC	TN1852B	016	0 to 11	CDMA Cluster Controller
02	ECU1/ TCU1	TN1711, TN1712, TN1716, TN1718	022	0 to 11	CDMA Channel Unit (CCU)
03	ECU2/ TCU2	TN1711, TN1712, TN1716, TN1718	028	0 to 11	CCU
04	ECU3/ TCU3	TN1711, TN1712, TN1716, TN1718	034	0 to 11	CCU
05	ECU4/ TCU4	TN1711, TN1712, TN1716, TN1718	040	0 to 11	CCU
06	BIU	TN1702	046	0 to 11	Bus Interface Unit
07	ACU	TN1853	052	0 to 11	Analog Conversion Unit
08	BCR	44WR1	062	0 to 11	Baseband Combiner and Radio
09	SCT	TN1703	072	Only 6 & 7	Synchronized Clock and Tone unit
09	DFI	TN3500B or TN1713B	072	2, 5, 8, & 11	Digital Facilities Interface
10	PCU	415AE or the older 415AC	080	0 to 11	DC/DC Power Converter Unit

Frame Configuration

In addition to the partitioning of the DDGF frame and the circuit packs it supports, the DDGF is configured with:

- A fan shelf for cooling
- A15-MHz reference frequency distribution network, to support CDMA timing
- An RF distribution network located in the Interconnection Panel Assembly (IPA) on top of the DDGF
- DC power distribution
- DC power circuit breakers
- An optional CDMA Radio Test Unit module (CRTUm), in the bottom of the frame, to support CDMA testing requirements

These will be examined more closely in the sections that follow.

Using the DDGF in a Series II Analog Cell Site

Cell Site Requirements

The CDMA DDGF may only be installed in an indoor, controlled-access Series II base station operating on DC power. To install a DDGF into an Analog SII cell site, the Cell Site must be equipped with the following:

1. Linear Amplifier Frame (LAF): The LAF contains the Modular Linear Amplifier Circuits (MLACs) that amplify and transmit signals. Each transmit amplifier can support up to four CDMA radios. There can be up to two LAFs depending on the configuration of the Cell Site.
2. Antenna Interface Frame (AIF): The AIF houses:
    1. Transmit and receive filters
    2. Receive pre-amplifiers
    3. The Reference Frequency and Timing Generator (RFTG/RFTGm-II)

The DDGF is a CDMA growth frame and therefore needs a Global Positioning **S**ystem (GPS) antenna, in addition to an RFTG/RFTGm-II in order to establish proper frame timing.

The DDGF usually replaces one of the two growth frames in a Series II cell site. (System software allows up to two growth frames in a Series II cell site).

Configurations Supported for DDGF

The DDGF supports the three configurations listed below and illustrated in Figure 4-15, Figure 4-16, and Figure 4-17. The three configurations supported are:

Configuration 3: DDGF with SII Primary Frame

Configuration 4: DDGF with SII Primary and SII CDMA Growth Frames

Configuration 5: DDGF with SII Primary and SII Analog Growth Frames

Configurations 1 and 2 are no longer supported and so are not listed here. However, for historical reasons Configurations 3, 4, and 5 have retained their original numbering and will continue to be referred to as Configuration 3, Configuration 4, and Configuration 5.

Series II Configurations and Cell Site Line-Up Supported for DDGF

Each of the three Series II cell site configurations which use the DDGF contains at least one and no more than two LAFs and at least one and no more than two AIFs. All the frames used for each configuration, and the way in which the DDGF is used in each configuration, are illustrated in the three figures below and in the table following the figures.

Because of RCC and MLAC limitations, the maximum number of CDMA radios that a Series II cell site can support is 12. Therefore, all the CRC quadrants of the DDGF cannot be populated with CDMA radios. The quadrants that can be populated depends on how the DDGF is being used at the Series II cell site.

Because the SCT boards are always installed in CRC quadrant 3, the TDM bus cable from the other radio frame always connects to CRC quadrant 3 first. Additionally, TDM bus cables are always installed "red stripe up." Therefore, the sequence in which the CRC quadrants are populated is:

1. Quadrant 3
2. Quadrant 4
3. Quadrant 2
4. Quadrant 1

Table 4-9. DDGF Configuration Schemes

Configuration Number	Primary RCF	1st Growth RCF	2nd Growth RCF	DDGF Quadrants Populated			
				1	2	3	4
Configuration 3:	SII Analog RCF	DDGF		Y	Y	Y	Y
Configuration 4:	SII Analog RCF	CDMA RCF	DDGF is 2nd CDMA RCF	N	N	Y	Y
Configuration 5:	SII Analog RCF	SII Analog RCF	DDGF is 1st CDMA RCF	Y	Y	Y	Y

Circuit Pack Placement for Series II Cell Site DDGF Configurations

For each of the configurations 3, 4, and 5, already defined, the information below lists the following:

- How the quadrants of the DDGF are populated
- The specific circuit packs used for each configuration
- The slot into which each circuit pack may be installed for each configuration

Configuration 3: All four CRC quadrants (i.e., the entire frame) can be populated to obtain the maximum number of CDMA radio channels supported by the SII cell site.

RCV **Configuration 3 (s2-ddgf)** is a four quadrant ddgf (12 shelves).

Circuit Pack	Shelf Number(s)	Slot Number(s)
SCTs	6, 7	9
DFIs	2, 5, 8, 11	9
CCCs	All	1
CCUs		2, 3, 4, 5
BBAs	All	6, 7, 8

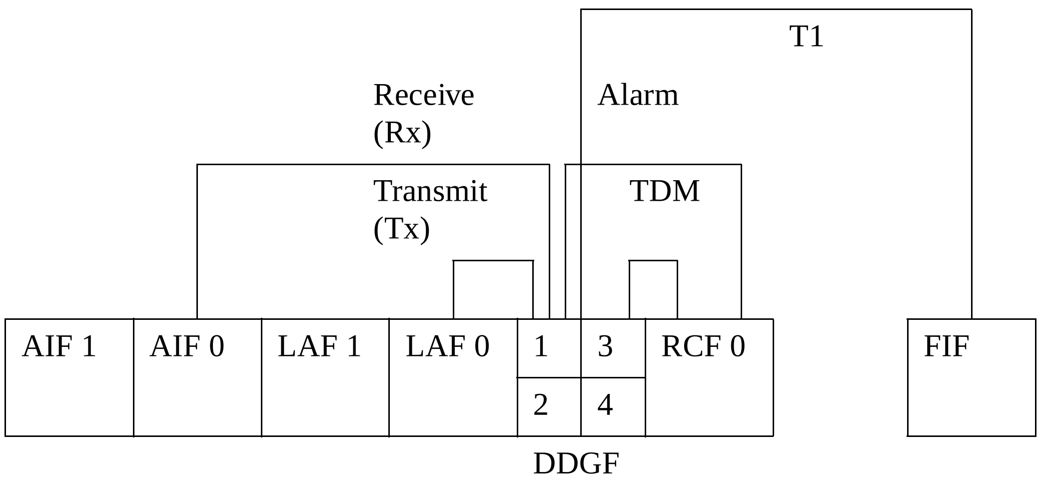


Figure 4-15. Configuration 3: AIF, LAF, and SII Primary, with DDGF as 1st CDMA Growth Frame

Configuration 4: Two of the CRC quadrants can be populated, to obtain the maximum number of CDMA radio channels supported by the SII cell site.

RCV **Configuration 4 (s2-c-ddgf)** is a two quadrant ddgf (6 shelves).

Circuit Pack	Shelf Number(s)	Slot Number(s)
SCTs	6, 7	9
DFIs	8, 11	9
CCCs		1
CCUs		2, 3, 4, 5
BBAs		6, 7, 8

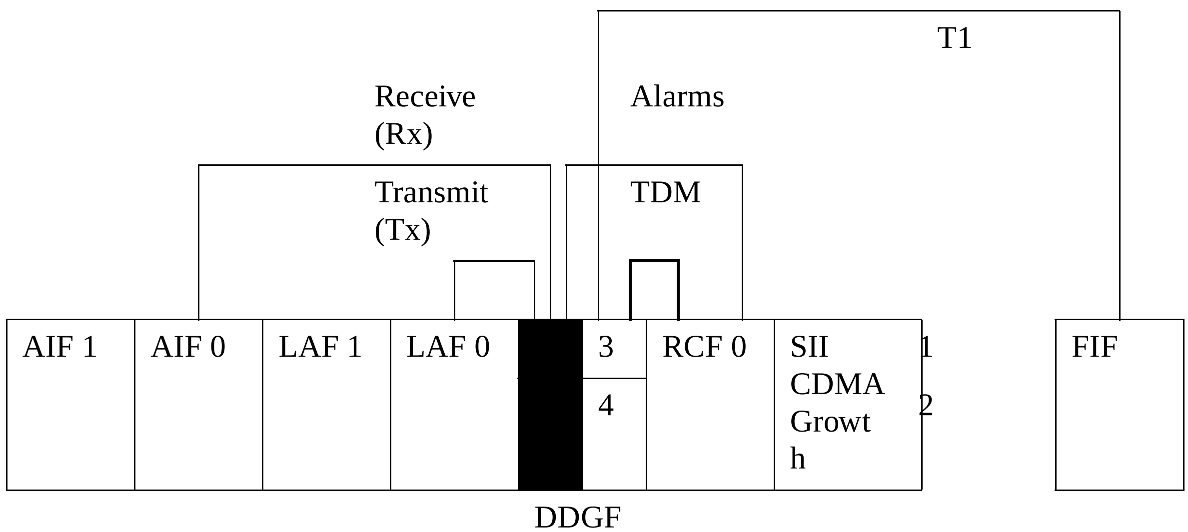


Figure 4-16. Configuration 4: AIF, LAF, SII Primary, SII CDMA Growth, with DDGF as 2nd CDMA Growth Frame

Configuration 5: Four of the CRC quadrants can be populated, to obtain the maximum number of CDMA radio channels supported by the SII cell site.

RCV **Configuration 5 (s2-s2-ddgf)** is a four quadrant ddgf (12 shelves).

Circuit Pack	Shelf Number(s)	Slot Number(s)
SCTs	6, 7	9
DFIs	2, 5, 8, 11	9
CCCs	All	1
CCUs		2, 3, 4, 5
BBAs	All	6, 7, 8

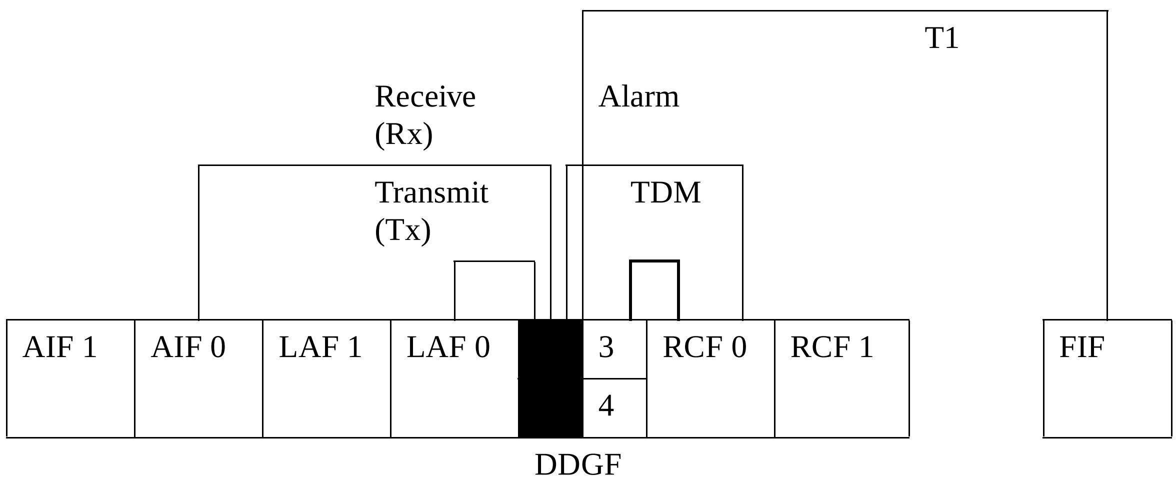


Figure 4-17. Configuration 5: AIF, LAF, SII Primary, SII Analog (i.e., non-CDMA) Growth, with DDGF as 2nd Growth Frame and 1st CDMA Growth Frame

Recent Change and Verify (RC/V) forms

The Recent Change and Verify (RC/V) forms used with the DDGF are:

- **cell2**: How the DDGF frame is being used (e.g., first growth frame, etc.)
- **ceqcom2**: Operation of equipment, such as circuit boards, on the DDGF shelves

- **ceqccu**: Configure the CCCs
- **ceqcloc**: Configure timing, such as the timing of the SCT and DFI boards
- **ceqface**: PN offset, Pilot/Sync/Page, etc
- **pptg**: Trunks
- **pptm**: Set up Packet Pipes, trunk status, DS1 board number, DS0 channel assignment, etc
- **sub**: CRTU information

DDGF Interface

Table 4-10, lists the connections between the DDGF and supporting SII equipment.

Table 4-10. Connections Between DDGF and Supporting SII Equipment

Connections between DDGF and AIF (RFTG/RFTGm-II) and GPS timing signals (RS-485, 15 MHz)	RF receive cables
Connections between DDGF and LAF	RF transmit cables
Connections between DDGF and FIF	T1 or E1 lines
Connections between DDGF and Primary Frame	TDM bus, Alarm lines

RFTG

The RFTG, which is housed in the Series II Antenna Interface Frame (AIF), provides CDMA radio equipment with the clock generation and distribution it needs to meet CDMA timing requirements.

The RFTG consists of two reference units that are disciplined by Global Position System (GPS) signals received by the GPS antenna.

1. The unit on the left-hand side (side 0) is identified as REF0. REF0 of the RFTG is a 15-MHz Rubidium oscillator (Rb) unit (RFTG-Rb). It provides a 15 MHz sine wave reference frequency and one pulse per second (1 PPS) timing signal. The 15-MHz reference frequency is distributed over a 50-ohm system incorporating power splitters and coaxial cable, shown in Figure 4-18, below. The RFTG distributes the 1PPS timing signal to the DDGF SCT.

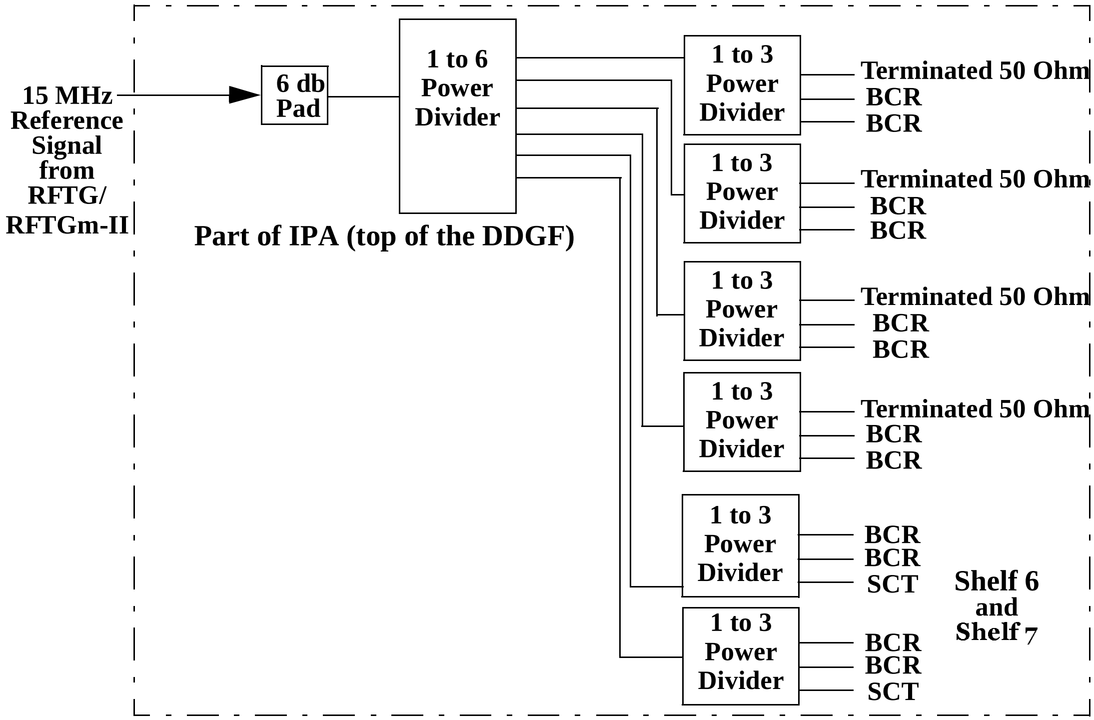


Figure 4-18. 15-MHz Reference Frequency Distribution Scheme

2. The unit on the right-hand side (side1) is identified as REF1. REF1 is a 15-MHz Ovenized temperature-controlled Crystal Oscillator (XO) unit with a built-in GPS receiver, RFTG-XO. The GPS receiver generates the 1PPS and GPS time message.

The REF0 and REF1 units work together as redundant units. These two units are interconnected to provide:

- Phase lock
- Failure detection
- Autonomous switching

During normal operation, the Rb unit is active, and supplies the 15-MHz reference frequency and a 1PPS timing signal. The XO unit is activated by an autonomous failure triggered sequence if the Rb unit fails. The RFTG is shown in Figure 4-19.

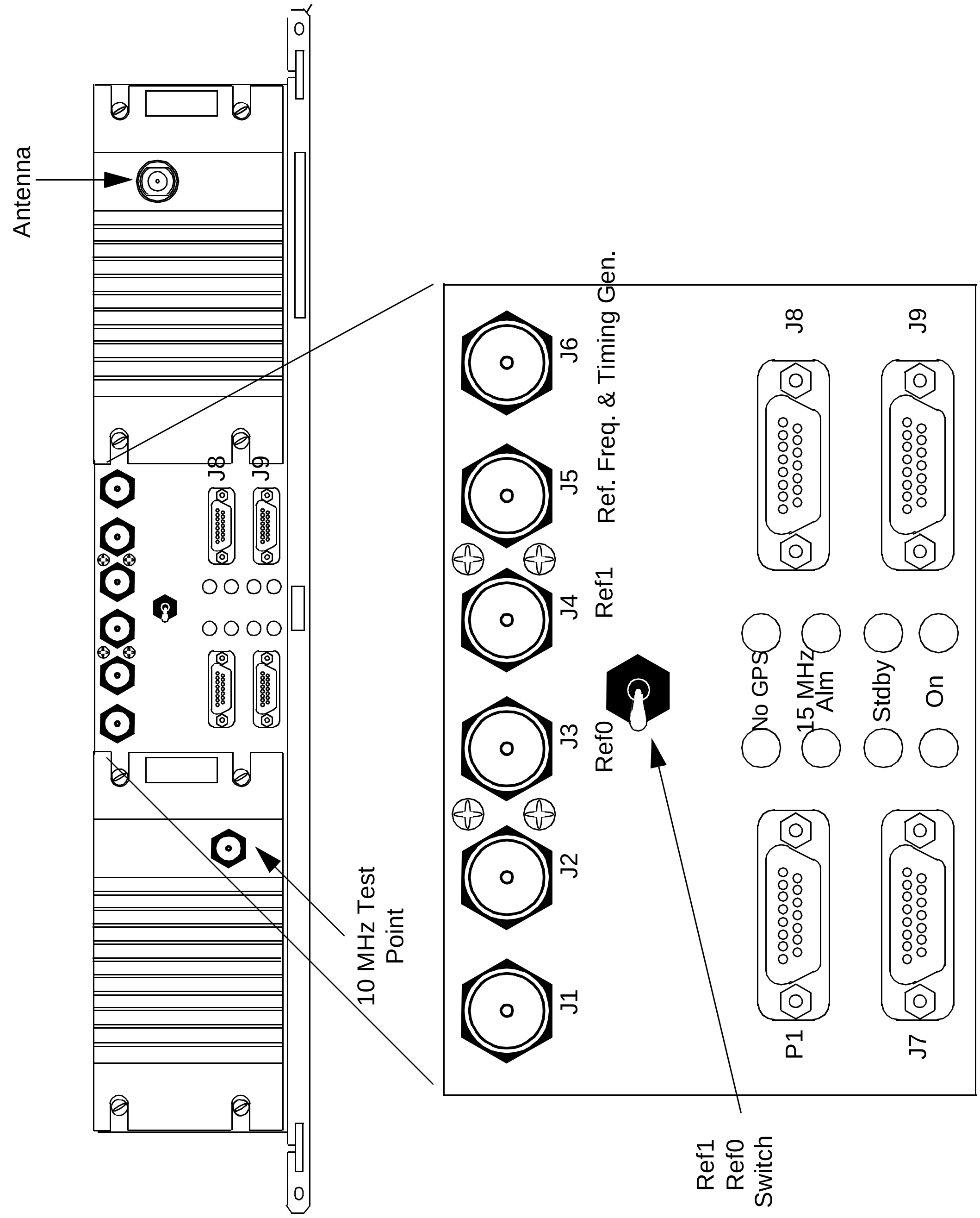


Figure 4-19. Reference Frequency and Timing Generator (RFTG)

RS-485 communication data ports are provided by both RFTG units for unit status inquiry and GPS Time information. The RS-485 duplex serial interface communicates to and from the RFTG to both the SCTs in CRC shelves 6 and 7 of the DDGF.

If you are installing a new RFTG, refer to *Base Station CDMA Reference Frequency Timing Generator and Antenna System - Description, Operation, Installation and Maintenance Guidelines,* document number 401-660-128.

CDMA DDGF Power Requirements, Distribution, and Calibration

CDMA DDGF +24 Volt Power Requirements

Because of losses in the power distribution system, the input voltage available at a DDGF can range from 0.75 to 0.5 volts below the battery plant voltage. The input voltage range measured at the frame input can vary between +25 to 27.25 V DC. This range varies depending on the float voltage of the batteries used in the cell site. For simplicity, the nominal input voltage specified is +24 V DC.

+24 Volt Power Distribution

The 24-volt Returns in the DDGF connect to a Common Return Bus Bar inside the frame. The twelve +24-volt feeders are then distributed to a series of 20-amp, three-amp, and two-amp circuit breakers located in the power distribution assembly. They are shown in Figure 4-19. The outputs from the twelve 20-amp circuit breakers feed the 415AE DC-to-DC converters on each CRC shelf. (The older 415 AC may also be used.These DC-to-DC converters supply the +5 volts at 60 amps maximum required for the circuit packs on each CRC shelf. The twelve 20-amp circuit breakers also feed the +24-volts required on each CRC shelf for the BIU/CCC/SCT circuit packs. The three three-amp circuit breakers feed the +24 volts required for the three fan groups, and the two-amp circuit breaker feeds the optional CRTUm module.

Power feeder connections on the top of the DDGF IPA are run to the 30-amp circuit breakers in the Series II Power Cabinet.

CDMA Power Calibration

Installation Engineering Handbook 226, Section 31 contains power calibration procedures for all 850 CDMA products including:

1. Cellular CDMA Growth Frame
2. Double Density Growth Frame (DDGF)
3. CDMA Hybrid Minicell
4. Classic CDMA Minicell
5. CDMA Adjunct
6. Cellular CDMA Compact Minicell

These procedures should be performed after integrating the CDMA frame to the MSC and after all CDMA diagnostics have passed all tests. The CDMA product being calibrated must be installed and integrated before performing the procedures in Handbook Section 31.

Table 4-11 contains a list of the CDMA integration handbook sections that ***MUST*** be completed before starting CDMA power calibration.

Table 4-11. Related Installation Engineering Handbook Sections

Section	**Description**
Glossary	Terms and Acronyms
1	Equipment Description And Planning
30	Test Equipment Calibration
414	CDMA Database Translations
424	CDMA Minicell and Compact Minicell Integration
441	CDMA Growth Frame Integration
442	CDMA Double Density Integration
443	CDMA Adjunct Integration
445	CDMA Compact Growth Integration

This power calibration procedure requires that the CDMA cabinet has been successfully booted to an ECP via datalinks. The CSC (RCC) must be updated to the correct NVM and all diagnostics (CSC and CDMA) must pass. If these requirements have not been met, refer to the appropriate CDMA Integration Handbook Section (see Table 4-11).

Test equipment (CSTS, BSTS, or power meter) ***MUST*** be calibrated prior to beginning the CDMA power calibration. For test equipment calibration, refer to Handbook 226, Section 30.

CAUTION:
Proper Electrostatic Discharge practices, including use of wrist straps, must be used when handling circuit packs to prevent damage of components sensitive to ESD.

CAUTION:
To prevent personal injury and/ or damage to cell equipment, never disconnect RF cables while any RCU or BCR is in the TRANSMIT state (TX LED ON).

CAUTION:
The HP8481H Power Sensor Head may be permanently damaged if a 30dB attenuator is not connected between the sensor head and the foam jumper measurement point.

Pilot-only calibration is used for the LAC/MLAC amplifiers. The pilot-only calibration generates a constant pilot with the paging, sync, and traffic channels disabled.

[1] Update cell translation forms with the following data. Note the original data so that it can be restored after power has been set:

- Update ceqface:

  Pilot Channel Gain (dgu)**108**

  Paging Channel Gain (dgu)**0**

  Sync Channel Gain (dgu)**0**

- Update ceqcom2:

  LAC Type**l**

  Max Power**13.5**

  BCR Attenuation Factor (dB)**10**

NOTE:
The BCR Attenuation Factor was in the ceqface form prior to ECP 12.0.

NOTE:
Repeat this procedure for the CDMA clusters associated with each carrier. There should be one cluster for each carrier.

[2] If inhibited, allow call processing:

alw:cell a, cp

[3] Switch all faceplate switches (BCR and RCU) to OFF.

[4] Remove all BBAs from service:

rmv:cell a, bba b; ucl

CAUTION:
To prevent personal injury and damage to cell equipment, never disconnect RF cables while radio units are transmitting.

[5] Disconnect the foam jumper cable from the transmit antenna associated for the CDMA cluster being adjusted. The foam jumper is the cable connecting the transmit filter J4 port to the antenna cable at the cell hatch plate.

[6] Use an ITE-6924 test cable to connect the HP8921A or HP8935 RF In port to the foam jumper cable, or connect the HP437B/ HPE4418A power meter sensor through the 30dB attenuator to the foam jumper cable. Do not use a test cable with a power meter unless an offset value is entered in the meter.

[7] Operate the faceplate switch on the BCR to be adjusted to AUTO and use the following command to unconditionally restore the BBA for the desired sector and carrier:

rst:cell a, bba b; ucl

b = BBA member being adjusted.

[8] Verify the BCR ACT LED comes on.

[9] If this is a new CDMA cell site and there is no analog service, then the pre-amp may have never been adjusted. If the pre-amp has never been adjusted for this cell site, then adjust the LAC/MLAC pre-amp to electrical center before adjusting the first BCR. To do this, turn the LAC pre-amp from its minimum power level to its maximum power level and then set it at the electrical mid-point.

NOTE:
Anytime a LAC pre-amp is adjusted, all the RCUs and BCRs transmitting on that LAC must be re-adjusted.

[10] The metering device should display the approximate desired power. If the reading is beyond the maximum and minimum values shown in Table 4-12, ensure that the ceqface and ceqcom2 forms are correct and verify the BCR transmit path before attempting to adjust the BCR.

[11] Adjust the BCR faceplate pot to achieve the desired level as specified in Table 4-12.

Table 4-12.

Metering Device	Approximate Minimum	Desired Power	Approximate Maximum
CSTS BSTS	29 dBm 0.8 W	33 dBm 2 W	41 dBm 13 W
HP437B HPE4418A (30dB Attn)	-1 dBm 0.8 mW	3 dBm 2 mW	11 dBm 13 mW

BCR Attn = 10, Pilot DGU = 108, Page/Sync DGU = 0/0

Amplifier type = I, Max_power = 13.5

[12] When the desired level is set, operate the BCR faceplate switch to OFF.

[13] To set power on a multiple carrier system, repeat steps [7] through [12] for each remaining carrier cluster on the sector the metering device is connected to. If a LAC/MLAC pre-amp was adjusted to electrical center, do not re-adjust it.

[14] When BCR power for all carriers of this sector have been set, disconnect the metering device from the foam jumper and connect the foam jumper back to the antenna cable.

[15] Repeat steps [5] through [14] for each BCR associated with the remaining sectors.

[16] When power is set for all BCRs, restore the original Pilot, Page, Sync, Max Power, and BCR Attenuation values to the ceqface and ceqcom2 forms.

[17] Ensure that all the CDMA clusters have been adjusted and that the transmit antennas have all been reconnected.

[18] Switch all faceplate switches (BCR and RCU) to AUTO.

[19] Perform a cell stable clear:

init:cell a: sc

Grounding Requirements

The DDGF requires two separate kinds of grounding, as follows:

1. 24 Volt DC Return (Grounding)
2. Frame Grounding (FRM_GRD)

Volt DC Return (Grounding)

The +24 V DC return feeders are connected to the return bus at the Battery/Rectifier power plant. The return bus in the Battery/Rectifier power plant is bonded to the grounding system with the appropriate grounding conductor.

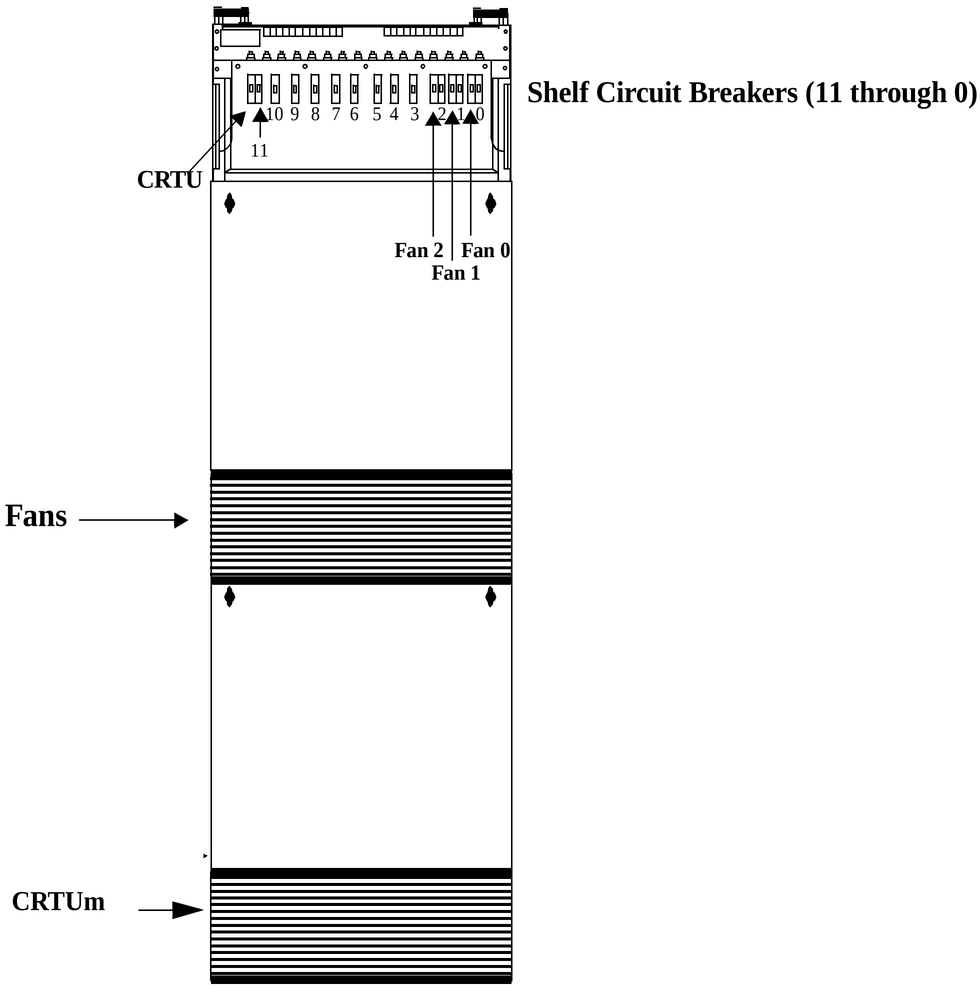


Figure 4-20. Double Density Growth Frame (top panel removed to expose circuit breakers - Rear View)

Frame and Base Station Grounding

All equipment frames are bonded to the grounding system at a minimum of two locations. Additionally, the DDGF is bonded to adjacent existing radio equipment frames. All base station grounding must follow the guidelines provided by Lucent Technologies document 401-200-115, *Grounding and Lightning Protection Guidelines for Lucent Technologies Network Wireless System Cell Site*, or the warranty may be voided.

Cable Installation for the DDGF

Cable installation for the DDGF is as follows:

Transmit coax connections are made from the DDGF Transmit Power Combiner in the IPA to the LAF Transmit In.

Receive coax connections are made from the AIF Receive Power Dividers to the DDGF Receive Power Dividers.

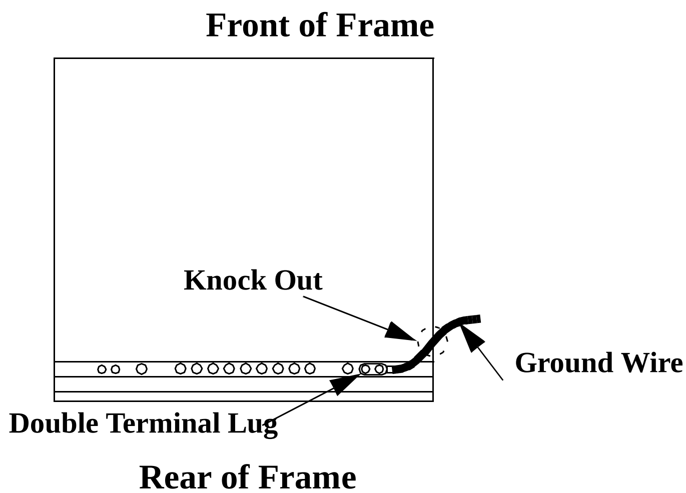


Figure 4-21. Frame Ground From Adjacent Cabinet

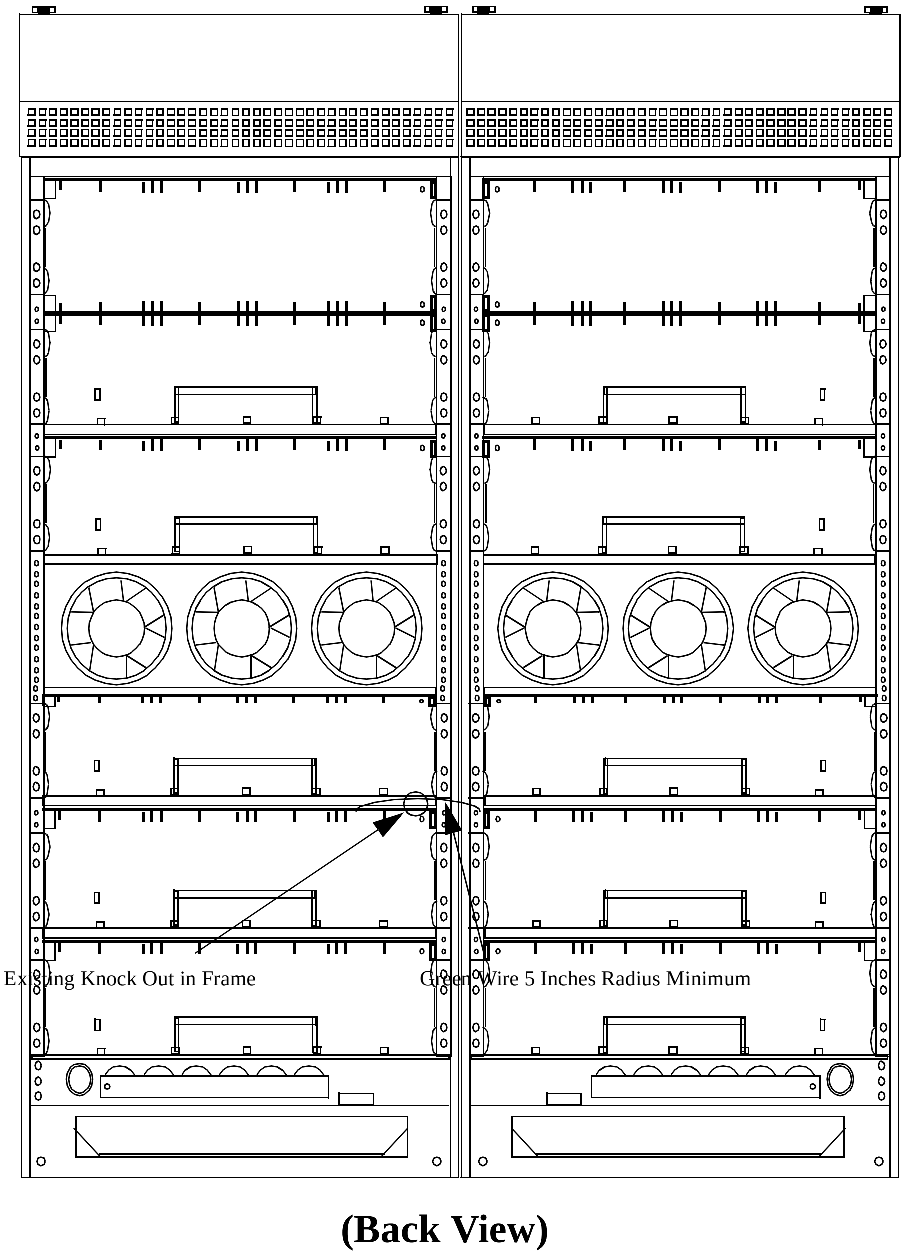


Figure 4-22. Ground Wire Connections Between Frames

Connecting the DDGF to Frames in a Series II

Connecting the DDGF to Series II frames requires cables similar to those used when connecting a CDMA Growth Radio Frame. The following guidelines apply to installing these cables:

1. **The nominal impedance** for all RF paths is 50 ohms.
2. **CDMA transmit path**: The transmitter outputs from the BCR are cabled to a common 4:1 power combiner in the IPA. The IPA can accommodate up to six 4:1 transmit power combiners for either an omni, three-sector or six-sector configuration. The outputs from the 4:1 power combiners at the top of the DDGF IPA are then cabled to the appropriate LAF input.
3. **CDMA receive path**: A 1:4 dividing scheme similar to the transmit path combining scheme is used for the receive path. There are two receive paths (RX0 and RX1). The IPA can accommodate up to twelve 1:4 power dividers (six for RX0 and six for RX1) for either an omni, three-sector or six-sector con-figuration. The inputs to the 1:4 power divider at the top of the DDGF IPA for the installer are cabled from the appropriate AIF output.
4. **Transmit/Receive**: J101/J102 are transmit/receive signaling for quadrants 3 and 4. J105/J106 are transmit/receive signaling for quadrants 1 and 2.

Additionally, the following note applies to all cabling connected to the DDGF.

The alarm cables are to be run on the cable racks to the proper bay. Additional slack is to be stored on the rack or top of the bay in a neat manner. All protection requirements are to be followed.

CAUTION:
No nylon ties are to be used to secure cables on the cable racks.

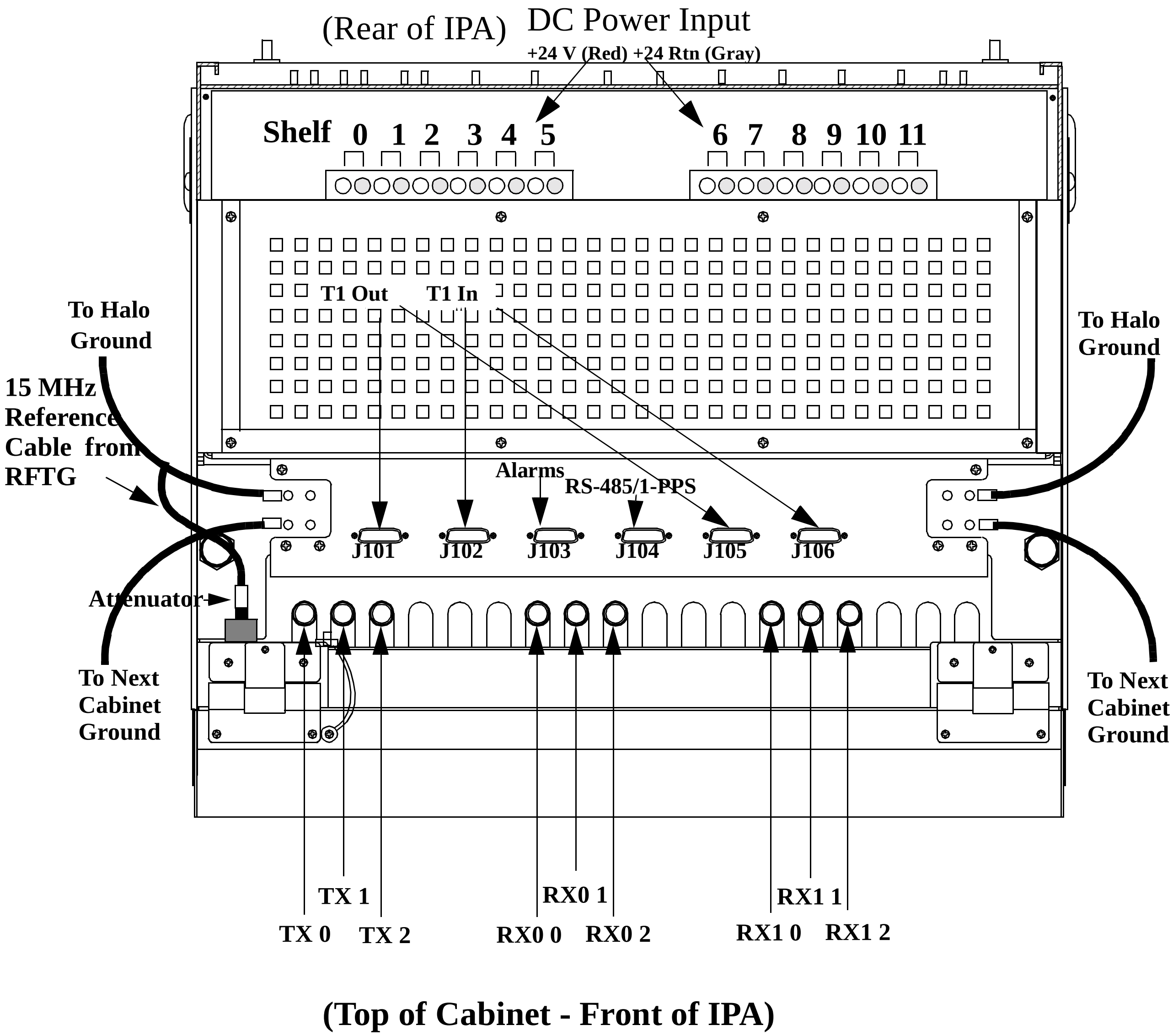


Figure 4-23. DDGF IPA

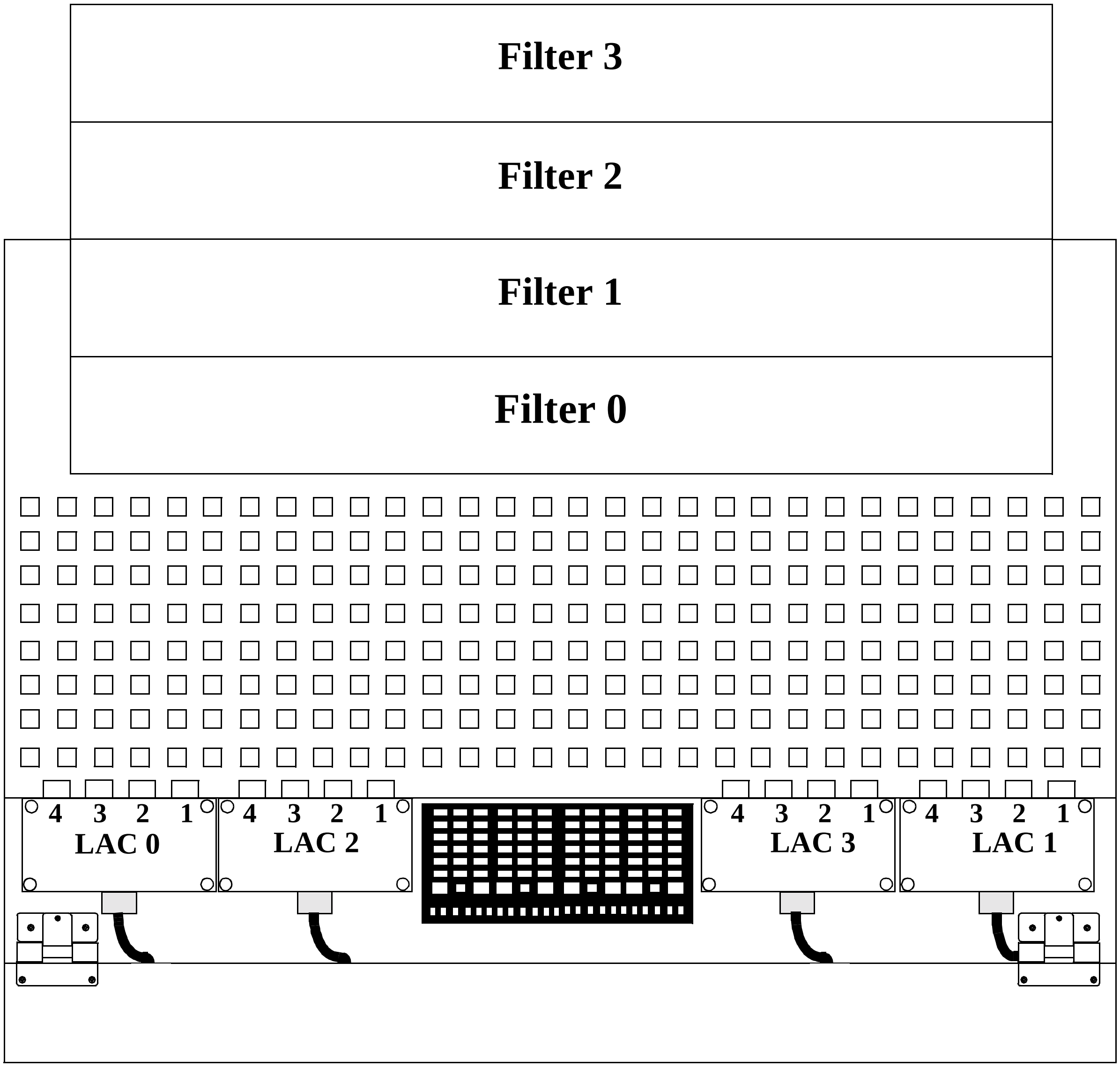


Figure 4-24. Top of LAF 0, MLAC Power Divider Inputs

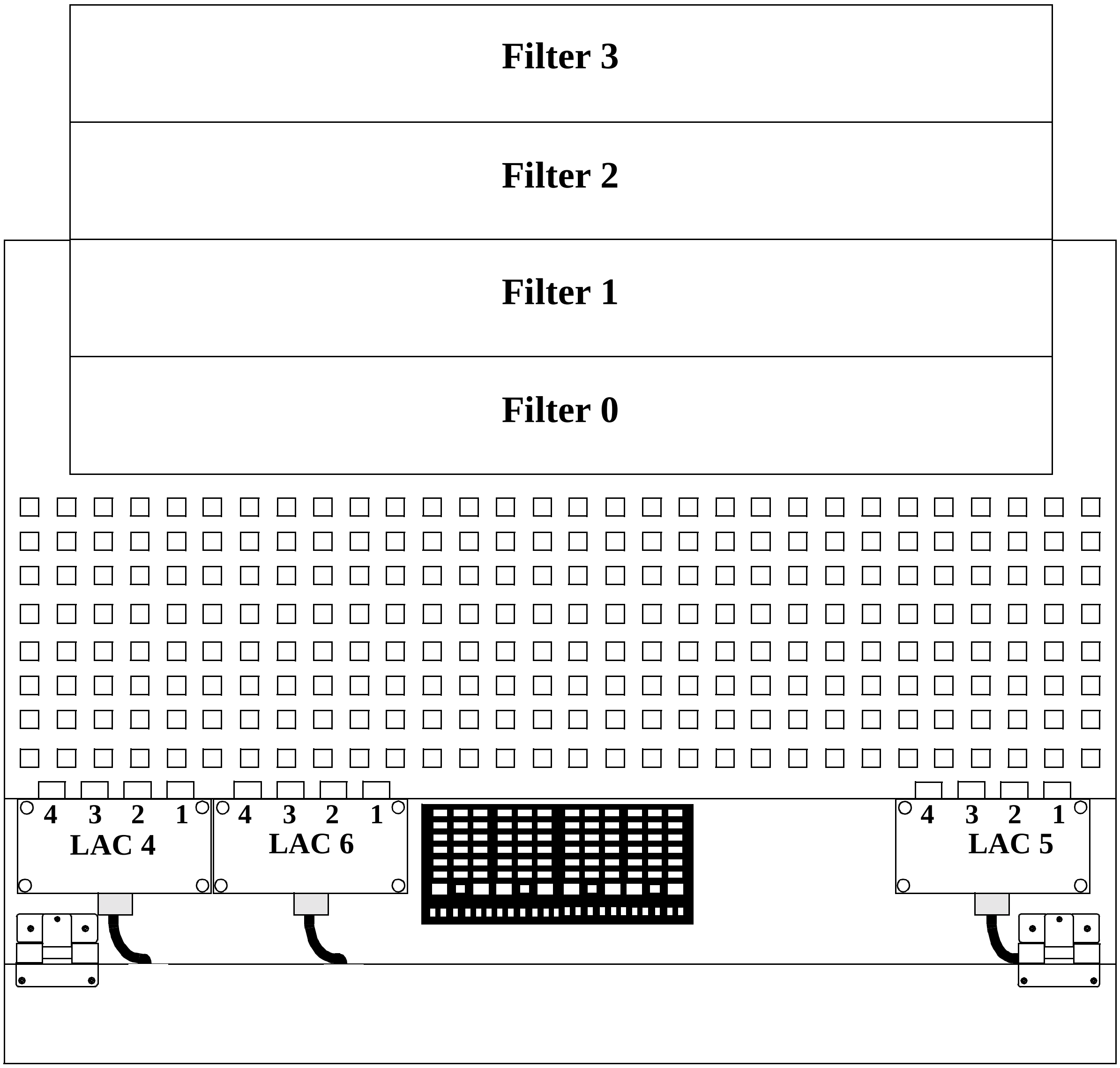


Figure 4-25. Top of LAF 1, MLAC Power Divider Input

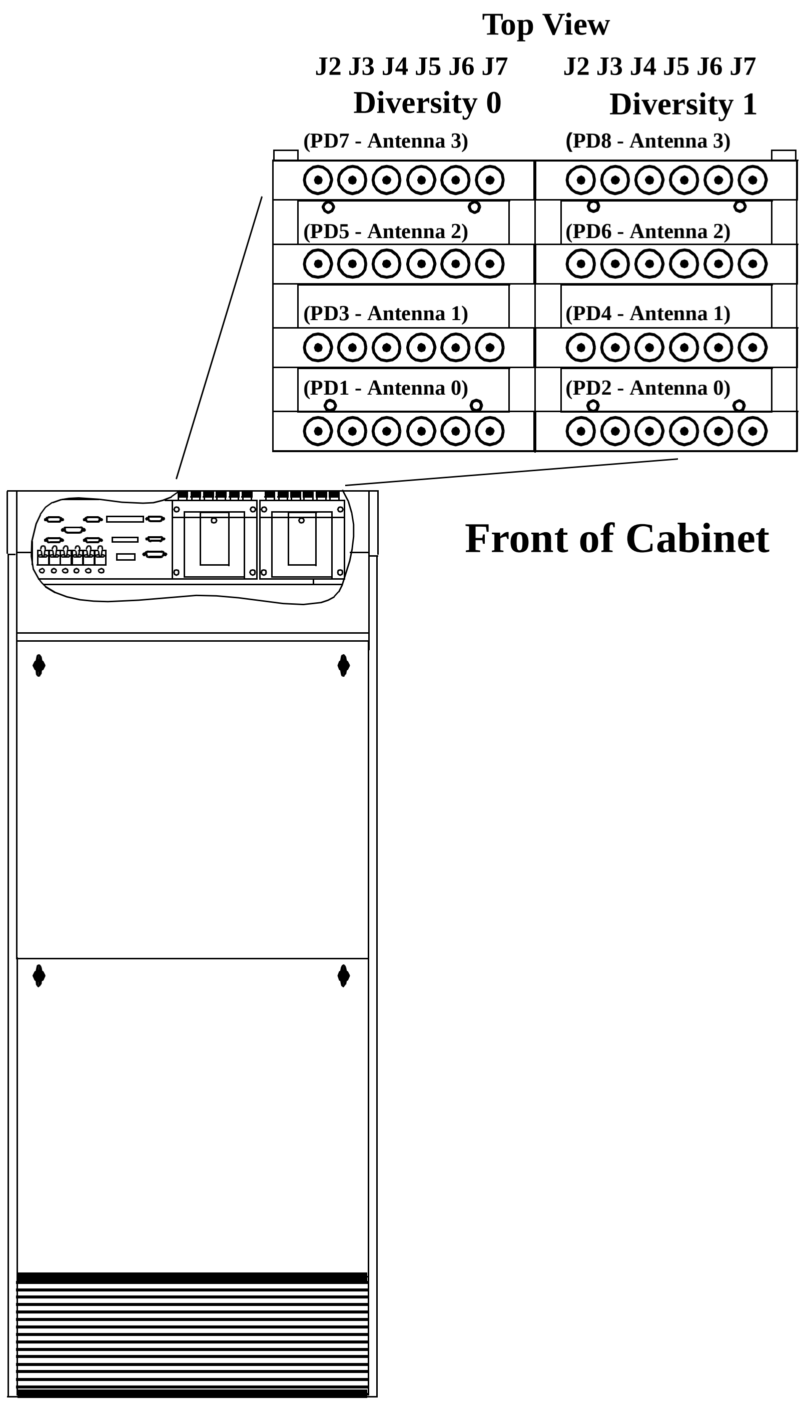


Figure 4-26. Top of AIF 0, RX 0, and RX 1 Power Divider Outputs (front view)

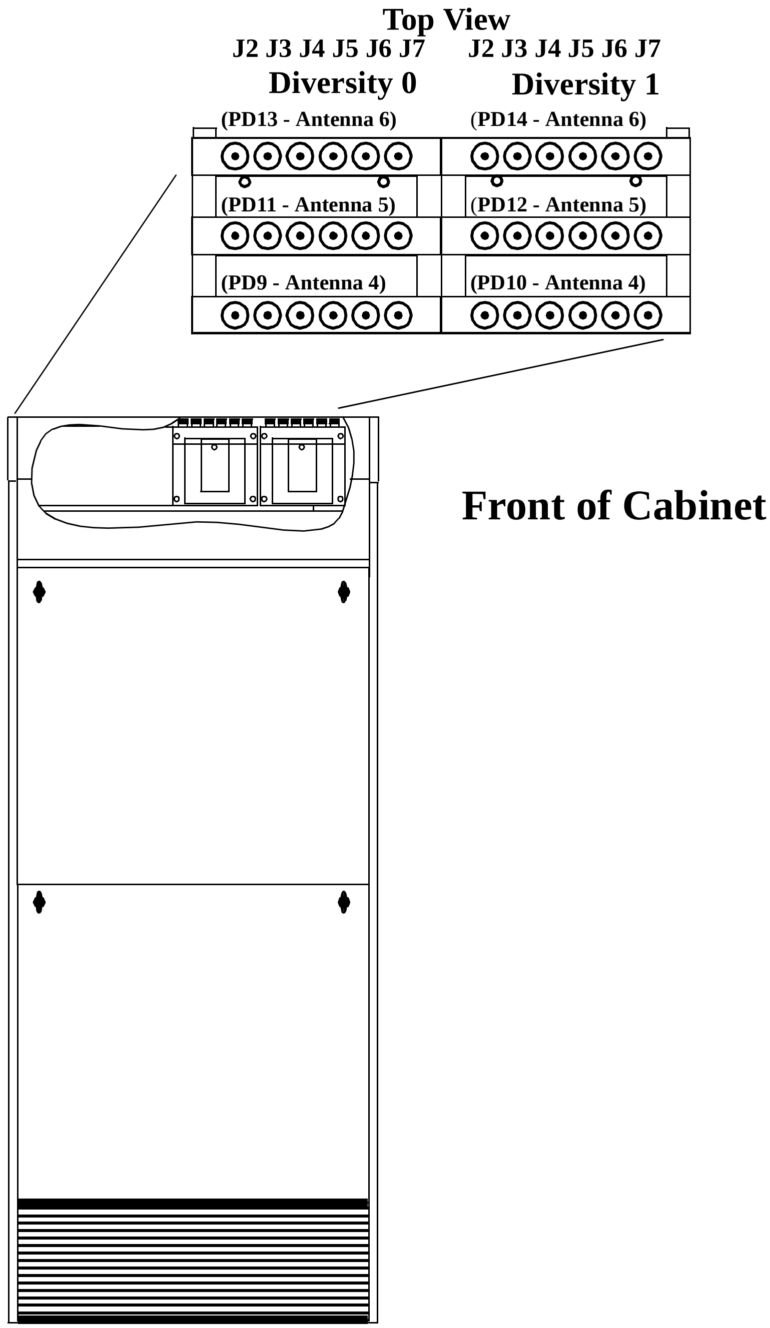


Figure 4-27. Top of AIF 1, RX 0, and RX 1 Power Divider Outputs

Time Division Multiplex (TDM) Bus 1

A Series II Cell Site equipped with a DDGF is installed using two TDM buses, with the DDGF using the second TDM Bus (TDM Bus 1). The TDM Bus is a 2.048-MHz 8-bit Time Division Multiplexed bus which provides voice, data, or control connectivity to the CCC, BIU, and SCT/DFI circuit packs on the CRC backplane. Transfer of TDM bus control channel messages between the core processor (RCF 0, RCC Shelf) and a port board are performed by the RCF 0, RCC shelf Network Control Interface (NCI). The CAT in RCF 0 provides the clock timing for TDM Bus 0, while the SCT in the DDGF provides the clock timing for TDM Bus 1. TDM bus cables are installed "red stripe up."

TDM Bus Termination and Interconnection Cabling

TDM bus 1 (installed "red stripe up") is always terminated at the DDGF backplane connector (P13, shelf 0) by inserting a AYD3 TDM bus termination board.

Some newer TDM bus cables include a strain relief. The cable is doubled back across the top of the connector, and a plastic strain relief is added to hold the cable in place. This causes the cable to extend further from the backplane, making the latch clamps insufficiently long enough to capture the connector.

Remove the strain relief. Depress the small tab located at each end of the connector with a ballpoint pen while pulling the plastic strain relief away from the connector.

CDMA Radio Test Unit Module and Interface

CRTUm and RSP Interaction

Through an RS-422 data link, the CRTUm (CDMA Radio Test Unit module - an embedded CDMA test mobile) along with a Radio Test Unit (RTU) Switch Panel (RSP) allows for on-site radio diagnostics and repair as well as diagnostics from a central office. The CRTUm consists of two major components:

1. CRTUm
2. CRTUm interface (CRTUi) circuit pack that plugs into growth slot #15 of the RCC shelf in RCF 0

NOTE:
The CRTUi and CRTUm communicate on the RS-422 link using the CRTUm data port. The Radio Test Unit (RTU) Switch Panel (RSP) enables testing of CDMA hardware. AMPS and Digital (CDMA only for DDGF) testing is done in conjunction with the RSP Control Board (RCB), AYD8, residing in the rear of the RTU shelf in RCF 0. An AYD12 adapter board allows the CRTUi to communicate with the RS-422 data links.

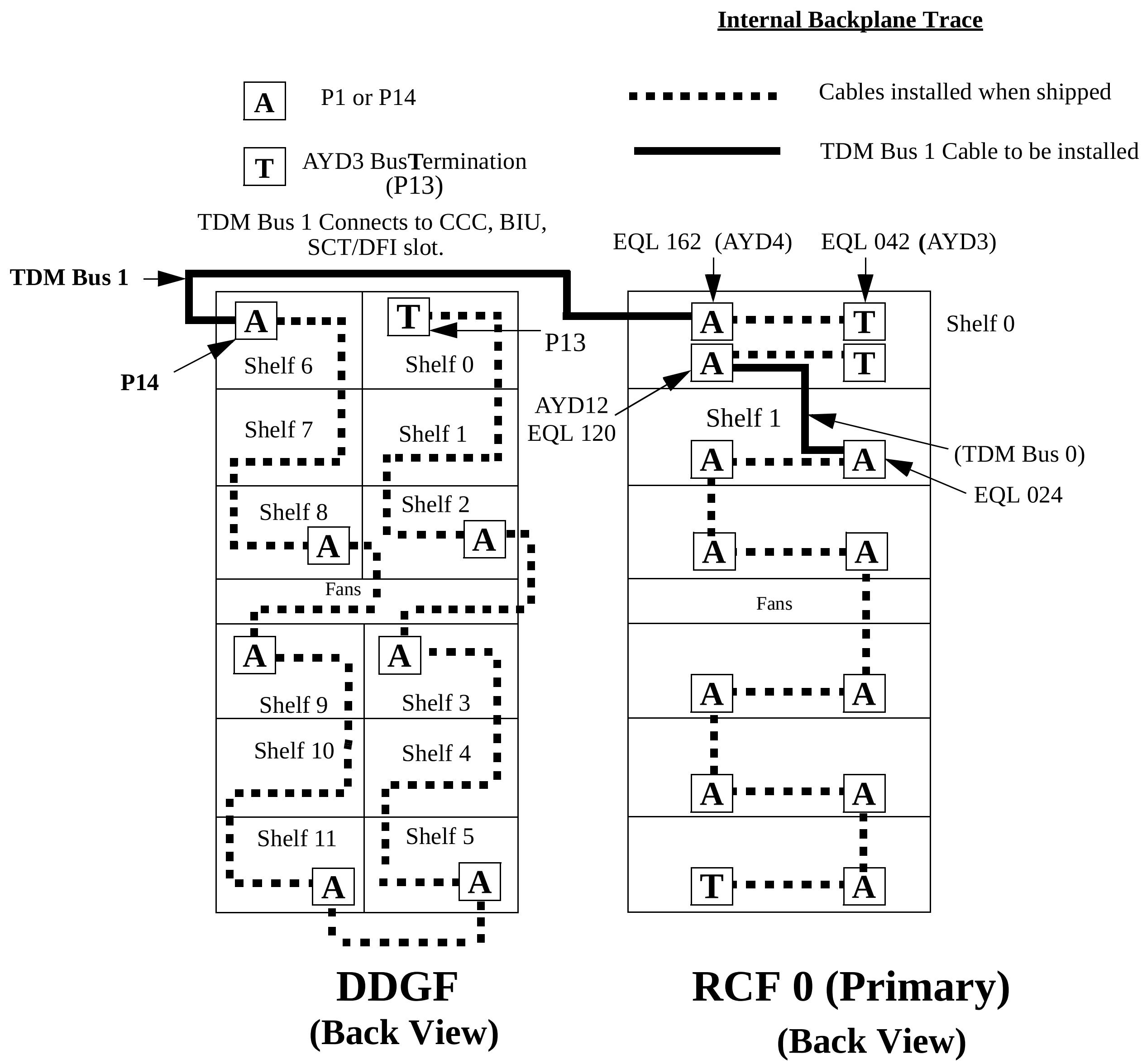


Figure 4-28. TDM Bus Installation. TDM bus cables are installed "red stripe up." (Configuration 3)

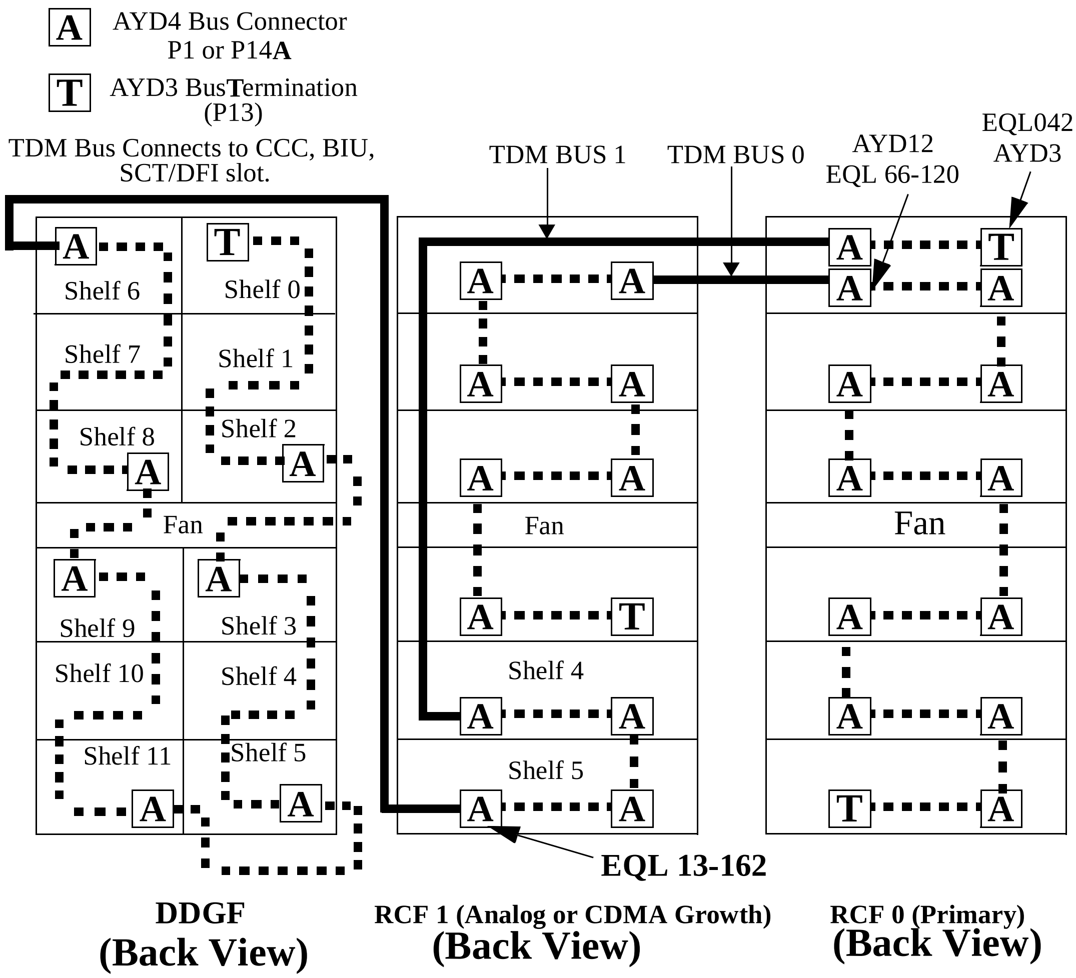


Figure 4-29. TDM Bus Installation. TDM bus cables are installed "red stripe up." (Configurations 4 and 5)

CDMA Radio Test Unit Module (CRTUm)

The CRTUm data interface is a nine-pin data connector. Power is supplied to the CRTUm through a two-pin connector. The CRTUm communicates with the Baseband CDMA Radio (BCR) via a test RF path established by the RSP test switch matrix. The RF interface is coupled from a mobile antenna coupling adapter through a duplexer and filter circuit to SMA Jacks for separate transmit and receive ports for test purposes. External attenuators are required to balance out the transmit and receive path losses. The (Tx and Rx) attenuators, which are external to the CRTUm, are part of the overall CRTU test path.

There are two options for mounting the CTRUm, and a different CTRUm is used for each option. The CTRUm may be:

1. Wall-mounted
2. Housed in the bottom of the DDGF

Installation kits include power jumpers and instructions. A DDGF circuit breaker provides the power to the CRTUm.

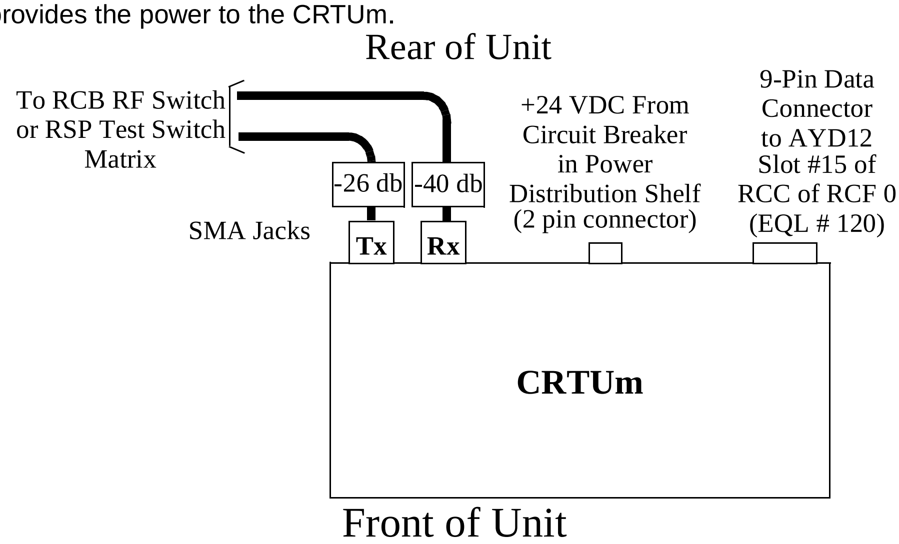


Figure 4-30. CDMA Radio Test Unit Module

Table 4-13. CRTUm RF and DC Power Requirements

CRTUm Requirements	Units
TX Output at Mobile Antenna Connector	-57 to +23 dBm (200 milliwatts max.)
RX Input at Mobile Antenna Connector	-25 dBm to -104 dBm (869 MHz to 894 MHz)
DC Voltage	+19.0 to +28.5 V dc
DC Current	2.0 amps max at 19 V dc

CRTUi/CRTUm/RCB/RSP Control And RF Interface

The CRTUi connects directly to the RSP, or through the RCB RF switch interface via a coaxial interface. In a cell site with multiple Test Units (TUs), i.e., AMPS RTU, TDMA RTU (TRTU) or CDMA RTU (CRTU), the RCB is responsible for switching the RF interfaces between the multiple TUs to the test paths. Only the TRTU and the CRTUi can control the RCB for their test functions. The RCB defaults to RTU control normally. The RSP responds to commands from the CRTUi via the RCB to determine which test paths need to be established. The CRTUi, upon request of the RCC, is able to request parameter reporting, update parameter changes and autonomous actions of the CRTUm.

DDGF Impact on RF Testing

RF testing of a cell site is done by connecting the CDMA Radio Test Unit module (CRTUm) to the cell site transmit and receive path filter panels. An RTU Switch Panel (RSP) is used in the interconnection to allow the CRTUm to interact with any chosen sector.

Addition of the DDGF to the cell site does not change how this RF testing is done because the DDGF adds radio capacity only; it does not affect the RF paths of the cell. Therefore, RF testing will continue to be based on the primary frame type, and will be independent of whether the growth frame is DDGF or another allowed frame type.

Alarms

The Alarm/FITS Interface (AFI) circuit pack in the RCC shelf of RCF 0 provides the interface for all the cell and hardware alarms. (In addition, the FITS testing computer can also be connected to the AFI board through a RS-488 connector at the front).

The four major alarm categories are:

1. Amplifier alarms
2. Frame alarms
3. Users alarms
4. AIF alarms.

Table 4-14. CRTUi/CRTUm/RCB/RSP Control Interface

CRTUi Backplane Pin	CRTUi Signal	AYD12 Backplane Pin	RSP Signal	Signal Description
046	SAGECTR	314		Sage Control Signal
147	GPIO	215		General Purpose I/O and Hard Reset
040	SER0RXDR	308		Serial Port 0 Receive
043	SER0RXDR	311		Data from CRTUm
142	SER0TXDR	210		Serial Port 0 Transmit

Table 4-14. CRTUi/CRTUm/RCB/RSP Control Interface (Contd)

140	SER0TXDR	208		Data to CRTUm
139	SER1TXD	207	ANT_SEL+	Serial Port 1
137	SER1TXD	205	ANT_SEL-	Transmit Data to RSP
035	RSPREQ1	303	RTU_ACT	Control Request of RSP by CRTUi
033	SER1RXD	301	ANT_MSG_ACK+	Serial Port 1
032	SER1RXD	300	ANT_MSG_ACK-	Receive Data from RSP
138	Ground	206		Ground
134	Ground	202		Ground

The DDGF uses the same type of frame alarms as the Series II CDMA Growth Frame. Therefore, the frame alarm handling is identical to Series II. The alarms are connected to the AFI pins normally allocated to a Series II growth frame. These AFI pins are located in the Primary Radio Channel Frame.

Frame alarms provide the status of the Power Converter Units (PCUs), temperature, and fans of the frame. There are 12 alarm signals (six for PCUs and six for fans) routed via cable to the IPA at the top of the DDGF.

Shelf alarms carry the status of the shelf PCU. The PCU alarms in the DDGF are wired such that an alarm can indicate a failure of the power converter in DDGF shelf 0, or in DDGF shelf 6, or both.

Fan alarms provide the status of the fans. For any fan that stops rotating, a failure alarm is generated for the fan and the failure is reported back to the AFI using the same interface cabling as the 415AE (or 415AC) alarms.

Table 4-15. DDGF Alarms

Alarm Name	Description	IPA J103 Pin Number
FAL0L	Fan 0 Failure	7
FAL1L	Fan 1 Failure	8
FAL2L	Fan 2 Failure	9
FAL3L	Fan 3 Failure	10
FAL4L	Fan 4 Failure	11
FAL5L	Fan 5 Failure	12
PWR_AL_SH0_SH6	PCU Failure Shelf 0, 6	1
PWR_AL_SH1_SH7	PCU Failure Shelf 1, 7	2
PWR_AL_SH2_SH8	PCU Failure Shelf 2, 8	3

Table 4-15. DDGF Alarms (Contd)

PWR_AL_SH3_SH9	PCU Failure Shelf 3, 9	4
PWR_AL_SH4_SH10	PCU Failure Shelf 4, 10	5
PWR_AL_SH5_SH11	PCU Failure Shelf 5, 11	6

415AE (or 415AC) DC-To-DC Converter Alarms

The alarms on each CRC shelf are 415AE (or the older 415AC) power unit alarm and circuit pack alarms. Alarms and/or faults associated with the circuit packs are handled at the pack level.

The Power Unit Alarm (relay contact) and LED Indicators are as follows:

- **Low output voltage** alarm if the output voltage falls below 80% of nominal (RED LED turns ON, relay contacts close)
- **High output voltage** alarm if the output voltage is greater than 120% of nominal (output turns OFF, unit latches OFF, RED LED turns ON, relay contacts close). The input voltage must be disconnected before the latch will clear
- **Red LED** on faceplate indicates an alarm
- **Green LED** on faceplate indicates the presence of input voltage
- Single isolated contact closure upon LV alarm or HV shutdown
- Relay contacts connected to the backplane [ALM1 (Pin 113) and ALM2 (Pin 014)]. The ALM2 pin is connected to ground. A relay closure connects ALM1 to ALM2 which indicates an alarm (Logic 0)

+5 V DC performance is not guaranteed below +20 V DC input to 415AE (or the older 415AC).

CDMA CRC Shelf Circuit Pack LED Indicators

The CDMA CRC shelf Circuit packs have various Light Emitting Diode (LED) indicators on their faceplates. These LEDs indicate either operational or alarm conditions.

Series II Cellular CDMA Adjunct to Small Cells

5

Contents

CDMA Adjunct

Overview

The CDMA Adjunct is one of several members of the CDMA Minicell product family. Its development was driven by the need to add a small amount of CDMA capacity to existing Series IIm (Minicell) and Series IImm (Microcell) cell sites. In particular, the CDMA Adjunct is a single frame that adds CDMA capability to Series IIm (Minicell) and Series IImm (Microcell) cells. When used with a Series IIm (Minicell) or Series IImm (Microcell) cell site, the CDMA Adjunct Frame adds:

- Omnidirectional CDMA Service with 1 to 3 Carriers
- Two-Sector CDMA Service with 1 Carrier per Sector
- Three-Sector CDMA Service with 1 Carrier per Sector

High Level Interface for the CDMA Adjunct

Most of the external interfaces supported by the CDMA Adjunct are to the host Series IIm (Minicell) or Series IImm (Microcell) cabinets, and there are no external interfaces to the MSC. The Global Positioning System (GPS) antenna signal interface and the power interface are the only ones that do not connect directly to the host cell.

Figure 5-1 shows the following high level external interfaces supported by the CDMA Adjunct Frame to the host (Series IIm (Minicell) or Series IImm (Microcell)) cell:

- Global Positioning System (GPS) Interface
- Transmit (Tx) and Receive (Rx) Interfaces to the host’s antennas
- DC (only) prime Power Interface
- CRTU Control and Test Interfaces
- TDM Bus Interface
- Reference Frequency and Timing Generator (RFTG) Interface
- Alarm Interface

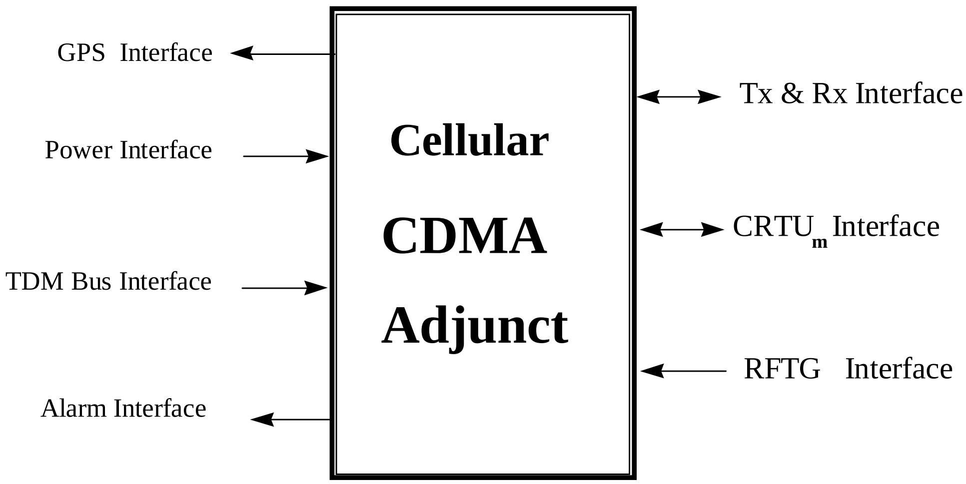


Figure 5-1. CDMA Adjunct Frame External Interfaces

Supported Technologies

The CDMA Adjunct supports only CDMA technology at cellular frequencies as defined in FCC Code of Federal regulations, Part 22, Subpart K. AMPS and TDMA technologies are not supported by the CDMA Adjunct or by any member of the CDMA Minicell product family. These products are focused on international start-up systems with no embedded AMPS subscriber base, or on domestic and international applications where CDMA is overlaid on an existing AMPS or TDMA system. When the CDMA Adjunct is added to a Series IIm (Minicell) or Series IImm (Microcell) host cell, the host cell supports only the AMPS technology; it can not support the TDMA technology.

For reference, the U. S. domestic cellular transmit and receive frequency bands are given in Table 5-1.

Table 5-1. U. S. Domestic Cellular Transmit And Receive Frequency Bands

Frequency Band	Transmit Frequency, MHz	Receive Frequency, MHz
A	870.030 to 879.990	825.030 to 834.990
A’	890.010 to 891.480	845.010 to 846.480
A”	869.040 to 870.000	824.040 to 825.000
B	880.020 to 889.980	835.020 to 844.980
B’	891.510 to 893.970	846.510 to 848.970

Traffic Capacity

The CDMA Adjunct hardware does not limit its traffic capacity; instead, the air interface is the limiting factor for traffic.

RF Coverage Area

The RF coverage area of a cell depends upon the RF rating of its transmit amplifier and the internal losses in the transmit path from the amplifier's output to the antenna. The CDMA Adjunct with the Series IIm (Minicell) supports only 1 high-power, 13-watt carrier per directional sector. The CDMA Adjunct with the Series IImm (Microcell) supports only 1 low-power carrier per directional sector.

Physical Aspects of CDMA Adjunct

CDMA Adjunct Components

The CDMA Adjunct components are illustrated in Figure 5-2 and listed below:

- Zero to Three Transmit Amplifiers
- CDMA Radio Complex
- DC Distribution Hardware
- Environmental Conditioning Equipment
- Synchronized Clock And Tone (CAT) boards
- CRTUm
- Cascade and Notch Filters, as needed
- Miscellaneous RF Interconnection Hardware.

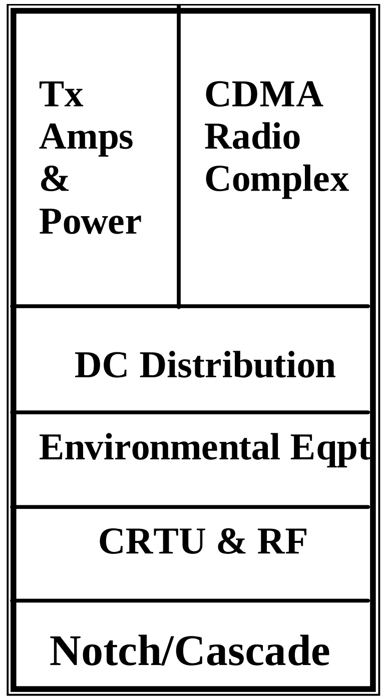


Figure 5-2. CDMA Adjunct Frame

Figure 5-2 is not an exact representation and is not intended to show exactly where within the CDMA Adjunct frame each piece of equipment is mounted.

The equipage is based on the following assumptions concerning the host cell:

- TDMA radios are not installed when the CDMA Adjunct is installed.
- The CDMA Radio Test Unit interface (CRTUi) is mounted in the host cell's Radio Control Complex (RCC) shelf.
- The single-antenna Test Radio Switch Panel (TRSP) is replaced with the multiple-antenna TRSP), suitable for supporting CDMA radio testing.
- CAT boards remain in the host cell and SCT boards are installed in the CDMA Adjunct.
- Unused DFIs in the Small Cell's Radio Control Complex and Channel Service Unit slots in the frame are populated as needed for additional CDMA traffic.
- The RFG is replaced with the RFTG.

New cables are added to:

- Bring the GPS input from the CDMA Adjunct to the RFTG

- Deliver the 15 MHz reference frequency and 1 second clock pulse from the RFTG to the CDMA Adjunct
- Connect Transmit (Tx) and Receive (Rx) signals from the CDMA Radio Test Unit module (CRTUm) in the CDMA Adjunct to the Radio Test Unit control board in the host cell
- Control the CRTUm.

When there are no transmit amplifiers in the CDMA Adjunct, it uses the transmit power amplifier located in the host cell. When the CDMA Adjunct contains its own amplifier, the allowable number of amplifiers varies from 1 to 3 based on the number of sectors in the cell.

The CDMA Adjunct uses the facilities interfaces provided in the host cell to communicate with the MSC. In other words, the CDMA Adjunct uses the DFI and DS1 lines that are in the host cell or connected to the host cell. The CDMA Adjunct and the host cell share a common TDM Bus (installed "red stripe up"). Therefore, the DFI and Cell Site Unit boards needed to support CDMA traffic do not reside in the CDMA Adjunct frame. Because the host cell RCC already has enough slots to house the number of DFI boards needed to support the additional CDMA traffic, and because there is sufficient mounting space elsewhere in the host for the Cell Site to support both the analog and digital traffic, no mounting space for these items is required in the CDMA Adjunct.

Table 5-2. CDMA Adjunct Line Connections

Series IIm (Minicell)	Series IImm (Microcell)
3 DS1s	11 DS1s
21 Voice Channels	63 Voice Channels
2 Data Links (analog radios)	2 Data Links (analog radios)
49 DS0s	199 DS0s

As shown in Table 5-2, the Series IIm (Minicell) supports up to 3 DS1s. Because Series IIm (Minicell) has at most 21 voice channels and 2 data links (assuming analog radios), there are up to 49 DS0s available for CDMA.

As shown in Table 5-2, Series IImm (Microcell) supports up to 11 DS1s. Because Series IImm (Microcell) has at most 63 voice channels and 2 data links (assuming analog radios), there are up to 199 DS0s available for CDMA.

Dimensions and Weight

The nominal dimensions of the CDMA Adjunct Frame are 75" H x 30" W x 30" D. The nominal weight of the CDMA Adjunct Frame less than or equal to1000 pounds.

Physical Appearance of the CDMA Adjunct

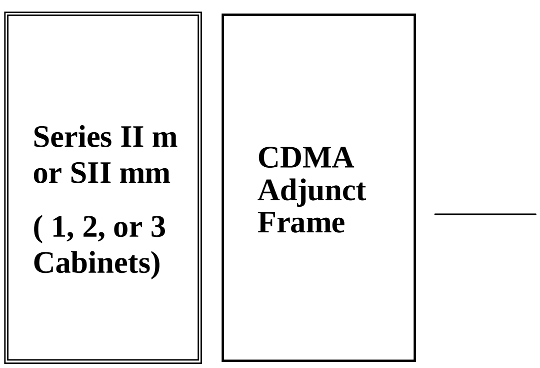
The physical design and appearance of the CDMA Adjunct Frame is similar in size, color, and markings to the following members of the CDMA Minicell product family: MiniPrimary, MiniGrowth, and MiniAntenna Interface.

CDMA Adjunct Physical Positioning and External Equipment

CDMA Adjunct Frame LineUp

The CDMA Adjunct is a single frame. Therefore its allowable frame lineup is just 1 frame. This frame is added to a Series IIm (Minicell) or Series IImm (Microcell) frame lineup that can consist of 1 to 3 frames.

Although the CDMA Adjunct is just a single frame, it supports several configurations. The frame lineup shown in Figure 5-3 does not necessarily show the exact placement of frames within a particular lineup; it is only intended to list the number of frames required. Frame electrical design drawings give the relative frame locations within each lineup.



SIIm/mm Sectors	Adjunct Sectors	Adjunct Carriers/Sector
1	1	1 to 3
2	2	1
3	3	1

Figure 5-3. CDMA Adjunct Frame LineUp

The CDMA Adjunct to small cells is a single frame of equipment for all supported configurations. Regardless of the number of sectors in the host cell, there is only 1 CDMA Adjunct Frame associated with each host cell. The CDMA Adjunct does not include any auxiliary frames of equipment needed to power the CDMA Adjunct or to provide battery backup; these must be supplied independently.

The CDMA Adjunct Frame supports the following configurations:

- 1 Sector, 1 to 3 Carriers per Sector
- 2 Sectors, 1 Carrier per Sector
- 3 Sectors, 1 Carrier per Sector

The configurations relative to the Series IIm/mm sectors are shown in Table 5-3.

Table 5-3. Frame Equipage Table

Series IIm/mm Sectors	CDMA Adjunct Sectors	CDMA Adjunct Carriers per Sector
1	1	1 to 3
2	2	1
3	3	1

The current Series IIm (Minicell) and Series IImm (Microcell) cells do not support omnidirectional cells with more than 2 transmit antennas, thus setting the limitation above for an omnidirectional, 2 carrier CDMA Adjunct configuration. If a Series IIm (Minicell) or Series IImm (Microcell) configuration with three transmit antennas becomes available, then the CDMA Adjunct will be expected to support it.

The CDMA Adjunct Frame is equipped with the same number of sectors as its host cell. Because the CDMA Adjunct must use the antennas of the host cell, it must have the same configuration as the host cell. Series IIm (Minicell) and Series IImm (Microcell) are available in 1-sector, 2- sector, or 3-sector configurations, where the 1-sector configuration may have 360° of coverage. Therefore, the CDMA Adjunct is available in 1- sector, 2- sector, and 3-sector configurations. This availability does not permit multiple directional CDMA sectors to be added to an omnidirectional (1-sector) host cell.

External Equipment Supported by the CDMA Adjunct

The CDMA Adjunct Frame provides a termination for an external GPS antenna. The GPS antenna cable terminates at an RFTG.

CDMA Adjunct Antenna Connections

The CDMA Adjunct connects to antennas that reside in the host Series IIm (Minicell) or Series IImm (Microcell) cell. Each radio in the CDMA Adjunct requires access to 1 Transmit (Tx) port and 2 Receive (Rx) ports in the host cell. The CDMA Antenna Connections are shown in.

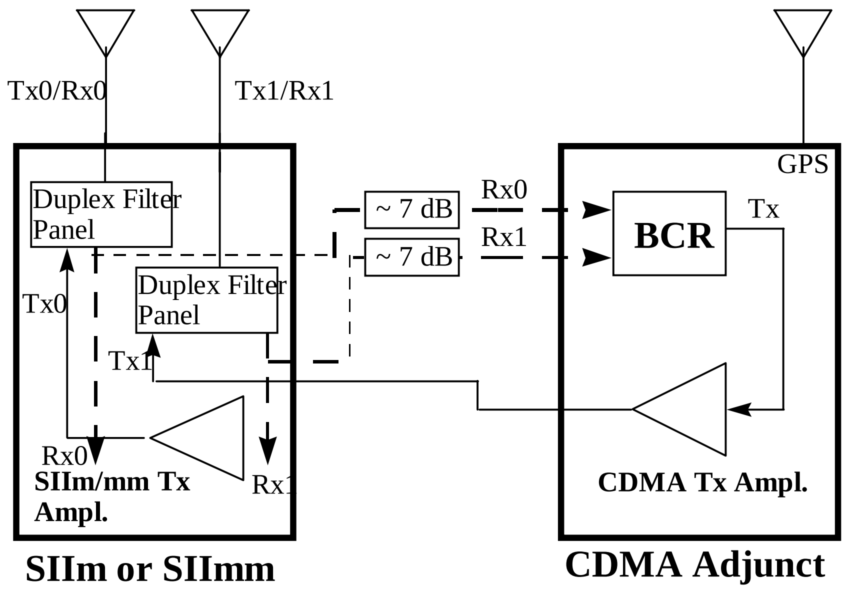


Figure 5-4. CDMA Adjunct Antenna Connections

CDMA Adjunct to Host Cell Inter-frame Hardware Interfaces

The host cell does not supply power to the CDMA Adjunct. The CDMA Adjunct accepts only DC as its power source; it does not operate directly from AC power. The CDMA Adjunct does not have a direct connection to the DS-1 or E1 lines that go to the MSC; it accesses these facilities through its TDM Bus connection to the host cell.

Also, note that the Transmit (Tx) cables that connect the CDMA Adjunct to the input of the amplifier in a Series IImm (Microcell) may be a smaller size than the Transmit (Tx) cables that connect the CDMA Adjunct to the transmit input of a duplex filter panel.

Figure 5-5 shows the physical interfaces to the CDMA Adjunct. The CDMA Adjunct's external interfaces are listed below:

- Input cable from the GPS antenna
- Output cable to connect the GPS signal to the host cell
- 3 RF transmit cables connected to the host cell (1 antenna per supported sector)
- External source of nominal 24 Volts DC power
- 3 RF Receive cables to support Diversity 0 (1 antenna per supported sector)

- TDM Bus (with "red stripe up") supplied from the host cell
- Alarm cable connected to the host cell to report alarms
- 3 RF receive cables to support diversity 1 (1 antenna per supported sector)
- CRTU control interface cable from the host cell
- Transmit (Tx) cable connected to the Radio Test Unit Control Board in the host cell
- Receive (Rx) cable connected to the Radio Test Unit Control Board in the host cell
- 1 second clock pulse cable from the RFTG in the host cell
- 15 MHz RFTG output to the host cell

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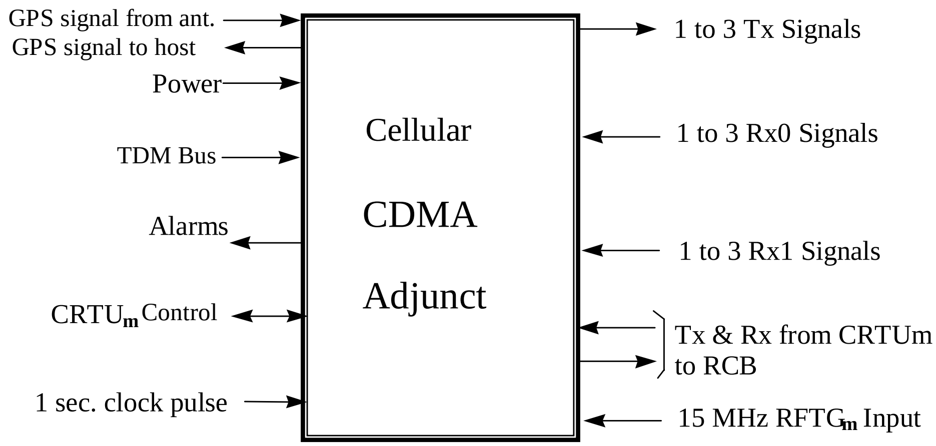


Figure 5-5. CDMA Adjunct Frame External Interfaces

RF Distribution Paths

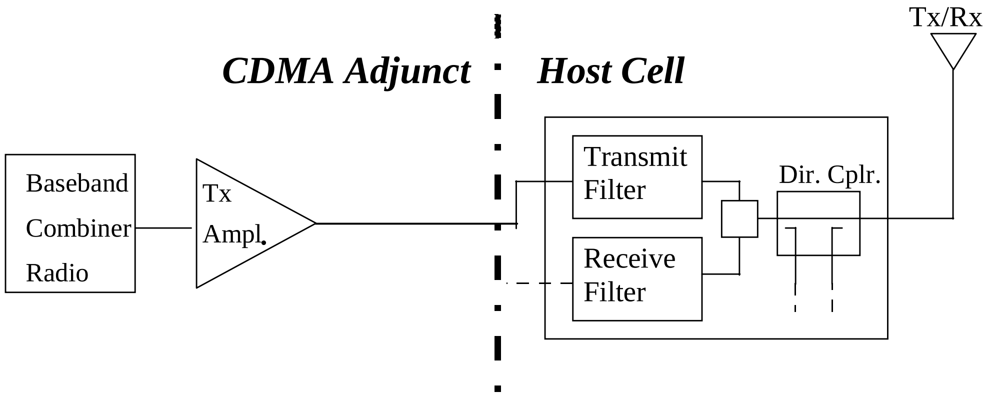
Transmit Paths

Direct Connections to Filter Panels in the Host Cell

The transmit path for each sector served by a CDMA Adjunct is connected at a high RF power level to Series IIm (Minicell) or to Series IImm (Microcell) through duplex filter panels in the host cell. Figure 5-6 shows the complete CDMA Adjunct transmit path with direct connections to duplex filter panels in the host cell.

- 1 CDMA radio for each CDMA carrier
- 1 Transmit Amplifier for each CDMA carrier
- Interconnecting Cables

- Duplex filter panels to provide transmit access to the host cell's Receive Diversity 1 Antenna (Rx Div 1).
- Notch and Cascade filter for the B-Band Transmit Filter Assembly.
- Duplex Filter Panel is for the A-Band Receive Filter Assembly



Note: SIIm & SIImm use identical duplex filter panel components, but different mounting hardware; therefore, the adjunct transmit paths are electrically the same, except for the gain setting of the transmit amplifier in the adjunct.

Figure 5-6. CDMA Adjunct/Host Cell Transmit Path

The above applies to single sector cells with 1 or 2 CDMA carriers. Therefore, when 2 CDMA carriers are used, 2 transmit amplifiers and 2 distinct filter panels for the CDMA transmit inputs must be provided. All transmit filter panels, simplex or duplex, are located within the host cell; thus, they are not required in the CDMA Adjunct. However, they must be accounted for when determining the overall CDMA transmit link budget.

The transmit amplifier has an output power rating sufficient for the CDMA downlink RF coverage area to equal or exceed to that of the host cell's downlink AMPS coverage area. This allows the cell to serve the existing AMPS coverage area with acceptable quality CDMA service. Therefore, the AMPS and CDMA coverage areas are consistent.

The transmit path loss from the output of the transmit amplifier in the CDMA Adjunct to the Transmit (Tx) output port of the host cell's filter panel does not exceed 3.5 dB. Note that this implies an allowable range for the loss of the RF cable between the CDMA Adjunct and the Transmit (Tx) filter panel in the host cell.

If the transmit amplifier's gain adjustment range is insufficient to work with both Series IIm (Minicell) and Series IImm (Microcell) when the Baseband Combiner Radio is adjusted for full power output, then the Baseband Combiner Radio output may need to be attenuated for the Series IImm (Microcell) application. This approach retains the full range of Baseband Combiner Radio output power adjustment for power control.

Direct Connections to a Series IImm (Microcell) Host Cell

The transmit path for each sector served by a CDMA Adjunct, connected to Series IImm (Microcell) through the low level input of the Series IImm (Microcell) transmit amplifier, contains:

- A CDMA radio for each CDMA carrier
- Interconnecting cables.

NOTE:
This implementation cannot be used when a CDPD CDMA Adjunct is present because the CDPD CDMA Adjunct must use the amplifier's low level input port. When it is used, the available output power of the transmit amplifier must be partitioned between the analog and the CDMA channels.

Also, Series IIm (Minicell) cannot support this implementation because Series IIm (Minicell) employs narrow band, high power, auto-tuned cavity combiners that cannot pass the nominal 1.23 Megahertz CDMA signal.

Figure 5-7 shows the complete CDMA Adjunct Transmit Path With Direct Connections to the Input of the Transmit (Tx) Amplifier in a Series IImm (Microcell), including both the CDMA Adjunct and the Series IImm (Microcell) cell.

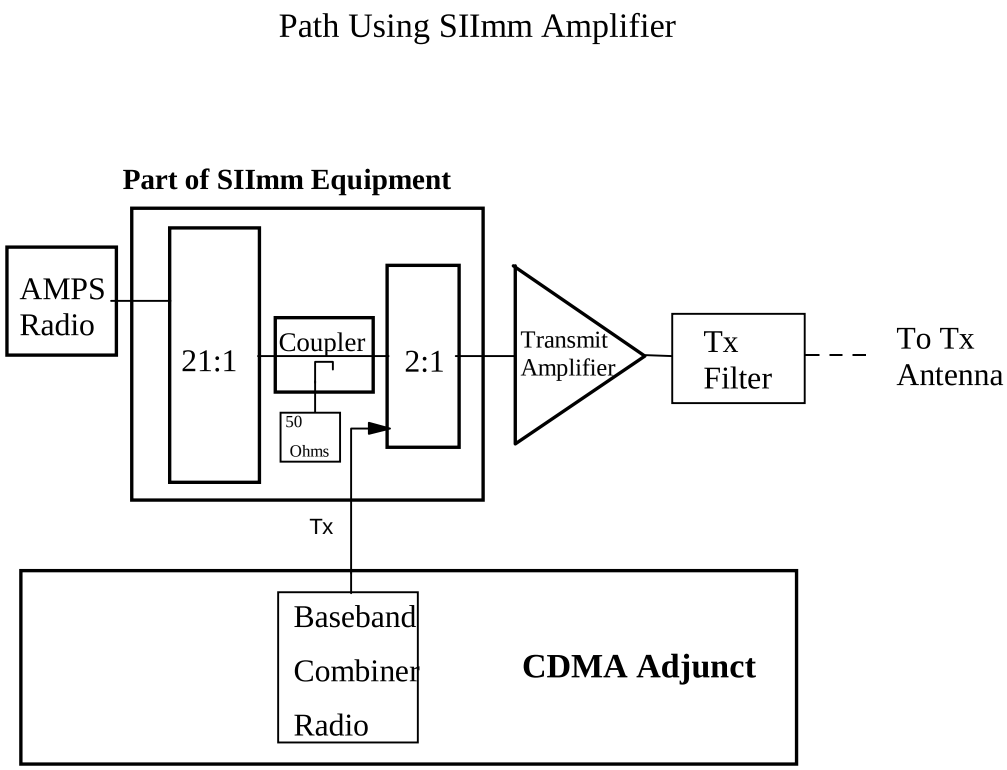


Figure 5-7. Series IImm (Microcell)/CDMA Adjunct Transmit (Tx) Path Using Series IImm (Microcell) Amplifier

Receive Paths

The receive path between the CDMA Adjunct and the host cell is the same for both Series IIm (Minicell) and Series IImm (Microcell).

Figure 5-8 shows a complete receive path, including both the CDMA Adjunct and the host. The receive path for each sector served by the CDMA Adjunct contains:

- 1 CDMA radio with 2 Diversity Receive (Rx) inputs for each CDMA carrier.
- Interconnecting Cables and RF Combiners and Splitters.
- An attenuator to provide signal strength to the CDMA Adjunct radio (BCR) that is identical to that of the RCU.

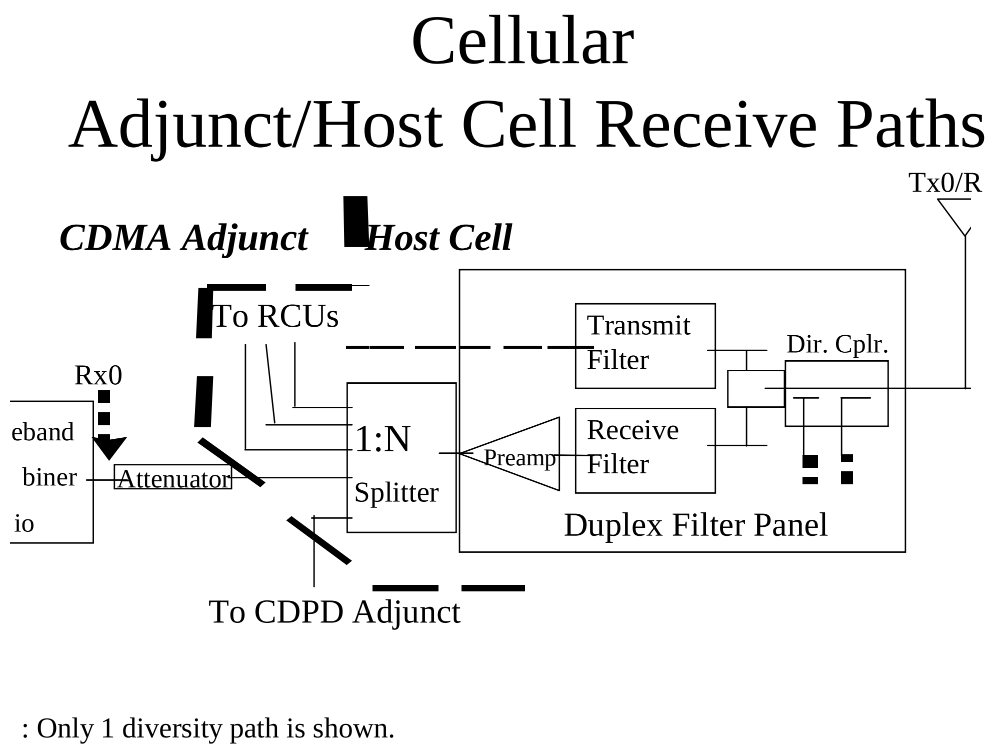


Figure 5-8. CDMA Adjunct/Host Cell Receive Paths

Table 5-4. The following values apply to Figure 5-8

	Series IIm	Series IIm
N (Splitter outputs in host)	6	6
Nominal Attenuation (in CDMA Adjunct)	7 dB	7 dB

There are other RF splitters downstream of the 1:6 splitter in the host cell. However, the exact value of these downstream splitters has no effect on the receive path gain from the antenna in the host cell to the CDMA radio in the CDMA Adjunct.

All receive filter panels, which include low noise preamplifiers, are located within the host cell; thus, they are not required in the CDMA Adjunct. However, the gain and noise figure of the receive panels must be accounted for in determining the gain and noise figure to allocate to the equipment in the CDMA Adjunct. The host cell must contain duplex transmit/receive filter panels to support the CDMA Adjunct. If the cell has only simplex receive and transmit panels, the panels must be replaced with duplex panels.

Receive Path Gain and Noise Figure

Because the CDMA Adjunct contains the same CDMA radio as the CDMA Minicell, it is designed for the same noise figure and for the same range of receive signal input as the CDMA Minicell. However, the receive path of the CDMA Adjunct differs from the receive path of the CDMA Minicell in one important aspect. The CDMA Adjunct's receive path consists of an attenuator in the CDMA Adjunct itself, plus a 1:N splitter in the common part of the receive path in the host cell. The components in the host cell are not changed because host cells are already in the field. Therefore, all components necessary to make the receive path gain of the interconnected CDMA Adjunct and host cell match that of the CDMA Minicell were added to the CDMA Adjunct.

The major components in the receive path are the receive preamplifier, the receive filter, miscellaneous RF dividers and directional couplers, the radio, and the interconnecting cables.

The receive path gain measured from the antenna input of the duplex filter panel in the host cell to one diversity input of the baseband combiner radio in the CDMA Adjunct is 23 ± 3 dB.

The noise figure measured from the antenna input of the duplex filter panel in the host cell to one diversity input of the baseband combiner radio is 5.5 dB or less at midband.

The receive path gain and noise figure of the total path, consisting of some components in the host cell and other components in the CDMA Adjunct, are equal to the values that are acceptable for the CDMA Minicell.

Radio Testing

Radio Test Paths

The CDMA Adjunct maintenance strategy uses the units below:

- CDMA Radio Test Unit module (CRTUm)
- CDMA Radio Test Unit interface (CRTUi)
- Test Radio Switch Panel (TRSP).

These units will be jointly referred to as CRTUm/CRTUi/TRSP. The TRSP is illustrated in Figure 5-9. The CRTUm resides in the CDMA Adjunct. The CRTUi resides in the small cell controller of the host cell. The TRSP also resides in the Host Cell. The CRTUm in the CDMA Adjunct is controlled by the CRTUi in the Host Cell over an RS-422 interface link.

The CDMA Adjunct provides an RF Test Signal Distribution Circuit that consists of 2 parts:

1. Test the components in every diversity receive path
2. Test the components in every transmit path.

The circuit provides all the components needed to test any of the CDMA Adjunct configurations.

The receive transmit test path in the CDMA Adjunct is designed so that no software changes from Series II cell tests are necessary. The CDMA Adjunct is tested using the Series II functional and diagnostic software. The test path losses are within the range tolerable by this software so that no changes are necessary.

The CDMA Adjunct is capable of testing both simplex and duplex antenna configurations. Duplex configurations require additional transmit/receive separation circuitry for the TRSP. This capability is provided by a combiner/divider on the duplex filter panel.

The CDMA Adjunct is capable of testing both diversity receive paths. Each diversity receive path is tested, though not simultaneously. The TRSP is switched between the diversity receive paths to connect each one to the test radio RF ports.

The CDMA Adjunct does not provide for the testing of analog or TDMA radios. When the CDMA Adjunct is used with a Series IIm (Minicell) or Series IImm (Microcell) host cell, the host cell tests the analog radios, and no TDMA radios may be equipped.

All unused RF ports in the test circuitry are terminated with 50 Ohm loads.

CDMA Adjunct Testing Hardware Connections

This section describes the hardware connections needed to execute functional and diagnostic tests related to the CDMA radios in the CDMA Adjunct. All the hardware associated with testing the CDMA radio, except for the radio itself and the CRTUm, is located in the host cell. Figure 5-9 is a high level sketch of the Test Radio Switch Panel (TRSP), located in the host cell, that is used to perform the CDMA radio tests. This switch panel is the same one currently used in the CDMA Minicell. AMPS test connections are made directly to the test ports, while CDMA test connections require external RF combiners and splitters for some configurations.

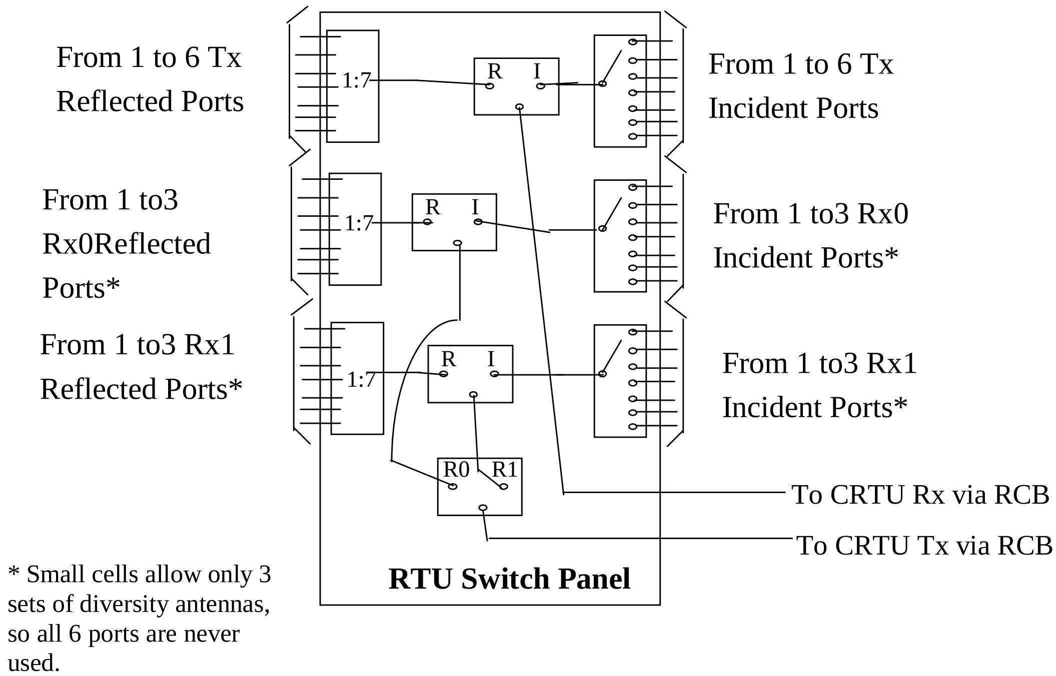


Figure 5-9. Test Radio Switch Panel (TRSP)

For CDMA testing the Test Radio Switch Panel (TRSP) in the host cell is able to switch each of the incident transmit input ports to the test radio; these ports cannot be combined into a single signal. If all incident Transmit (Tx) signals from independent sectors were combined, and they contained multiple CDMA signals using the same RF carrier, the CRTU could not uniquely determine which carrier to synchronize to.

This restriction precludes using the existing small cell Test Radio Switch Panel (TRSP). Nevertheless, when there are multiple CDMA carriers, all at the same frequency, serving the same sector (e.g. a multi-carrier omnidirectional configuration), these carriers at the same RF frequency must be combined to permit CDMA testing. This is accomplished with RF combiners external to the Test Radio Switch Panel (TRSP) for CDMA inputs only. These combiners are not required for sectorized cells with one CDMA carrier serving each sector. No combiners are used on any test ports that are associated only with AMPS signals so that existing AMPS test software and its pass/fail thresholds remain unchanged when the CDMA Adjunct is installed.

The incident Transmit (Tx) test ports of all antennas serving CDMA traffic, that are radiating into the same sector, at the same RF frequency are combined via an RF combiner external to the Test Radio Switch Panel (TRSP). The common output of that combiner is connected to only one Transmit (Tx) incident port of the Test Radio Switch Panel (TRSP). So, even though CDMA may require 2 Transmit (Tx) antennas to serve a common sector, only one Test Radio Switch Panel (TRSP) port for Transmit (Tx) incident is used on the Test Radio Switch Panel (TRSP). Thus, an omnidirectional host cell with a two-carrier CDMA Adjunct (where each carrier is at the same RF frequency) needs 2 Transmit (Tx) incident port connections to the Radio Test Unit (RTU).

Transmit Amplifiers

The CDMA Adjunct previously supported only the Transmit Power Amplifier (TPA). In CDMA release 6.0, the TPA for CDMA Minicells has been replaced with the Enhanced TPA. The Enhanced TPA improves CDMA Minicell Call Processing and Operations, Administration & Maintenance and Performance. Its installation, however, does not alter the functionality of the CDMA Cellular Minicell.

The enhanced High-power TPA (HTPA) is identical in function to its predecessor except that it is more resistant to thermal stress and therefore more environmentally adaptable. The power constant for an HTPA amplifier is 0.0001834, which increases the maximum power to 9 Watts. This change affects the ceqcom2 form, in which the maximum power allowed in the form is also 9 Watts. Additionally, the following RC/V error message is generated for out of range values:

"The Max Pwr of a BBA assigned to an HTPA LAC must be 0.5 - 9.0 watts."

The Enhanced TPA can be equipped on one Physical Antenna Face (PAF) or all PAFs.

The alarm signals for the transmit power amplifier are software compatible with those of the Series II Cell Site’s Modular Linear Amplifier Circuits (MLACs).

The CDMA Adjunct obtains its receive signal inputs from the host cell’s Receive (Rx) antennas and the associated RF distribution from the antenna. The Series IIm (Minicell) and Series IImm (Microcell) cells were designed to have sufficient receive ports to do this. Figure 5-10 is a sketch of the receive path connections between the host cell and the CDMA Adjunct. Neither Figure 5-10 or Figure 5-11 are intended to show complete interconnection details.

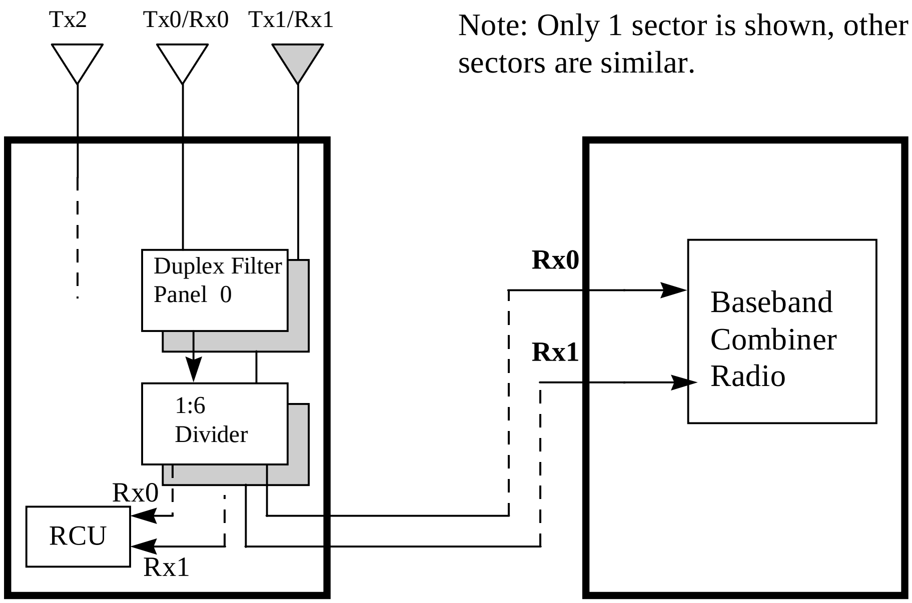


Figure 5-10. CDMA Adjunct Receiver Paths

The CDMA Adjunct is capable of sharing the host cell's duplexed Transmit (Tx) antennas on a per-sector basis, and it is also capable of using a simplex Transmit (Tx) antenna in the host cell on a per-sector basis. Because the CDMA Adjunct contains no filters, except for cascade and notch filters, the CDMA Adjunct can not support its own antennas; it must use the antennas of the host cell. Figure 5-11 is a sketch of this implementation of the transmit path interconnection between the Series IIm (Minicell) host cell and the CDMA Adjunct.

Input Voltage and Power

The CDMA Adjunct is powered independently of the host cell and can only be powered from a +24 Volt DC (+24 VDC) source.

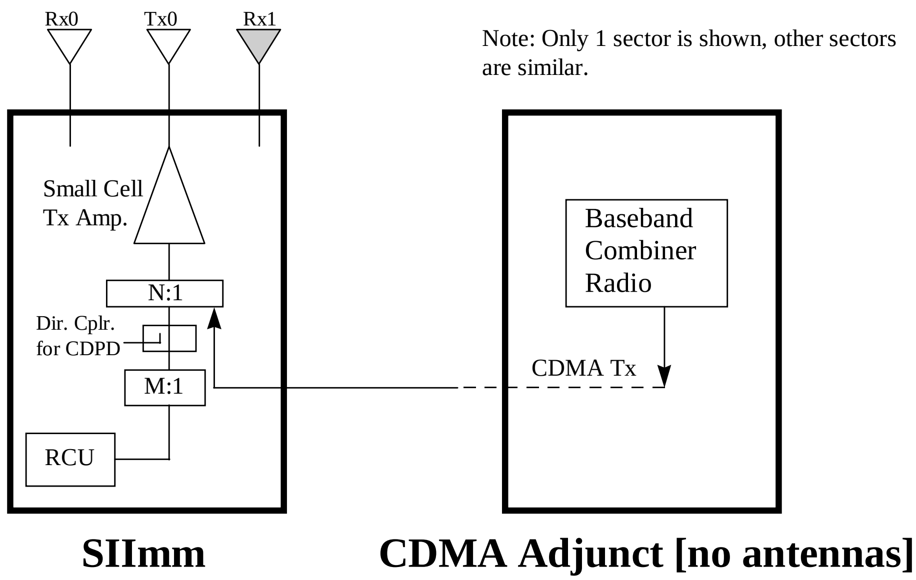


Figure 5-11. CDMA Transmit Path (Smm Only)

Environmental, Safety, and Handling Requirements

Environmental requirements: The conditions under which the equipment must operate. Safety requirements: How the equipment affects the well-being of personnel who operate the equipment or who are in its vicinity
Handling requirements: How the equipment survives the rigors of shipping and storage. The specifications that follow call for the CDMA Adjunct to meet the same environmental, safety, and handling requirements as the host cell to which it is connected.

Environmental Requirements

The 3 basic environments in which the equipment can operate are listed below. Because the environment is defined from the viewpoint of the equipment, an external environment, as seen by the equipment, does not necessarily imply that the equipment is outdoors.

External controlled environment: An environment in which the equipment is located inside a building that has its own heating and air conditioning systems to control the temperature and humidity to which the equipment is subjected.
External uncontrolled environment: An environment in which the equipment is located outdoors with no heating or cooling equipment provided externally.
Internal environment: The environment inside the equipment; does not necessarily imply that equipment is indoors.

External Controlled Environment

The CDMA Adjunct designated for use in an external controlled environment (commonly assumed to be an "indoor" environment) meets its performance requirements under the environmental conditions shown in Table 5-5.

Table 5-5. CDMA Adjunct External Controlled Environment Specifications

Controlled Environmental Range	Temperature, deg. C	Relative Humidity, Non-Condensing	Altitude, Feet Above Sea Level
Basic Range	+4.5 deg. C to +38 deg. C	20% to 55%	-200 ft. to +10,000 ft.
Short Term Range	+ 2 deg. C to +49deg. C	0% to 80%	-200 ft. to +10,000 ft.

The basic environmental conditions apply for steady state operation. The short term environmental conditions apply for not more than 72 consecutive hours, and not more than 15 days per year.

External Uncontrolled Environment

CDMA Adjunct designated for use in an external uncontrolled environment (commonly assumed to be an "outdoor" environment) meets its performance requirements under the environmental conditions shown in Table 5-6.

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Table 5-6. CDMA Adjunct External Uncontrolled Environment Specifications

Controlled Environmental Range	Temperature, deg. C	Relative Humidity, Non-Condensing	Altitude, Feet Above Sea Level
Basic Range	-40 deg. C to +46 deg. C	5% to 95%	-200 ft. to +10,000 ft.

The basic environmental conditions apply for steady state operation.

Internal Environment

The environmental control system within the CDMA Adjunct is designed such that all components operate within a safe temperature and humidity range and satisfy all performance and reliability requirements when the frame is subjected to the external environmental conditions given in Table 5-6.

Safety Requirements

Lightning Protection and Grounding

A ring ground arrangement as described in Customer Information Bulletin (CIB) 148 is installed and all the CDMA Adjunct frames are connected to it.

All equipment that ultimately interfaces with an RF antenna will not be damaged or degraded by 10 strikes of an input surge waveform of 8 x 20 microseconds duration, 20 kilovolts open circuit voltage, and 10 kilo-amperes maximum current capacity applied at the frame RF antenna interface connector. The equipment has the same level of protection typically used for equipment located outdoors with direct connections to towers and long facility feeders (see ANSI-C62.41).

All equipment that ultimately interfaces with the input DC power feeders and the user alarm interface is protected from lightning strike, except that 500 volt/500 amperes surge values apply.

All equipment that ultimately interfaces with the facilities input and the RS-422 amplifier alarm interface, when connected to transmit amplifiers in either the Linear Amplifier or External Transmit Amplifier Frames, is also protected from lightning strikes.

UL and Cell Site A

The CDMA Adjunct complies with UL 1950, 3rd edition, and with Cell Site A-C22.2 approval guidelines. The CDMA Adjunct as a whole is UL listed and its components is UL recognized.

Electromagnetic Compatibility

FCC regulations in "Code of Federal Regulations, Telecommunications", Part 15, Subpart C, and Part 22, Subpart K, published by the Office of the Federal Register, National Archives and Records Administration, 1992, is satisfied by each CDMA Minicell product; and the CDMA Adjunct complies with Part 15, Subpart C as a Class B device. Compliance with part 15 as a Class B device means that the product could be installed in a residential environment.

The CDMA Adjunct has interfaces to other frames and circuits in an actual installation. FCC testing was done with terminations that best represent the actual operating environment that the given product will experience. Because the CDMA Adjunct is part of a system that also includes Series IIm (Minicell) or Series IImm (Microcell) cabinets, the effects of that system on the CDMA Adjunct's performance was accounted for in the product test.

Electromagnetic emission and susceptibility requirements in IS-56B is satisfied by the CDMA Adjunct.

Electrostatic Discharge

The CDMA Adjunct is designed to have a reliability of no more than 5900 failures in 10^9 hours. Because the CDMA Adjunct is similar to a MiniPrimary Frame without a Radio Control Complex, its reliability is that of the frame, after subtracting the failure rate allocation for filters and for the Radio Control Complex.

Suggested DFI and DS-1 Configurations for use with the CDMA Adjunct

The following table shows some possible assignment of DFIs and DS1s that minimize the effects of a single DFI or DS1 failure on the combined traffic handling capacity of the host cell plus the CDMA Adjunct. Other assignments may accomplish the same end. There may be other possible assignments.

Table 5-7. Suggested DFI and DS-1 Configurations for use with CDMA Adjunct

Facilities Configurations	DFI-1		DFI-2		DFI-3		Comments
	DS1-A	DS1-B	DS1-A	DS1-B	DS1-A	DS1-B	
1 DFI, 1 DS1	DL-0, DL-1						Loss of 1 DFI or 1 DS1 causes total loss of service
	AMPS α						
	AMPS β						
	AMPS γ						
	CDMA α						
	CDMA β						
	CDMA γ						
1 DFI, 2 DS1	DL-0	DL-1					Loss of 1 DFI causes total loss of service. Loss of 1 DS1 maintains at least 1 technology on each sector.
	AMPS α	CDMA α					
	AMPS β	CDMA β					
	CDMA γ	AMPS γ					
2 DFI, 2 DS1	DL-0		DL-1				Loss of 1 DFI or 1 DS1 maintains at least 1 technology on each sector.
	AMPS α		CDMA α				
	AMPS β		CDMA β				
	CDMA γ		AMPS γ				
2 DFI, 4 DS1	DL-0	AMPS β	DL-1	CDMA β			Loss of 1 DFI or 1 DS1 maintains at least 1 technology on each sector.
	AMPS α	CDMA γ	CDMA α				
			AMPS γ				
3 DFI, 3 DS1	DL-0		DL-1				Loss of 1 DFI or 1 DS1 maintains at least 1 technology on each sector.
	AMPS α		AMPS β		AMPS γ		
	CDMA γ		CDMA α		CDMA β		
3 DFI, 3 DS1	DL-0	CDMA β	DL-1	CDMA α	AMPS β	CDMA γ	Loss of 1 DFI or 1 DS1 maintains at least 1 technology on each sector.
	AMPS α		AMPS γ				

Series II Cellular Digital Packet Data (CDPD)

6

Contents

CDPD Overview

CDPD interfaces with the Series II Cell Site to provide wireless data services through a commercial public mobile data communications network. CDPD provides this data communication in a manner that routes each data packet individually, based on the destination address carried in the packet and the knowledge of current network topology. CDPD also allows for multiple destination data (multicasting) packets on a single channel.

External packet data equipment is able to access the Cell Site Radio Frequency (RF) transmission and reception paths when the CDPD feature is enabled by a "Feature Activation File" (FAF) entry. Functional and diagnostic tests will not work properly unless the feature is enabled and the appropriate new translations are entered for the cell.

New Cell Site hardware (6-port LAF combiner) interfaces the packet data equipment to the Linear Amplifier Circuit (LAC) for amplification and transmission of the packet data signal. The CDPD equipment samples the Cell Site radio transmitter signals to detect any packet data that may be transmitted over the normal cellular RF frequencies. The CDPD detector monitors Cell Site radio channel activity to prevent packet data radios from simultaneously using the same channel as a voice Cell Site radio.

Interfaces

Series II systems configured with CDPD all share some basic connections see Figure 6-1 However, Since Series II systems have many variations, the corresponding CDPD system has variations as well. The parameters that may be different for each system and contribute to differing Series II/CDPD hardware configurations are described in the following paragraphs.

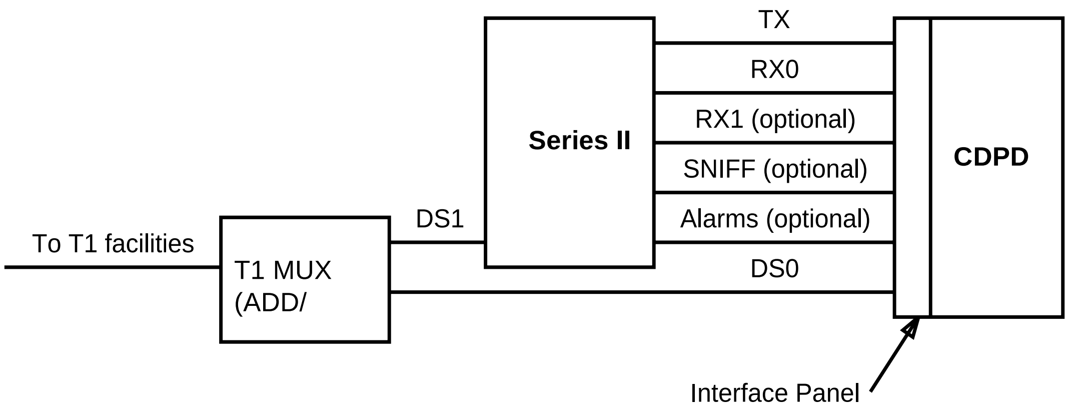


Figure 6-1. Series II CDPD Connections

Transmit (Tx)

All Series II CDPD systems are configured such that the CDPD transmit signal is amplified by the Series II Linear Amplifier Circuit (LAC).

Diversity Receive (Rx)

The standard Series II/CDPD system uses receive diversity (connections from two independent receive paths) for improved performance. If only a signal receive antenna is available, the second CDPD receive input must be properly terminated.

Channel Assignment, Hopping Versus Dedicated Channel

CDPD may be implemented on Series II either with sniffing and hopping or on a fixed channel. The sniffing and hopping configuration allows CDPD to use channels assigned to the Cell Site when they are idle, thereby providing much more CDPD capacity during off-peak Cell Site radio usage. This configuration requires a sniff connection.

A dedicated channel configuration always provides CDPD capacity, even if all Cell Site channels are in use, as may be the case during peak usage hours. This configuration does not require a sniff connection.

A combination of the two may be used if more than one CDPD radio is in service.

Sectorized Setup Versus Omni

Sectorized setup more preferable than omni, because it requires no additional hardware to support CDPD sniffing.

Omni setup is supported, but it requires combining the omni setup transmission path with each of the other sector transmission paths. This is necessary for two reasons:

1. Setup radio diagnostics use idle voice channels to conduct tests; when the omni path is combined and made available to the CDPD sniffer, CDPD will not interfere with the setup radio diagnostics
2. Sniffer diagnostics require the setup channel for measurement purposes. A 4:1 combiner is used to support these diagnostics. This combiner may also be used to support sniffing on multiple Linear Amplifier Circuits (LACs) (see next paragraph).

Linear Amplifier Circuits (LACs), per Sector, which CDPD Will Sniff

The most basic CDPD system that supports hopping will sniff only one Linear Amplifier Circuit (LAC) on each sector. This configuration requires one direct connection on each sector between the Series II sniff port and the CDPD sniff port on the Mobile Data Base Station (MDBS) Interface Panel (except for cells with omni setup, which require a combiner in the path).

Series II systems with more than one LAC per sector will support sniff combining on up to four LACs (three if omni setup is used), thereby providing a larger selection of channels to the CDPD and increased CDPD capacity. This configuration requires a combiner (a 4:1 is provided) between the Series II sniff ports and CDPD sniff port. However, combining sniff ports is beneficial only if there is ample excess power (headroom) on the LAC selected as the CDPD transmit amplifier. This LAC must have enough headroom available to amplify all the CDPD radios connected to the LAC in addition to the Cell Site radios already on the LAC. For example, if all Cell Site channels are in use on LAC 1 and CDPD selects a channel typically used by the Cell Site on LAC 2, then the first LAC must have enough power to supply all of its Cell Site radio channels plus one more for CDPD.

For Series II systems with more than one LAC per sector and no headroom on LACs, CDPD should be configured to sniff on one LAC only. This LAC must be the same one that amplifies the setup channel. The setup channel must be available to be measured by CDPD sniffer diagnostics.

LACs, per Sector, which CDPD Will Transmit

All CDPD system configurations transmit packet data through only one Linear Amplifier Circuit (LAC) on each sector. If CDPD is sniffing and hopping among channels that are normally transmitted on this LAC, total power required from this LAC is unchanged from normal Cell Site radio operation.

If CDPD is sniffing and hopping among channels that are not normally transmitted on this LAC, CDPD may be transmitted through either of the LACs, so long as sufficient power is available from the LAC to handle the additional CDPD radios.

Channels per Sector

The must basic CDPD system will have one CDPD radio per sector. Series II will support up to four CDPD radios per sector via the addition of 4:1 combiners and dividers in the transmit, receive, and sniff paths. More channels provide more capacity as long as a sufficient number of radio channels are idle and available to CDPD.

Alarm Support

The CDPD equipment provides two normally open alarm contacts. These may be optionally connected to the Cell Site Alarm Interface Module.

T1 Multiplexer

The standard Series II CDPD system multiplexes the CDPD DS0 connection (V.35 interface) onto one of the DS1 (Digital Signal - Level 1) trunks supporting Series II via a Lucent Technologies Paradyne T1 multiplexer (Model 3160). Customers may optionally provide their own T1 multiplexer equipment. One DS0 line running at 56 kbps will support one MDBS transceiver bank with up to 6 CDPD channels. the combined data rate from 6 CDPD channels will typically be less than 56 kbps. In cases where all channels are in use and transmitting at near maximum capacity, the MDBS will throttle back throughput to fit in 56 kbps.

When redundancy is supported (CDPD software Release 1.0 and beyond), two or three DS0 lines may be used to support one MDBS transceiver bank with up to 6 CDPD channels.

Typical Configurations

Some typical Series II/ CDPD configurations are shown in the figures contained in this section. In each case, only one sector is shown; all other sectors are identical.

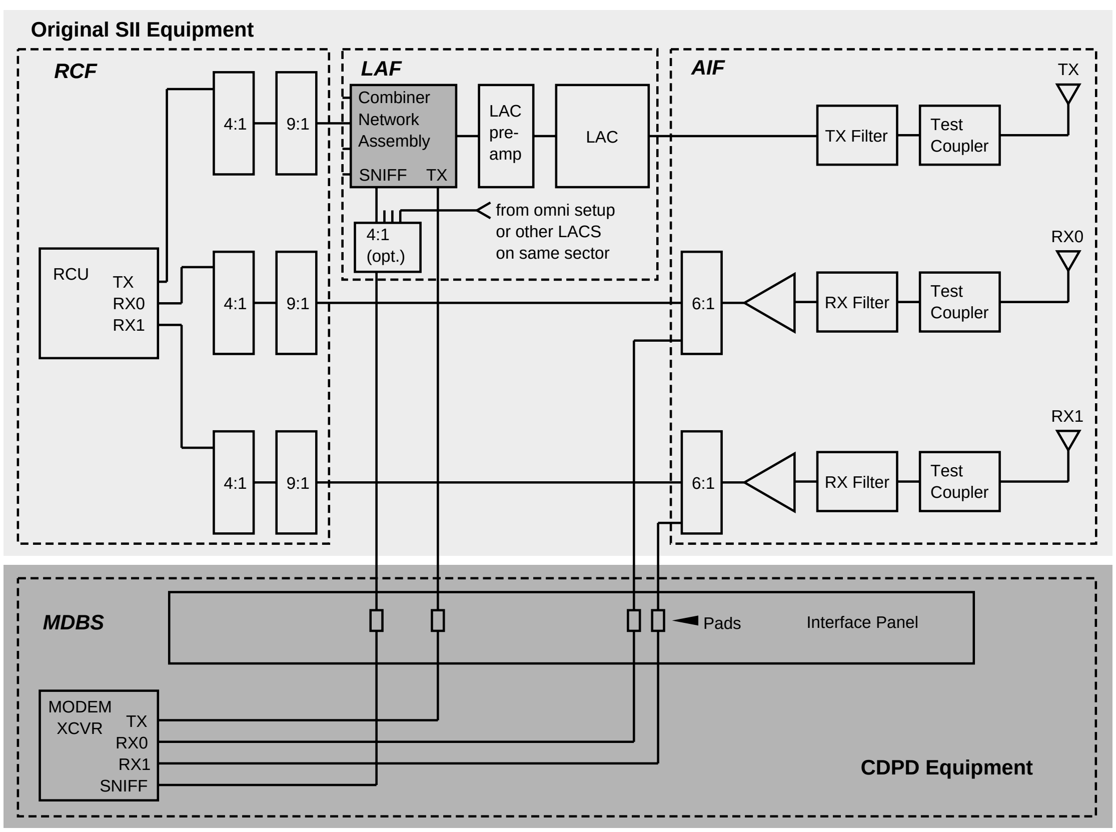


Figure 6-2. One CDPD Channel per Sector

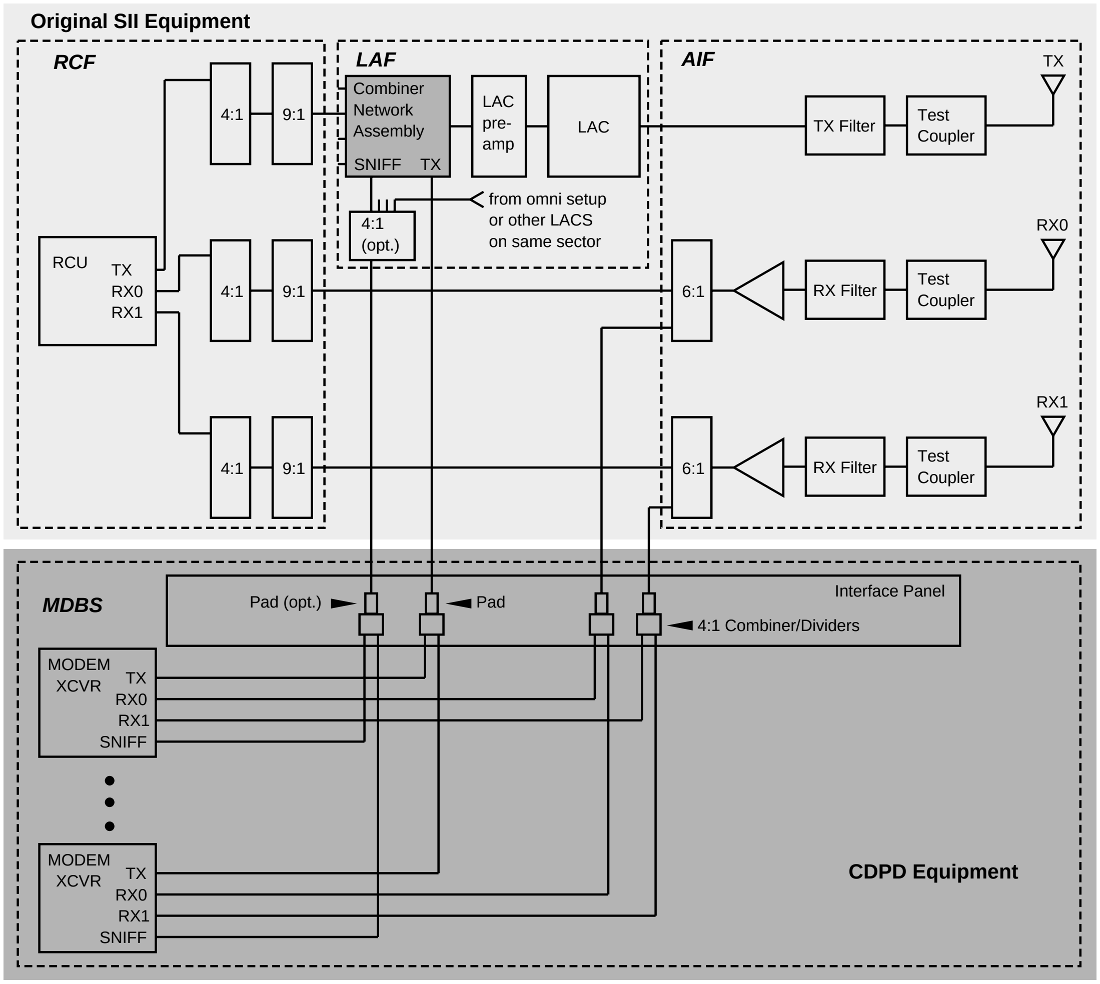


Figure 6-3. Two to Four CDPD Channels per Sector

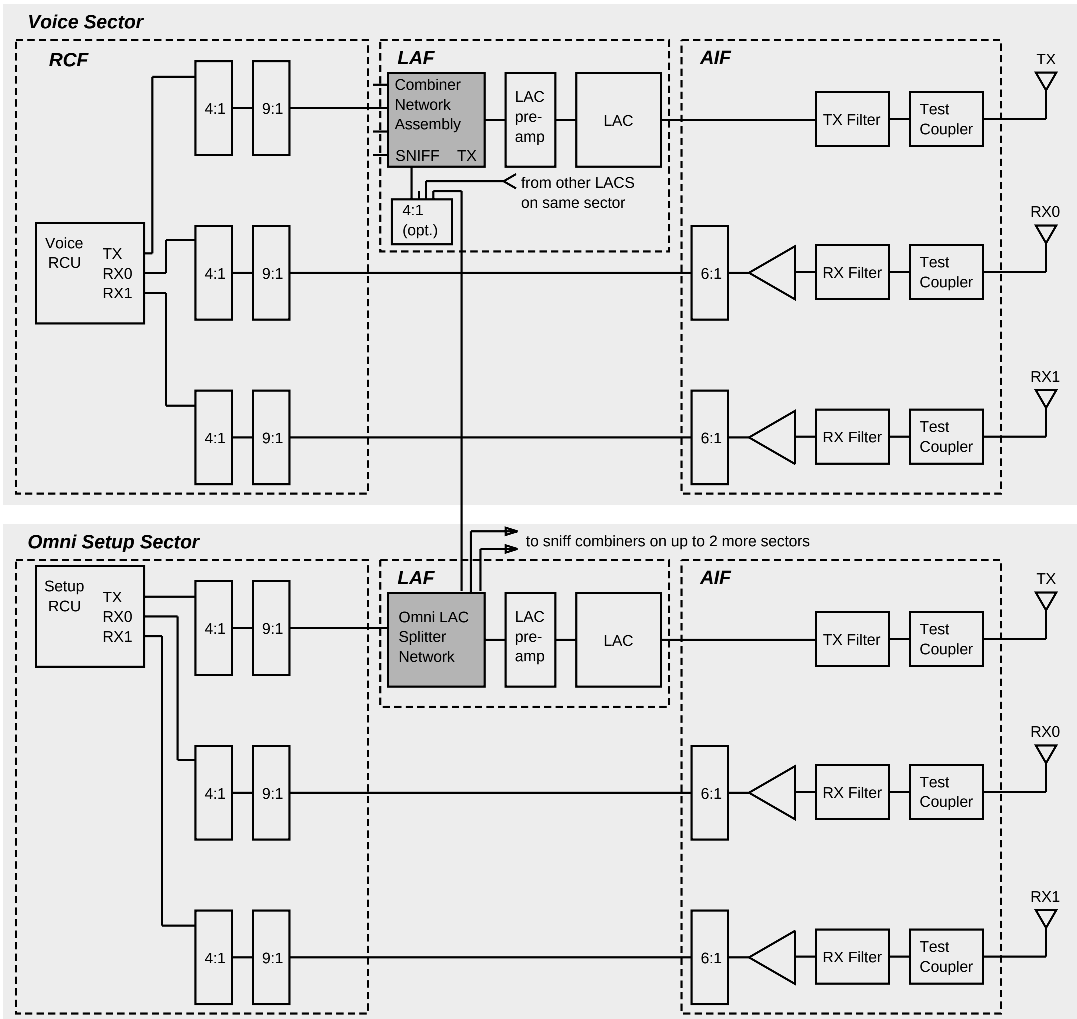


Figure 6-4. CDPD with Omni Setup

Hardware

The hardware required to interface with external packet data equipment is available as either a kit purchased and installed when the packet data feature is enabled for an existing cell or as part of a Series II configuration ordered directly from the factory (see Figure 6-5). The new hardware kits support Cell Site configurations that employ the Linear Amplifier Circuit (LAC) in the forward transmit path, up to the following maximum configurations:

- Directional setup cells with up to six directional voice sectors
- Omnidirectional setup cells with up to three directional voice sectors

- Configurations with up to four LACs per sector.

Dual server groups are not supported by CDPD. When CDPD is installed in a dual-server group cell, CDPD should be assigned to channels in the outer server group. These same frequencies will service CDPD in the inner server group area.

New components used in the CDPD hardware interface are described below.

Combiner Network Assembly KS21604, L23

The Combiner Network Assembly in the Linear Amplifier Frame (LAF) replaces the existing 3:1 combiner in the Linear Amplifier Circuit (LAC) input path. It is required for each LAC whose frequencies are available for packet data calls.

The Combiner Network Assembly and its connections to the CDPD equipment include sniff, transmit, and modem-transceiver receive functions.

Up to three Radio Frequency (RF) signals from the radios in the Radio Channel Frames (RCFs) may be applied to input ports 1 through 3 of the Combiner Network Assembly; typically, the three inputs come from the RCF. In the past, a fourth input was used for simulcast setup. However, simulcast setup is no longer supported. The output of RF sensing port 5 is applied to sniffer circuitry in the CDPD equipment to allow detection of active transmitting radios in the RCFs. When an idle frequency is found, the packet data radio may transmit its RF signal through port 6 of the Combiner Network Assembly. The loss from input ports 1 through 4 to output port 7 is the same as the nominal loss of the original 3:1 combiner (middle of the adjustment range). Therefore, output port 7 of the Combiner Network Assembly will provide the same signal level at the LAC preamplifier input for packet data radios, Radio Channel Units (RCUs), Digital Radio Units (DRUs) or Enhanced Digital Radio Units (EDRUs) as does the original LAC combiner it replaces (assuming the same level of inputs for both cases). Minor adjustment of LAC output power level (using the LAC preamplifier trim pot) may be required when packet data equipment is installed.

4:1 Combiner KS21604, L22

This combiner is used to support sniffing on up to four Linear Amplifier Circuits (LACs) on the same sector. The sense port of each Combiner Network Assembly is connected to the 4:1 input port (unused ports must be terminated) and the 4:1 output port is connected to the MDBS sniff input port.

LAC Splitter Network KS21604, L24

This splitter network is only used in configurations with omni setup and directional voice/CDPD sectors. This custom splitter replaces the 3:1 combiner in the omni LAC path and provides the same nominal level at the corresponding output. The remaining three output ports provide the proper levels to interface with the 4:1 sniff combiner.

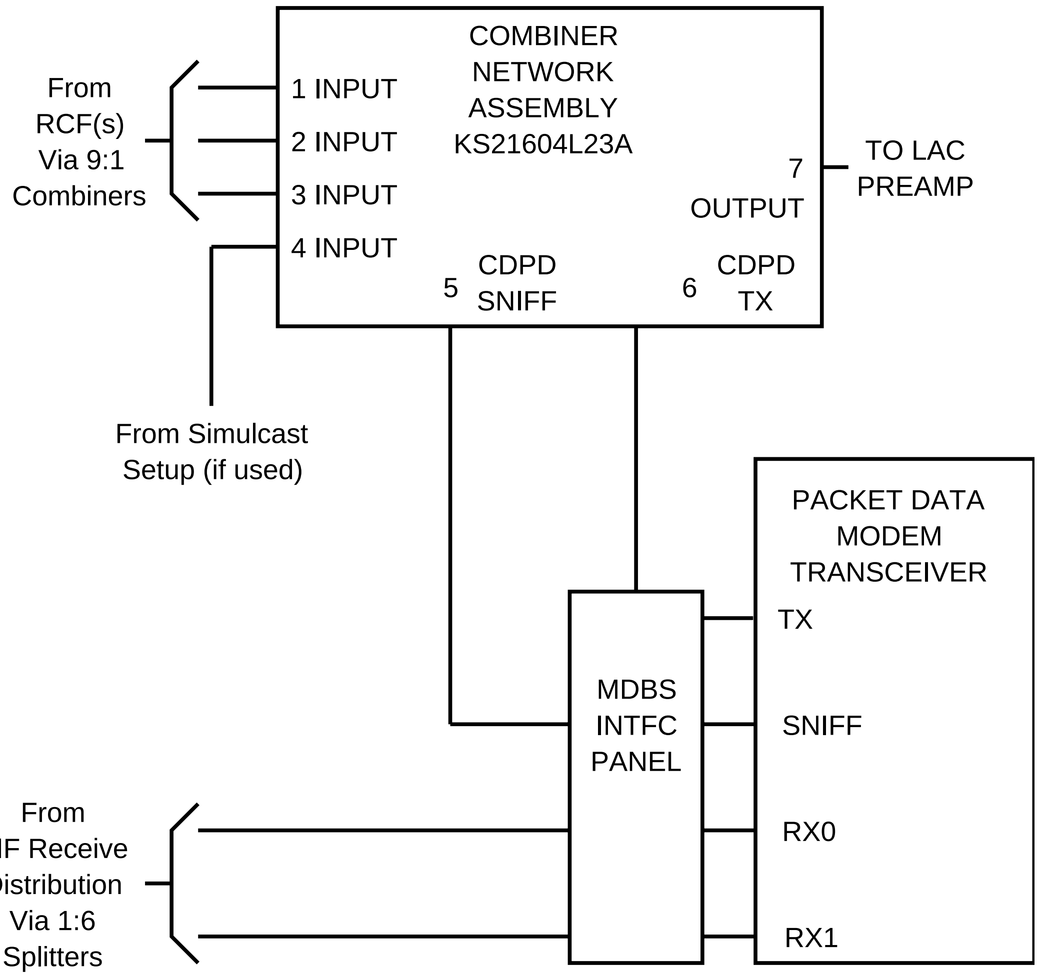


Figure 6-5. Functional Diagram

Detailed Diagrams of Supported Configurations

Table 6-1 lists the Supported Configurations. A detailed diagram is shown for each of the configurations listed in the table.

Table 6-1. CDPD Modem Transceiver Configuration per Sector

One Modem Transceiver per Sector

Directional Setup	Omnidirectional Setup
One LAC per sector	One LAC per sector
Multiple LACs per sector- Sniffing on one LAC	Multiple LACs per sector- Sniffing on one LAC

Table 6-1. CDPD Modem Transceiver Configuration per Sector (Contd)

One Modem Transceiver per Sector	
Multiple LACs per sector- Sniffing on multiple LACs	Multiple LACs per sector- Sniffing on multiple LACs
Multiple Modem Transceivers per Sector	
One LAC per sector	One LAC per sector
Multiple LACs per sector- Sniffing on one LAC	Multiple LACs per sector- Sniffing on one LAC
Multiple LACs per sector- Sniffing on multiple LACs	Multiple LACs per sector- Sniffing on multiple LACs

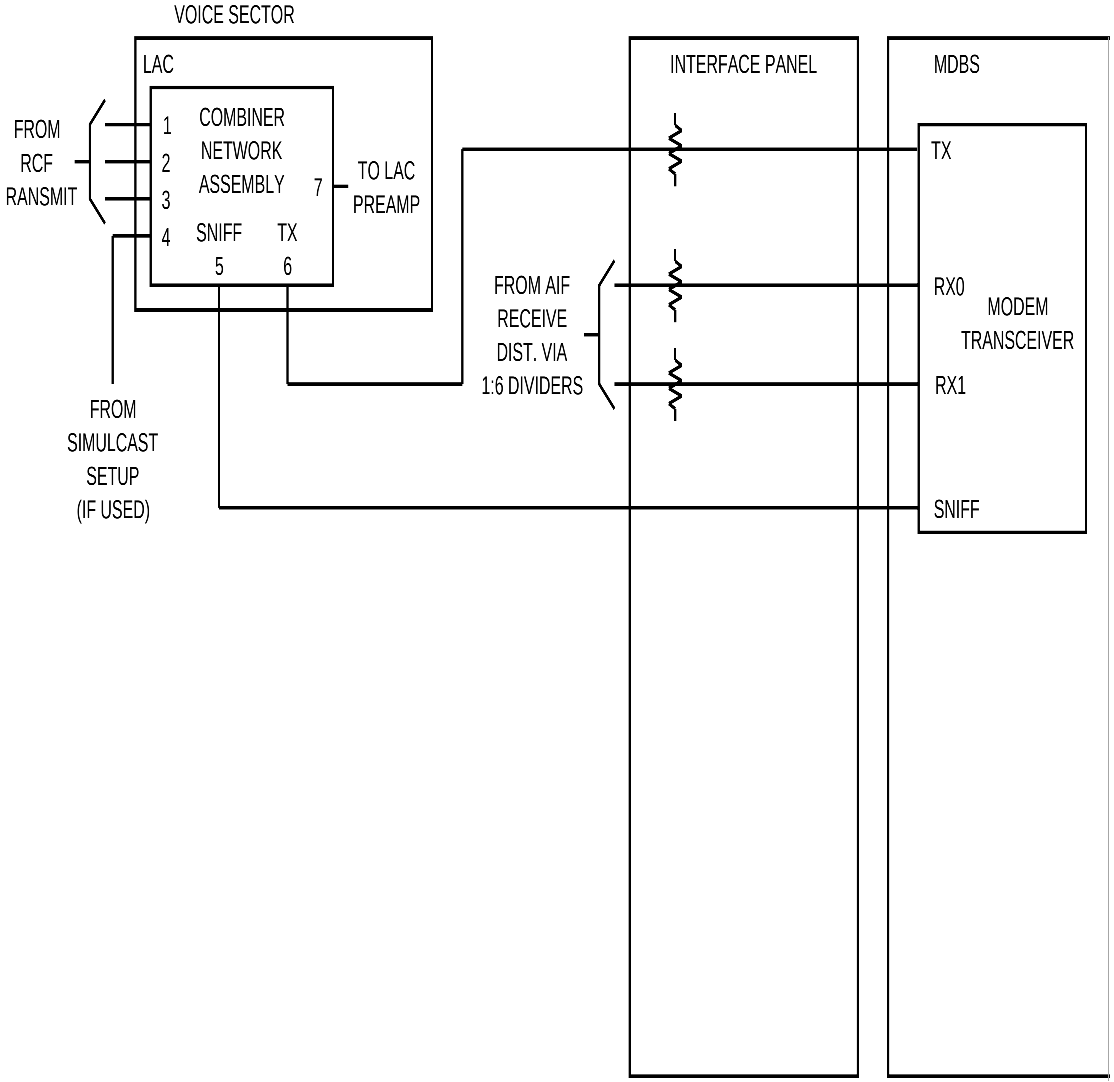


Figure 6-6. One Modem Transceiver Per Sector, One LAC per Sector - Directional Setup

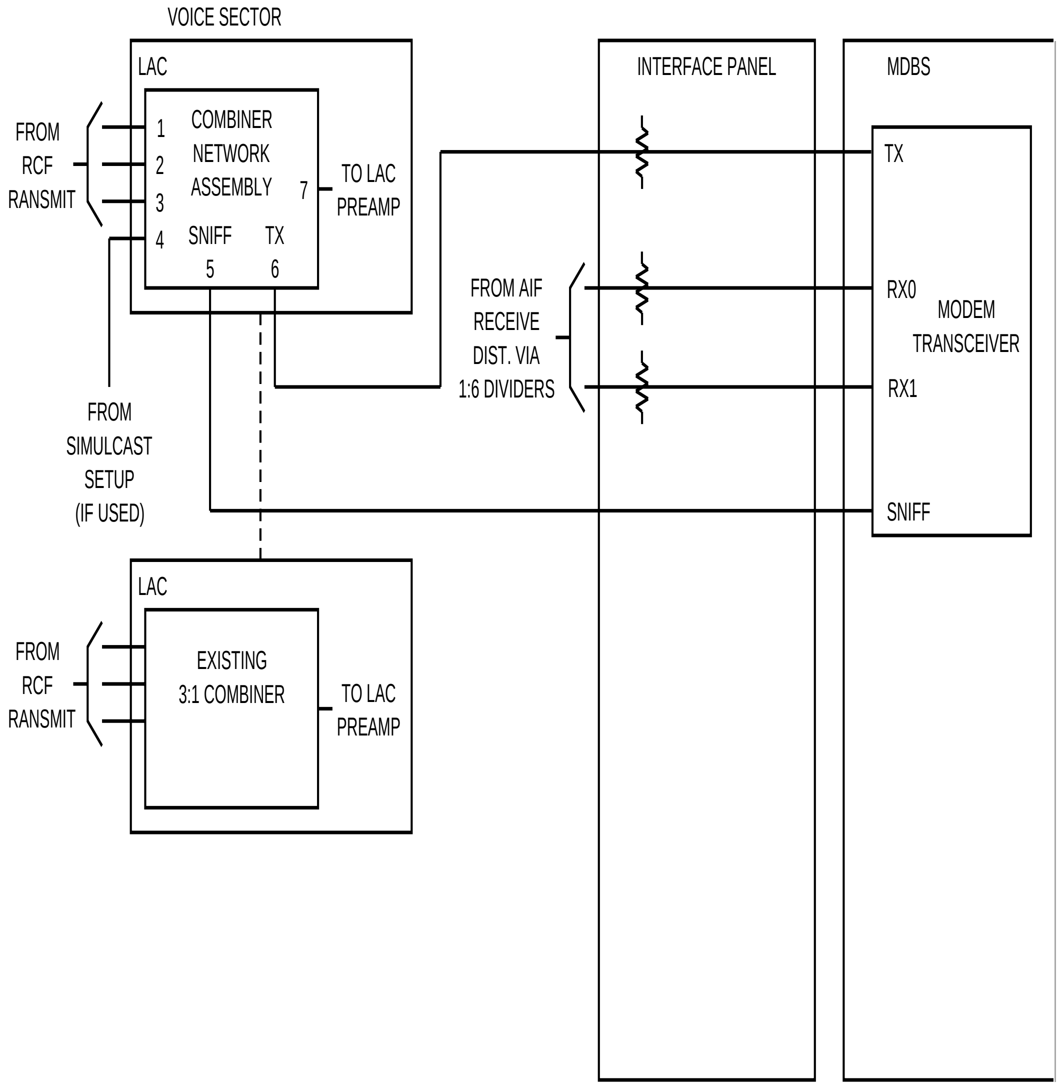


Figure 6-7. One Modem Transceiver per Sector, Multiple LACs per Sector - Sniffing on One LAC - Directional Setup

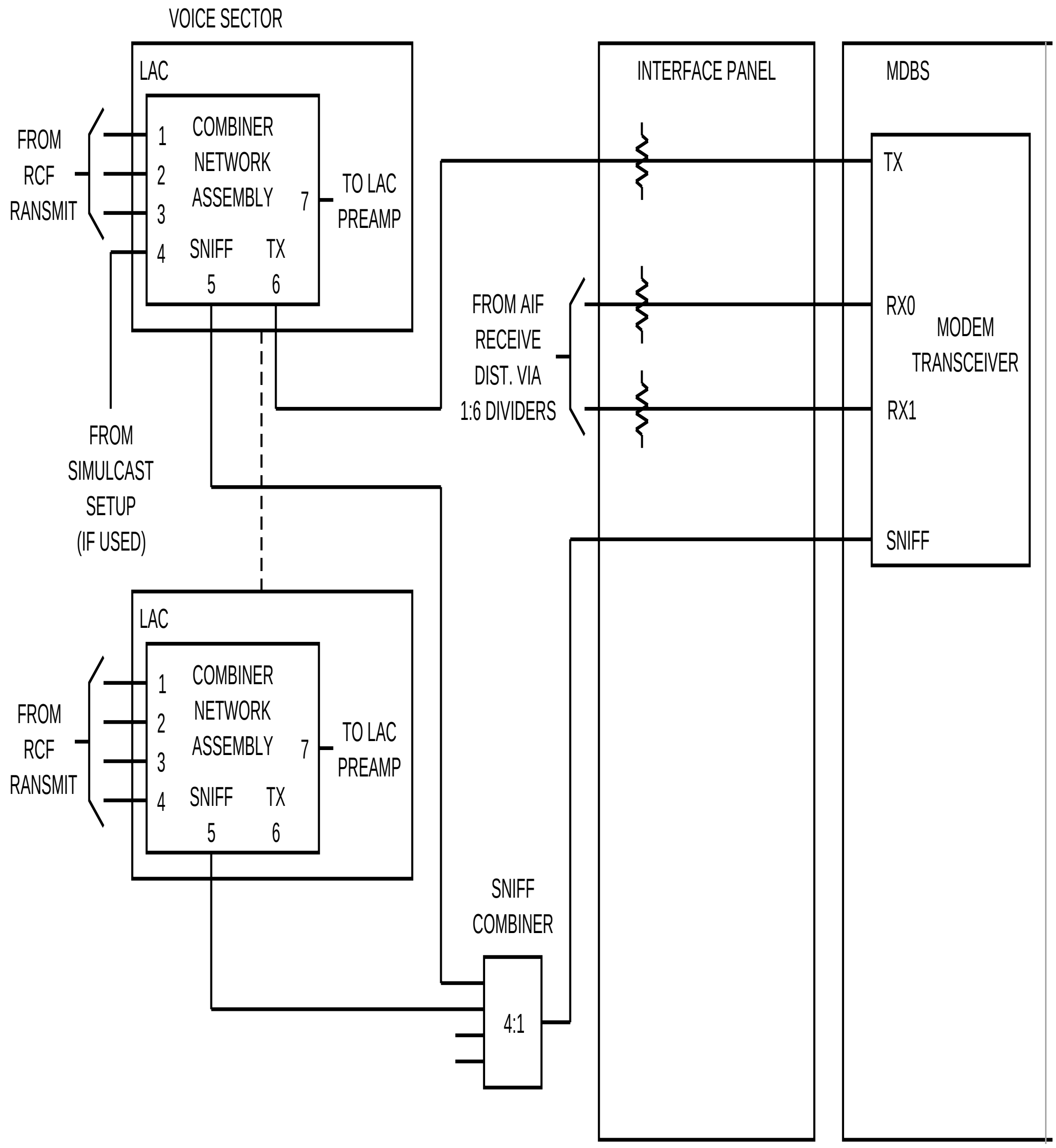


Figure 6-8. One Modem Transceiver per Sector, Multiple LACs per Sector - Sniffing on Multiple LACs - Directional Setup

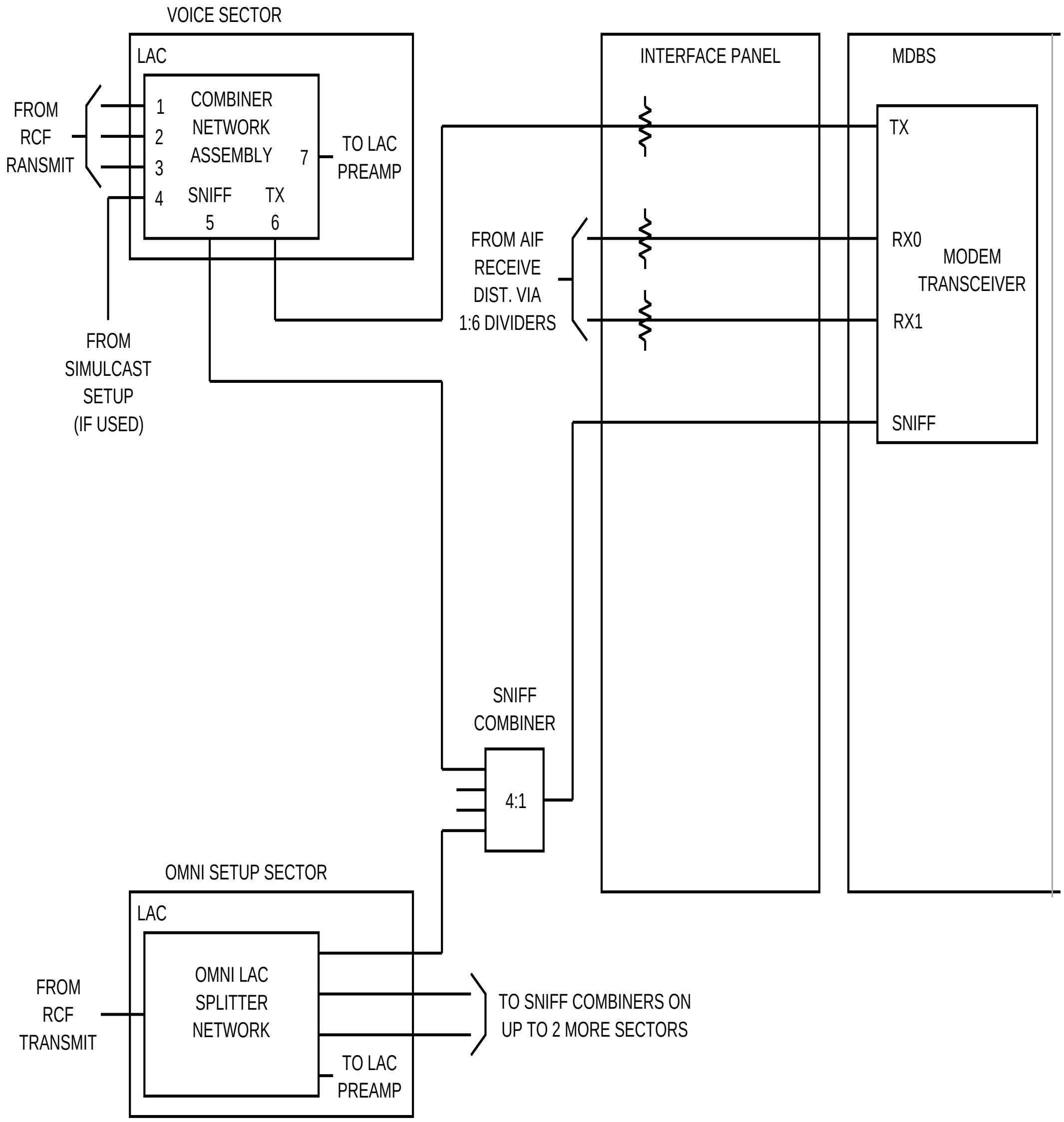


Figure 6-9. One Modem Transceiver per Sector, One LAC per Sector - Omnidirectional Setup

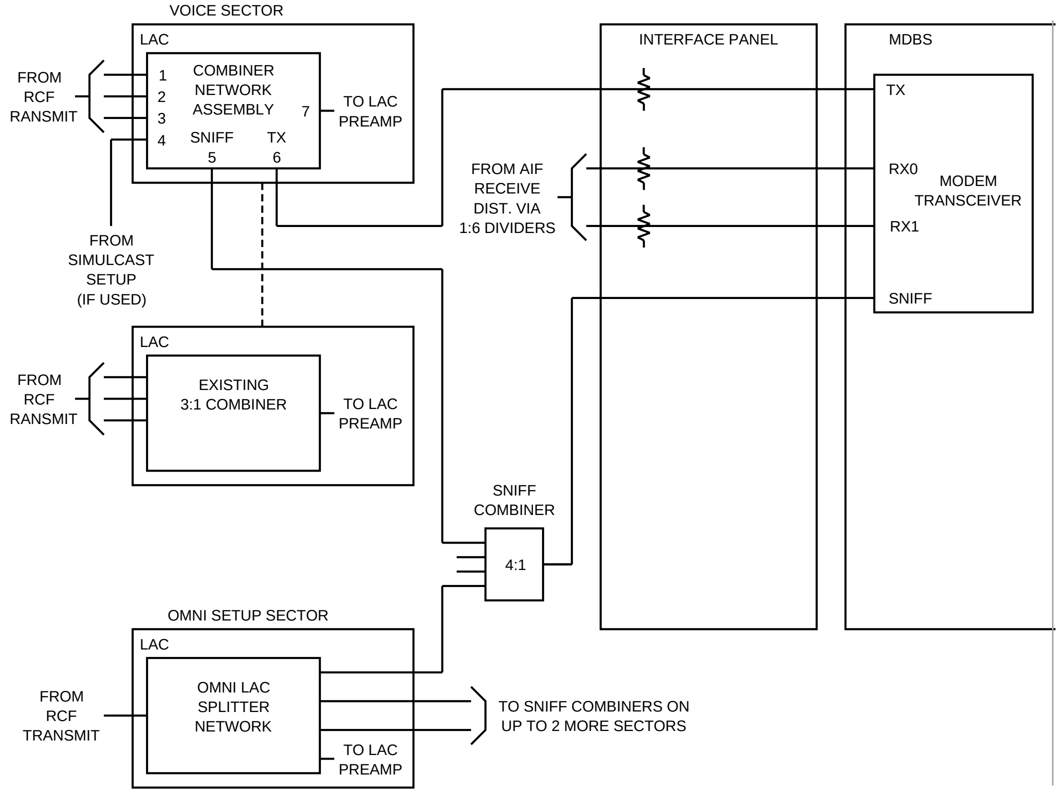


Figure 6-10. One Modem Transceiver per Sector, Multiple LACs per Sector - Sniffing on One LAC - Omnidirectional Setup

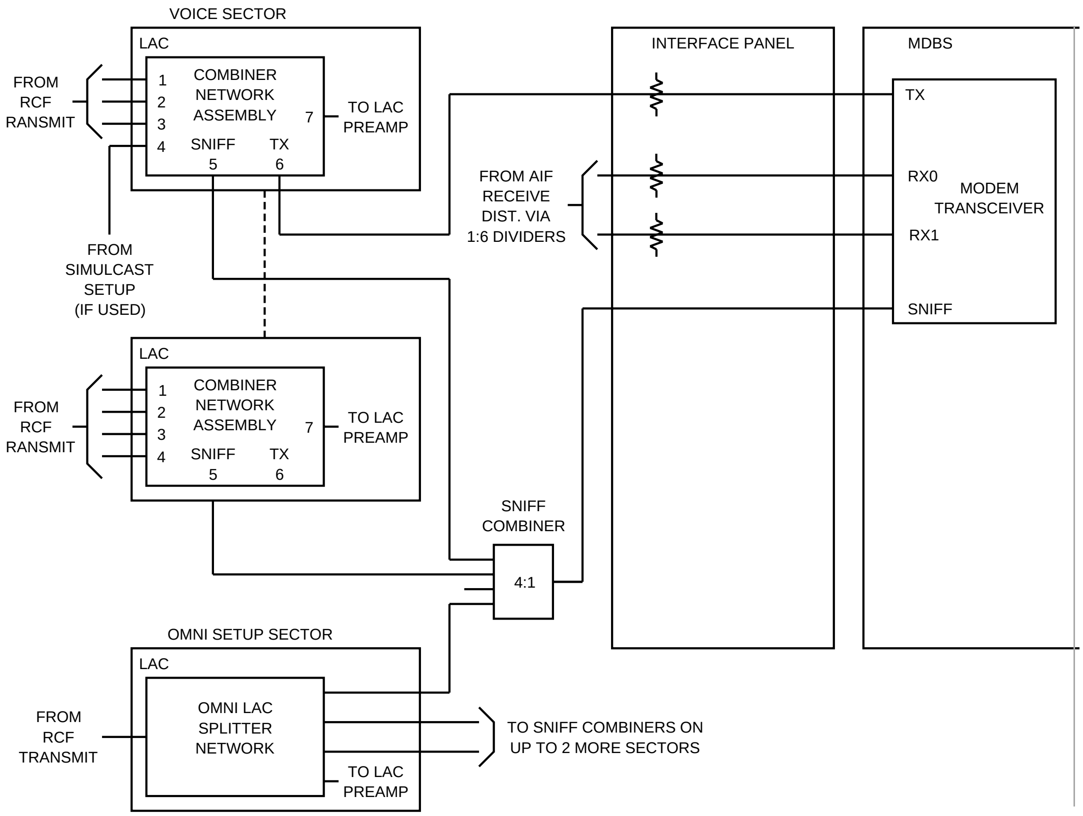


Figure 6-11. One Modem Transceiver per Sector, Multiple LACs per Sector - Sniffing on Multiple LACs - Omnidirectional Setup

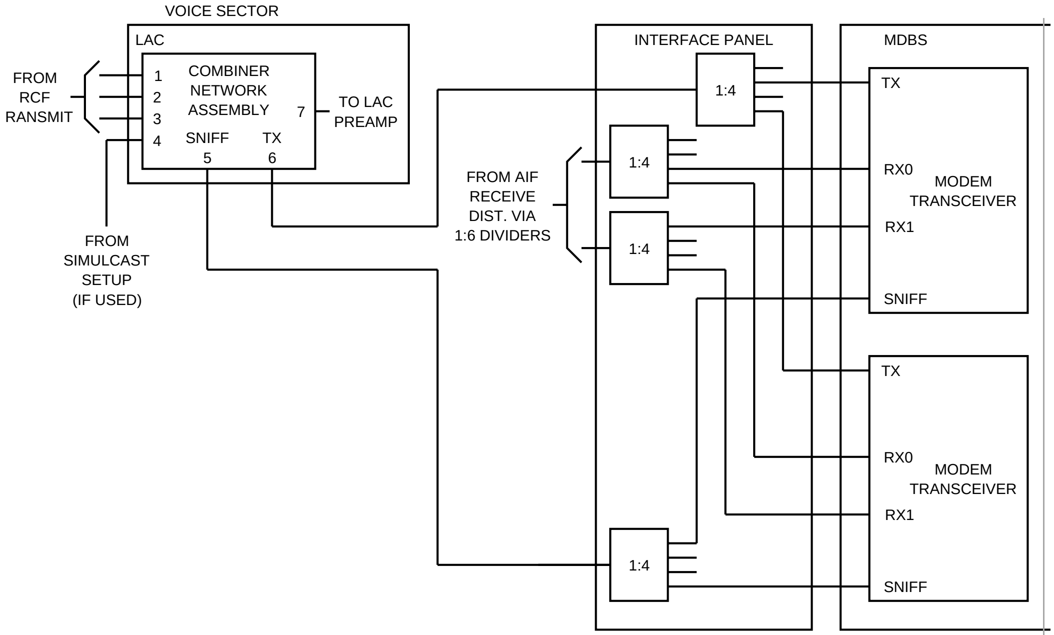


Figure 6-12. Multiple Modem Transceiver per Sector, One LAC per Sector - Directional Setup

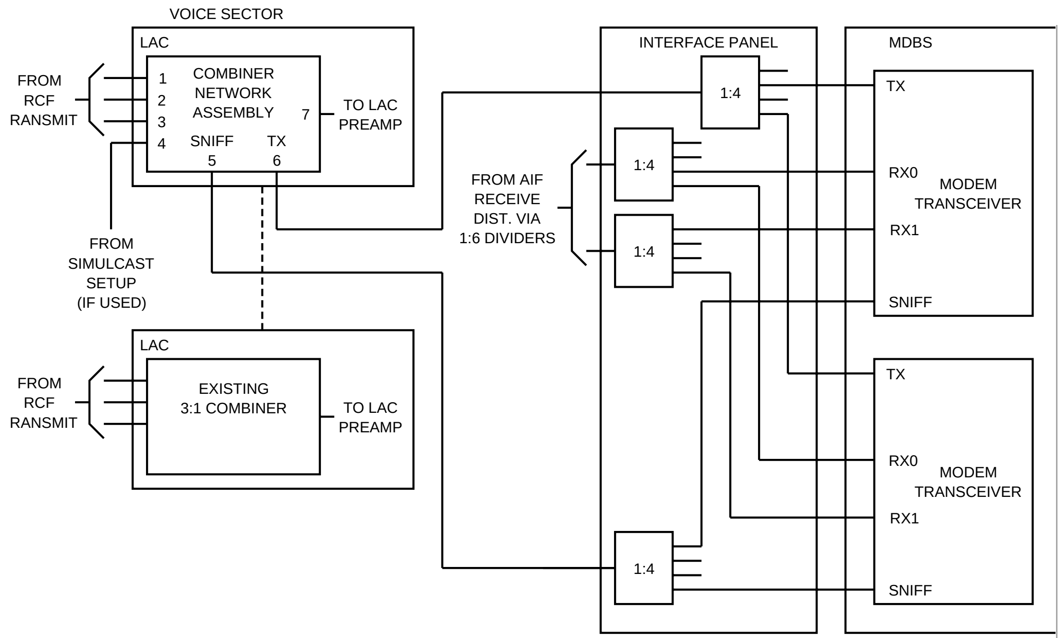


Figure 6-13. Multiple Modem Transceiver per Sector, Multiple LACs per Sector - Sniffing on One LAC - Directional Setup

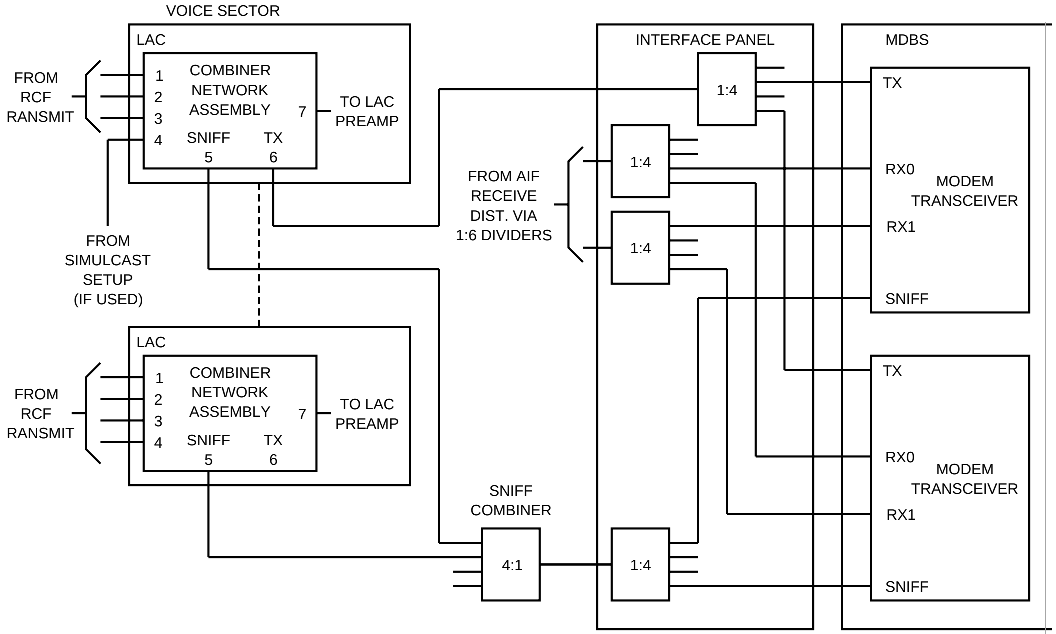


Figure 6-14. Multiple Modem Transceiver per Sector, Multiple LACs per Sector - Sniffing on Multiple LACs - Directional Setup

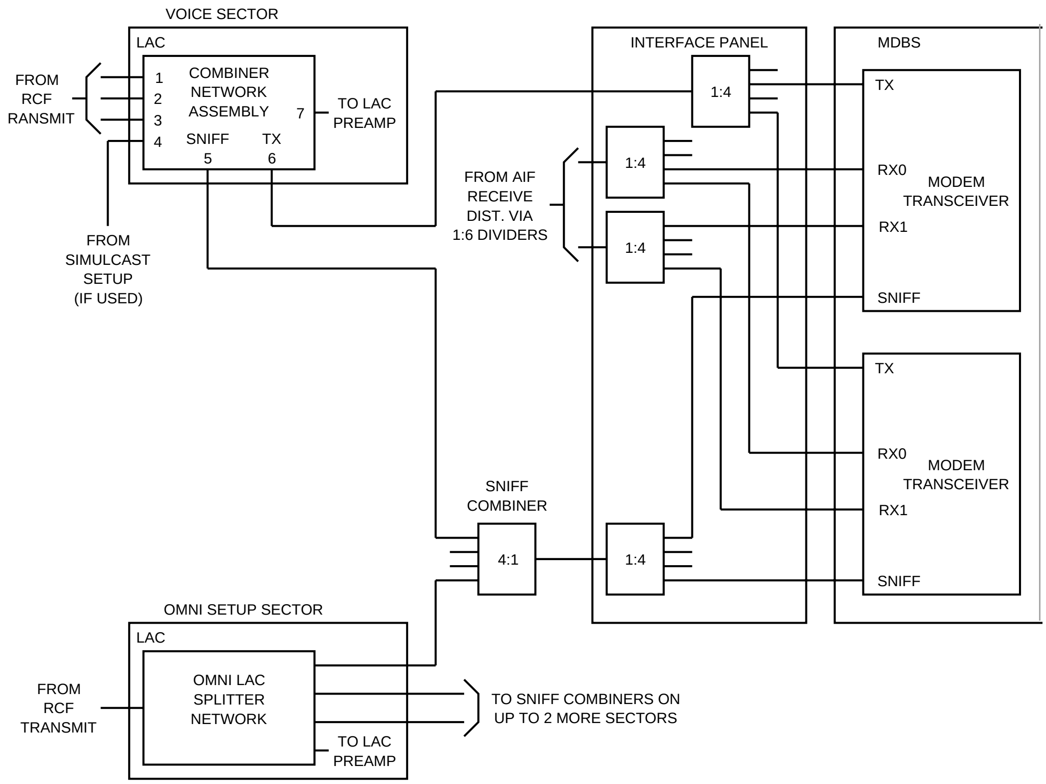


Figure 6-15. Multiple Modem Transceiver per Sector, One LAC per Sector - Omnidirectional Setup

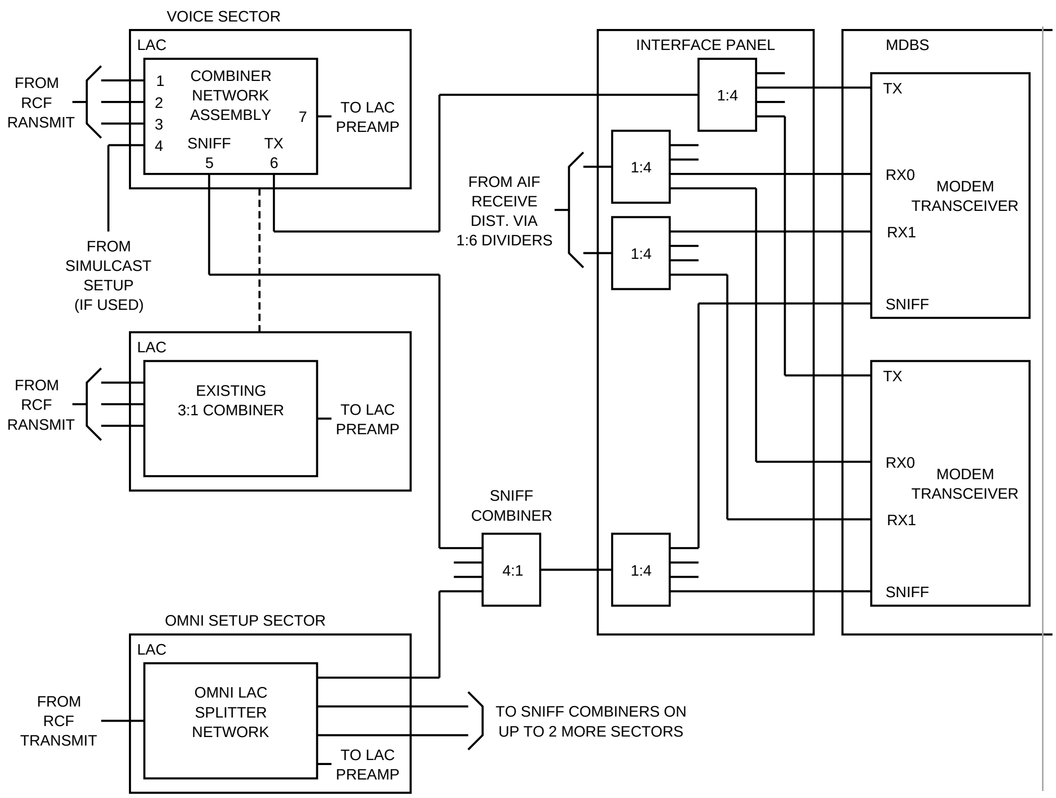


Figure 6-16. Multiple Modem Transceiver per Sector, Multiple LACs per Sector - Sniffing on One LAC - Omnidirectional Setup

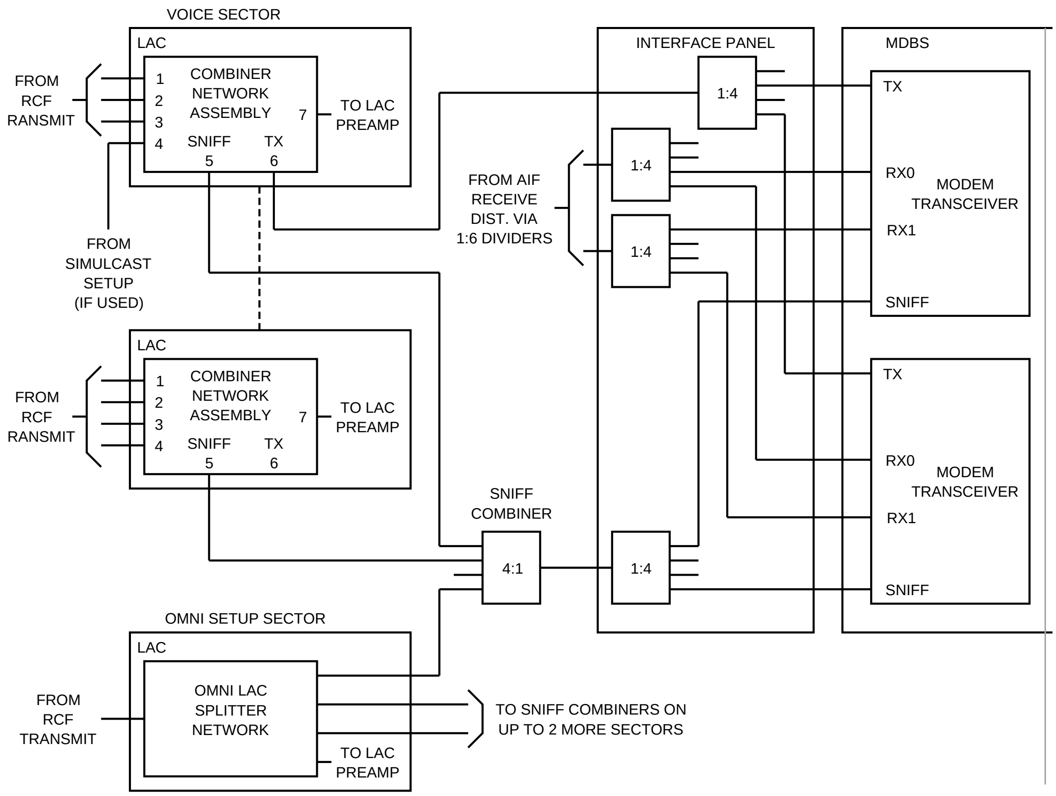


Figure 6-17. Multiple Modem Transceiver per Sector, Multiple LACs per Sector - Sniffing on Multiple LACs - Omnidirectional Setup

Grounding and Lightning Protection

Grounding and lightning protection are provided by connecting the external packet data equipment to the Cell Site's ring ground.

Related Documentation

Related Cell Site documentation is Lucent Technologies 401-660-101, *Cell Diagnostic Tests.* Documentation for the CDPD equipment listed in Table is provided in the following Lucent Technologies documents:

Table 6-2. CDPD Documentation

Document Number	Document Title
401-401-100	*MDBS Installation Manual*
401-401-101	*MDBS User's Guide*
401-401-102	*CDPD Subscriber information Update Guide*

Table 6-2. CDPD Documentation (Contd)

Document Number	Document Title
401-401-110	*CDPD MD-IS Operations Manual*
401-401-111	*CDPD Administration Server Operations Manual*
401-401-112	*Network Management System User's Guide.*
401-401-113	*CDPD MD-IS Complex Hardware Reference Manual*

Mini, Micro, and Fiber-Link Series II Cell Site Options

7

Contents

General

There are many possible options and combinations of Cell Site hardware and new hardware/software options are continually being developed to enhance the *AUTOPLEX* System 1000. To determine which hardware/software options are currently available, please contact a Lucent Technologies Account Executive.

Table 7-1. Technology Options - Related Documentation

Document Number	Title
401-610-006	*Planning Guide*
401-610-036	*Data Base Update*
401-610-055	*Input Message Manual*
401-610-057	*Output Message Manual*
401-610-075	*System Routine and Corrective Maintenance*
401-610-077	*ECP/CDN Recovery/Messages Audits Manual*
401-610-078	*Cell Site Audits Manual*
401-610-079	*System Recovery*
401-610-120	*Recommended Spare Parts, Tools, and Test Equipment*
401-610-135	*Service Measurements*
401-610-151	*Daily Operations*
401-612-064	*Multiple System Subscriber Administration (MSSA)*
401-660-101	*Series II Cell Site Diagnostic Test Descriptions*
401-660-106	*Series I and II Cell Translations Applications Guide*
401-660-108	*Cellular Operations Systems* *Performance Analysis and Cellular Engineering Users Guide*
401-660-115	*Series IIm T1/E1 Minicell Description, Operation, and Maintenance*
401-661-111	*Series II Microcell Implementation, Installation, and Maintenance Guidelines*
401-661-116	*Universal Fiber Microcell Implementation, Installation, and Maintenance Guidelines*
401-661-215	*Universal Fiber Microcell Primary Remote Administrator (PRA) User Guide*
401-661-216	*Universal Fiber Microcell Secondary Administrator (RA) User Guide*
401-703-000	*PCS CDMA Systems Product Overview*

Table 7-1. Technology Options - Related Documentation (Contd)

Document Number	Title
401-703-203	*PCS CDMA Minicell Guidelines for Systems Acceptance and Test*
401-703-201	*PCS RF Engineering Guidelines for PCS CDMA Implementation*
401-703-301	*PCS CDMA Minicell Description, Operation, and Maintenance*
401-612-131	*PCS CDMA Minicell CATV Distribution Optional Feature*
SD2R236, Issue 7	*AUTOPLEX System Application Schematic*

Series IIe Cell Site

Series II Cell Site Release 4.34 and later (with the ECP running APXEC5.1 or later Generic) provides for a Series IIe Cell Site. The information contained herein is based on Series II Cell Site Release 5.06 and later.

The Series IIe is a small capacity Cell Site based on the standard Series II Cell Site hardware and software. Call processing for Series IIe is identical to the Series II Cell Site. Series IIe offers the Receive Calibration Generator (RCG) and the redundant Reference Frequency Generator (RFG) as optional equipment. A reduction in hardware and the offer of non-redundant hardware from the Series II Cell Site tailors the Series IIe for smaller market applications.

The Series IIe is intended to economically address the Rural Service Area (RSA), and some outlying Metropolitan Service Areas (MSA). The Series II Primary Radio Channel Frame (P-RCF) and the Antenna Interface Frame (AIF) were redesigned for Series IIe. The Linear Amplifier Frame (LAF) remains unchanged and contains a standard Series II linear amplifier. The ECP Recent Change and Series II cell software have been enhanced to incorporate Cell Site translations specific to this product. Translations provide equipage data fields for optional hardware and a unique cell identification.

Table 7-2. Series IIe Configurations

	R4.34		**R5.06**
	Model Configuration Package	**Max. Capacity of Model Configuration Package without Additional Frames**	**Max. Capacity with Additional Frames**
Antenna Configuration	*OMNI*	*OMNI*	*OMNI* *3 Sectored* *6 Sectored*
Primary Radio Frame	*1*	*1*	*1*
Growth Radio Frames	*0*	*0*	*2*
Analog Radio Channel Units	*10*	*32*	*176*
Linear Amplifier Frame	*1*	*1*	*2*
240-Watt Linear Amplifier Circuit	*1*	*4*	*7*
Antenna Interface Frame	*1*	*1*	*2*
Transmit Filter Assembly	*1*	*4*	*7*
Receive Filter Assembly	*2*	*8*	*14*
Digital Radio Channel Units	*0*	*0*	*86*

The "Model Configuration" Series IIe Cell Site only allows an omnidirectional setup and voice configuration, analog radios, and equipage of up to 32 radios. Cell Release 5.06 provides for growth greater than 32 analog radios, TDMA, sectorization, support for all microcell configurations, a second LAF, a second Antenna Interface Frame, and duplex as well as simplex filter arrangements.

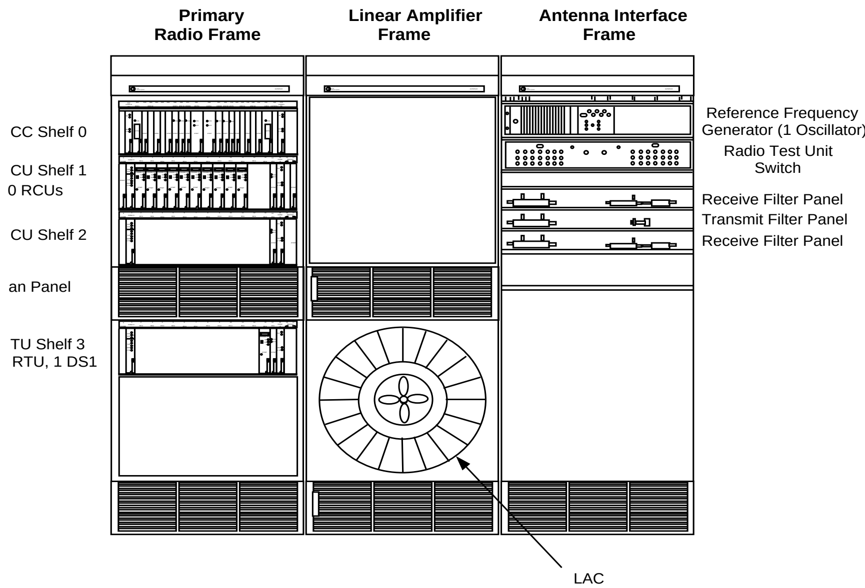


Figure 7-1. Series IIe Radio Frame Set

Compact Base Station (CBS)

The Compact Base Station (CBS) (see Figure 7-2) is a Cell Site where Series II technology is repackaged into a compact cabinet designed for an outdoor environment. The CBS shares many of the Series II advantages such as compatibility with Series I, all digital interfaces, easy maintenance, on-site diagnostics, and programmable radio channels.

The CBS contains three bays:

- The Radio Channel Bay (RCB)
- Linear Amplifier Bay (LAB)
- Antenna Interface Bay (AIB).

The CBS radio channel equipment is housed in the RCB. The CBS accommodates up to 32 radio channel units and contains a single Linear Amplifier Circuit (LAC) which can be equipped to deliver either 100 or 240 watts total average Radio Frequency (RF) output power when measured at the amplifier output. The transmit and receive filter panels can be optioned for either “A” or “B” band operation, and an integrate duplexer option is also available. For additional information, refer to Lucent Technologies Customer Information Bulletin (CIB) 182, Introduction to Series II Compact Base Station and Lucent Technologies 401-660-060, Compact Base Station Description, Operation, and Maintenance.

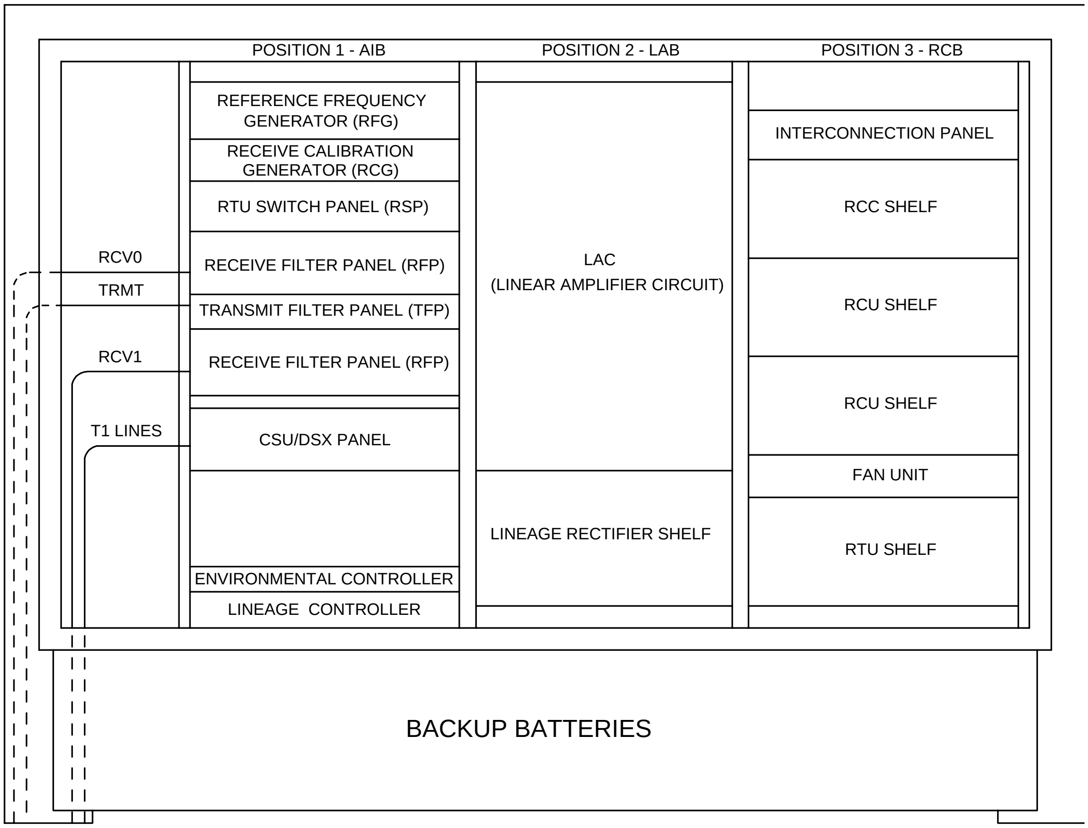


Figure 7-2. Series II Compact Base Station (CBS) Hardware Architecture

CBS Documents

Series II Compact Base Station Description, Operation, and Maintenance (401-660-060)

Series II Compact Base Station Cabinet Installation Manual (401-660-200).

Series IIm T1/E1 MiniCell

The Series IIm MiniCell is designed to provide high-power, low-channel capacity cellular coverage for rural environments where wide area coverage is desired and low traffic is expected. It provides high Radio Frequency (RF) transmit power to cover a large geographic area.

The Series IIm is connected to the Mobile Switching Center (MSC) via T1/E1, wired, or microwave facilities. A single primary cabinet may be used to provide as many as 8 cellular radio channels. One channel is used for set-up communications and the remaining 7 channels are used for voice.

Installing the TRTU and DRU(s)

In Series IIm and Series IImm cells, the TRTU is installed in slot 22 of the radio shelf in the primary cabinet. (For more information see Chapter “Series II Cell Site Equipment Descriptions,” Section “Installing the TRTU and DRU(s)”.

Installing the T-EDRU and EDRU(s)

In Series IIm and Series IImm cells, insert T-EDRU in slot 22 of radio shelf in primary cabinet. When installing in the Series IIm/IImm cabinet, EDRUs (44WR8) require two shelf slots. Lucent Technologies recommends equipping these radios in even numbered shelf slots only (i.e., positioned in slots 2-3, 4-5, 6-7, etc.). (For more information see Chapter “Series II Cell Site Equipment Descriptions,” Section “Installing the TRTU and EDRU(s)”.

Cabinet Descriptions

The primary Series IIm cabinet may be combined with up to 2 growth cabinets where each growth cabinet can provide as many as 8 additional radio channels for voice communications. Although a battery back-up system is provided in each cabinet, an extended battery back-up cabinet can be installed to provide a longer backup time.

Cabinets designed for outdoor installation are AC-powered and are equipped with heat exchangers to maintain a tolerable interior temperature regardless of outdoor environment. Cabinets designed for indoor installation may be either AC or DC powered.

Series IIm T1/E1 Minicell Documentation

Series IIm T1/E1 Minicell Description, Operation, and Maintenance (401-660-115)

Series IIm-T1 Minicell and Series IImm-T1 Microcell Introduction and Ordering Guide (230 CIB).

Series IImm T1/E1 MicroCell

The Series IImm MicroCell system uses a Series II Cell Site and is:

- Compact
- Low-power Radio Frequency (RF)
- High-channel capacity
- Advanced Mobile Phone Service (AMPS) and/or Time Division Multiple Access (TDMA).

Cabinets designed for outdoor installation are AC-powered and are equipped with heat exchangers to maintain a tolerable interior temperature regardless of outdoor environment. Cabinets designed for indoor installation may be either AC or DC powered.

Series IIm and IImm AC cabinets have a "fold up lip" on:

1. the top of the front door
2. the rear (heat exchanger equipped) door
3. both of the pedestal area covers.

This lip prevents any water sitting on top of the door edge from being sucked into the cabinet when the door or pedestal cover is opened.

To address concerns about door latches breaking in the field, the door latching mechanism consists of four individually operated one quarter turn latches. To further increase security, the top and the bottom latch are equipped with hasps that can accommodate a pad lock.

To address concerns about gaskets coming off in the field and water getting into the cabinets, door gaskets are placed on the mating surface of the cabinet drip lip.

For details, refer to 401-660-117 "Small Cell Installation" and 401-660-116 "Series II Description, Operation, and Maintenance.

AMPS/TDMA Mix with DRU Radios

The Series IImm primary cabinet permits a maximum of 19 transmit SBRCU radios, a setup radio, a receive-only locate radio, and two test radios. Because test radios are not required in the growth cabinets, the growth cabinets can accommodate 21 SBRCU radios.

Because an RCU is twice the width of an SBRCU, the installation of RCU radios is limited the number of transmit radios that can be accommodated. When the cell is configured to support AMPS and TDMA, one locate radio must be an RCU or SBRCU and the other locate radio may be a locate EDRU (L-EDRU) or a locate DRU (L-DRU). The Radio Test Unit (RTU) for the RCU and SBRCU must be located in radio shelf slot 21, and if at least one DRU or EDRU is installed, a TDMA RTU (TRTU) or a test EDRU (T-EDRU) must be installed. The TRTU is four slots wide and occupies slots 22 through 25 and the T-EDRU is two slots wide and occupies slots 22 and 23.

AMPS/TDMA Mix with EDRU Radios

When EDRUs are used, an EDRU can be placed in any two adjacent slots starting with an odd numbered slot. The number of EDRUs that can be installed on the radio shelf is limited by the shelf power supply and the cabinet heat dissipation.

There are two types of Series IImm primary and growth cabinets. They are differentiated by the cabinets' production date. Cabinets manufactured prior to December 1995 provide 20A service to the radio shelf, and cabinets manufactured after this date provide 30A service to the radio shelf. When EDRUs are installed, the +5-volt PCU 415AC should be replaced with +5-volt PCU 430AB regardless of the cabinet's manufacture date and the number of EDRUs to be installed.

NOTE:
Prior to replacing any electrical component in the radio shelf, the cell or sector should be taken off line and the power to the component being replaced should be shut off.

A single circuit breaker rated at either 20A or 30A, depending on the cabinet manufacture date, supplies power to the radio shelf at 5-volt and +12-volt PCU. The 20A RCU circuit breaker (CB1) in the Series IImm cabinet permits the operation of up to nine EDRUs and two analog RCUs. If ten or more EDRUs are to be installed, the +5V CONV circuit breaker must be replaced with a 30A circuit beaker.

In addition, the feeder line to the new 30A circuit breaker must be changed from a 12 AWG wire to twin 10 AWG feeders. If the number of EDRUs to be installed is ten or more, a 12-volt power converter unit (PCU) 419AC must be replaced with PCU 419AE .

Radio Self Power Upgade

The introduction of EDRU radios may require a radio power supply upgrade. This upgade involves replacing +5-volt PCU 415AC with +5-volt PCU 430AB, and possibly replacing 20-A RCU circuit breaker CB1 with a 30-A circuit breaker. Prior to replacing any electrical component in the radio shelf, the cell or sector should be taken off line and the power to the component to be replaced should be shut off. If circuit breaker CB1 is to upgraded from 20A to 30A, power to the cabinet must be turned off.

1. To remove a cell from service, use the dial-up terminal to log on to the MSC and perform the following:
   - Inhibit call processing, routine diagnostics, and functional test of the cell by entering the following commands:

- inh:cell a,cp (where a = cell number)
- inh:cell a,rtdiag
- inh:cell a,ft su
- inh:cell a,ft lc

■ Wait for all in-process calls to complete [all voice RCU, SBRCU, DRU and EDRU Tx (Transmit) LEDs OFF].

■ Remove all beacon radios (if equipped) from service by entering the following code:

- rmv:cell a,ra b;ucl (where a = cell number and b = radio number of beacon)

■ Remove cell data links to/from MSC by entering the following code:

- rmv:cell a,dl 1

2. If a +5-volt PCU 415AC is to be replaced by a +5-volt PCU 430AB, set RCU circuit breaker CB1 to the OFF position and then replace the +5-volt PCU board. Set RCU circuit breaker CB1 to the ON position. If RCU circuit breaker CB1 needs to be replaced, perform the following; otherwise restore the cell back to service.

3. To replace RCU circuit breaker CB1, perform the following:

■ On DC cabinets, remove the 24-volt supply.

■ On AC cabinets, set the main AC circuit breaker to OFF. The cell will run for about 10 minutes using the backup battery power. Remove the side access panels from the AC pedestal to gain access to the battery positive leads and disconnect the battery.

■ Remove the four machine screws from the front four corners of the circuit breaker panel and remove the top cover. It may be necessary to clip (remove) cable ties that secure the power wires in order to provide additional installation space.

■ Remove the machine screws from the DC circuit breaker panel.

■ Remove 20A RCU circuit breaker CB2 from the circuit panel. Remove two 5/16 nuts from the circuit breaker power terminals and disconnect the power wires.

■ Install the new 30A circuit breaker by reversing the sequence in which the circuit breaker was removed.

■ Ensure that the circuit breaker is oriented correctly and that line and load power wiring is correctly replaced on the circuit breaker.

■ Ensure that the circuit breaker power terminal nuts are adequately torqued.

- Using a 1/8-inch stamp and white ink to stamp “30 A,” which indicates the value of the new circuit breaker.
- Reinstall the top cover on the panel; reinstall the circuit breaker panel.
- Ensure that the power wiring is not kinked or pinched when sliding the panel back into the cabinet.
- Secure the panel using four machine screws.
- Re-install cable ties that were previously removed.
- On DC cabinets, restore power to the cabinet and then restore the cell back to service.
- On AC cabinets, use antioxidant compound to prevent high resistance caused by oxidation and reconnect the positive battery leads.
- On AC cabinets, set the main AC circuit beaker to ON and then restore the cell back to service.

Restoring Cell to Service

To restore the cell back to service, use the dial-up terminal that is logged on to the MSC and do the following:

a. Restore cell data links by entering the following commands:
b. **rst:cell x,dl 0;ucl** where x = cell number
c. rst:cell x,dl 1;ucl
d. MSC automatically boots cell under test. Verify by entering the following command:
e. **op:cell x** where x = cell number
f. Wait for the boot process to complete (approximately 5 minutes when equipped with 56 kbps datalinks, and 20 minutes with 9.6 kbps datalinks). When the boot process is complete, each RCU displays its channel number. Make sure that RCFs are alarm free.

Series II Cell Site Equipment Descriptions

8

Contents

General

Series II Cell Site hardware is designed, arranged, and packaged on a functional basis. Although there is a considerable amount of hardware involved, each hardware unit is straightforward in its purpose, and specific hardware units are associated with specific functions. Service reliability to the cellular subscriber is provided in many different ways by the design and functional grouping of hardware. This functional grouping of hardware, combined with diagnostic tests, provides a direct and time-saving approach to maintenance tasks.

Radio Channel Frame (RCF) Description

The Primary Radio Channel Frame (P-RCF) (see Figure 8-1) is equipped with a fully redundant Radio Control Complex (RCC). The RCC is the Cell Site controller — this includes communication with the Mobile Switching Center (MSC) and control of voice and data communication with subscriber units and the Cell Site maintenance equipment. The Radio Channel Units (RCUs) in the P-RCF serve functionally as setup, locate, and voice channel radios. Each of 2 Growth RCFs can contain up to 72 RCUs.

The Primary Radio Channel Frame J41660A-2 and the growth Radio Channel Frame J41660B-2 weigh approximately 800 pounds each fully loaded and have the following dimensions:

26" wide by 22" deep by 81" high
Total height = 70" to top of bay + 10 1/2" for the interconnection panel.

Major assemblies located in the Primary Radio Channel Frame (P-RCF) are called out by ED number.

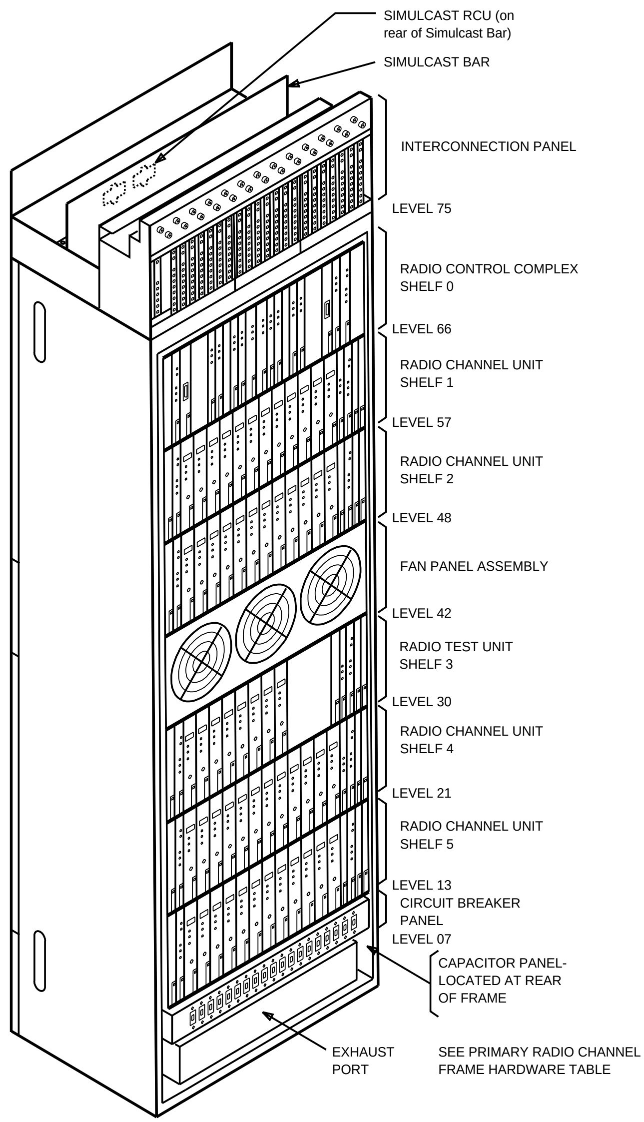


Figure 8-1. Primary Radio Channel Frame J41660A-2

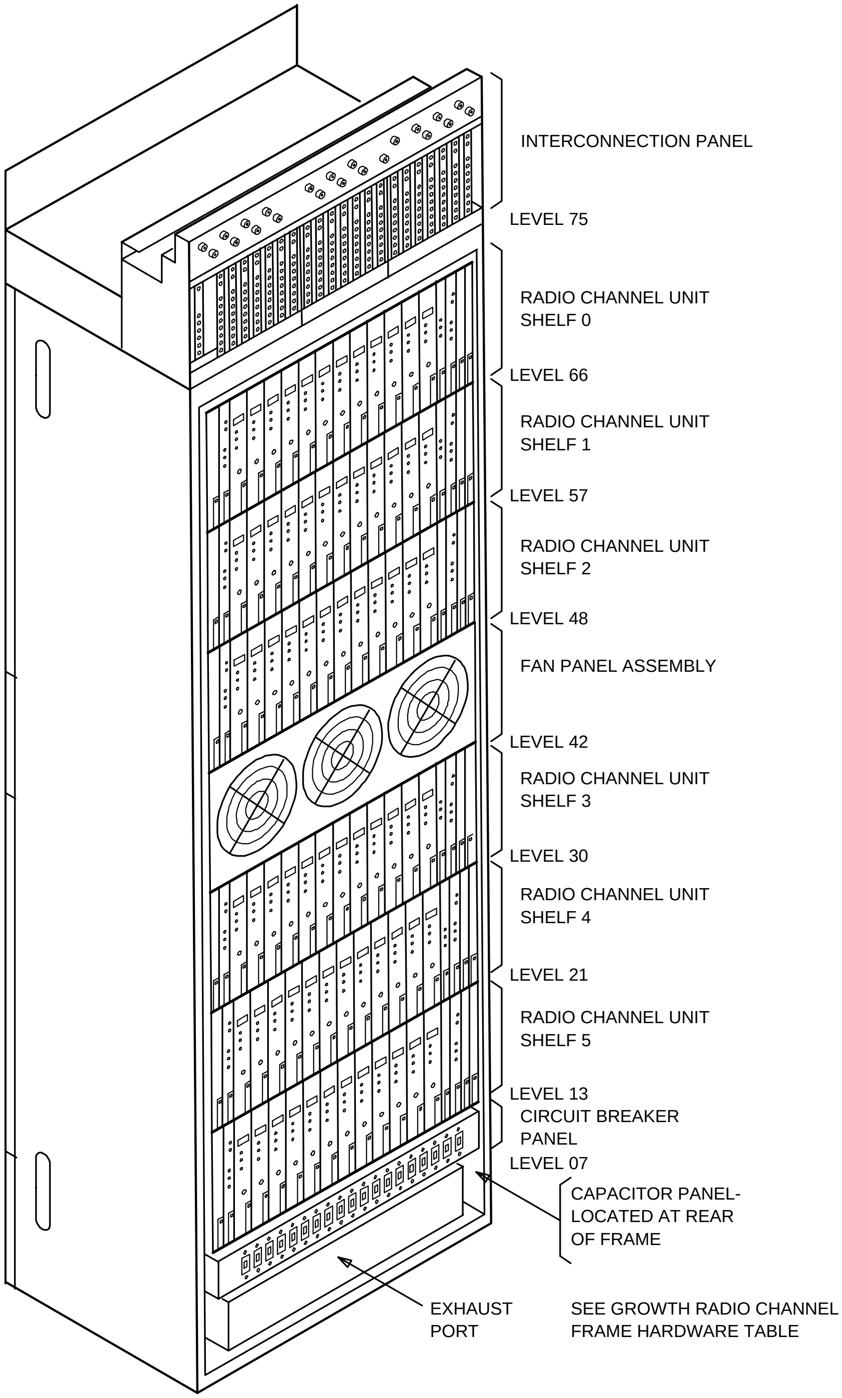


Figure 8-2. Growth Radio Channel Frame (J41660B-2)

The major hardware units are listed in the tables below.

Table 8-1. Primary Radio Channel Frame Hardware (J-41660A)

Item	Max Qty	Code	Eq. Loc
Interconnection Panel	1	ED-2R831-30	80
Tx, Rx Power Dividers (9:1)	21	KS24235, L5	
Radio Control Complex (Shelf 0)	1	ED-2R832-30	66
+5V Power Converter	2	415AB	
Alarm/FITS Interface	2	UN166	
*Alarm Adapter Interface for Increased Cell Alarms (Installed in Cable Tray Assembly)	1 (Optional)	AYD10	
Network Control Interface	4	TN168	
Communications Processor Interface	2	TN167	
Core Processor Unit	2	UN524	
8-Megabyte Memory Board	2	TN1710	
High Capacity Processor Unit (HCPU)	2	UN530	
Bus Interface Board	1	TN2245	
Digital Facilities Interface (DFI)	1	TN1713B or TN3500B	
Radio Channel Unit Shelf (Shelf 1 and Shelf 2)	1	ED-2R833-30	57,48
Transmit Combiner	2	BBN2	
+12V Power Converter	2	419AE	
Radio Channel Unit	24	ED-2R836-30	
Digital Radio Unit	12	ED-2R920-30	
Power Converter Unit	2	430AB (Req'd for EDRU)	
Enhanced Digital Radio Unit	Maximum 12 per shelf. 23 per RCF0, 40 per RCF1, 16 per RCF2	44WR8	
Clock And Tone (CAT)	2	TN170	
Receive Switch Divider (Manual) (Switchable)	4	BBN1 or BBM1	
Fan Panel Assembly	1	ED-2R824-31	42
Fan	6	406029041	

Table 8-1. Primary Radio Channel Frame Hardware (J-41660A) (Contd)

Item	Max Qty	Code	Eq. Loc
Radio Test Unit (Shelf 3)	1	ED-2R835-30	30
Transmit Combiner	1	BBN2	
+12V Power Converter	1	419AE	
Radio Channel Unit	8	ED-2R836-30	
Digital Radio Unit	4	ED-2R920-30	
Power Converter Unit		430AB (Req'd for EDRU)	
Enhanced Digital Radio Unit	Maximum 8 per shelf	44WR8	
TDMA Radio Test Unit (TRTU)	1	ED-2R921-30	
Radio Test Unit (RTU)	1	ED-2R837-30	
Digital Facilities Interface (DFI)	1	TN1713B or TN3500B	
+5V Converter	1	430AB	
Receive Switch Divider (Manual)	2	BBN1	
Radio Channel Unit Shelf (Shelf 4 and Shelf 5)	2	ED-2R834-30	13, 21
Transmit Combiner	1	BBN2	
+12V Power Converter	1	419AE	
Radio Channel Unit	12	ED-2R836-30	
Digital Radio Unit	6	ED-2R920-30	
Power Converter Unit		430AB (Req'd for EDRU)	
Enhanced Digital Radio Unit	Maximum 12 per shelf	44WR8	
Digital Facilities Interface (DFI)	1	TN1713B or TN3500B	
Receive Switch Divider (Manual)	2	BBN1	

Table 8-1. Primary Radio Channel Frame Hardware (J-41660A) (Contd)

Item	Max Qty	Code	Eq. Loc
*Busbar Assembly Unit (Manufactured 5/98 or later)	2	KS24355, L1	[redacted]
Circuit Breaker, Plug-In, 15.0 A	2	KS24356, L6	
Circuit Breaker, Plug-In, 25.0 A	10	KS24356, L8	
Circuit Breaker, Plug-In, 5.0 A	3	KS24356, L4	
Note: This table is for hardware identification only. Do ***not*** use this table for ordering hardware items. * Replaces Circuit Breaker Assembly ED-2R826-30 and Capacitor Panel Assembly ED-2R829-30.			

Table 8-2. Primary Radio Channel Frame (P-RCF) Radio Shelves 0 through 5 Controls and Indicators

Circuit Pack/Unit	Control/ Indicator	Type	Function
+5V Converter 430AB	-5V	Test Jack	Test Point — Monitor -5V
	+5V	Test Jack	Test Point — Monitor +5V
	Off	LED (Red)	Indicates converter is off
	V in	LED (White)	Indicates +24V to converter
Alarm/FITS Interface UN166	Fail	LED (Red)	Indicates board failure
Comm. Proc. Interface TN167	Fail	LED (Red)	Indicates board failure
Network Control Interface TN168	Fail	LED (Red)	Indicates board failure
8-Megabyte Mem. Board TN1710	Fail	LED (Red)	Indicates board failure
Core Processor UN524	Fail	LED (Red)	Indicates board failure
	Act	LED (Green)	Indicates active (on line)
DS1 Board TN171	Fail	LED (Red)	Indicates board failure
or	CLF	LED (Amber)	Indicates T1 or E1 line fault
DFI Board TN1713B or TN3500B	SYNC	LED (Green	Indicates on line
+12.0V Power Converter 419AE	R	Test Jack	Test Point — Monitor +12V Return
	-12V	Test Jack	Test Point — Monitor -12V
	+12V	Test Jack	Test Point — Monitor +12V
	Off	LED (Red)	Indicates converter is off
	V In	LED (White)	Indicates 24V to converter

Table 8-2. Primary Radio Channel Frame (P-RCF) Radio Shelves 0 through 5 Controls and Indicators (Contd)

Circuit Pack/Unit	Control/ Indicator	Type	Function
Radio Channel Unit ED-2R836-30 Digital Radio Unit ED-2R920-30 Enhanced Digital Radio Unit 44WR8	Auto/Off	Switch	Switches Radio Channel Unit On/Off
	Fail	LED (Red)	Indicates Radio Channel failure
	StdBy	LED (Amber)	Indicates Radio Channel Unit is in StandBy Mode. Non-Volatile Memory (NVM) update in process.
	Tx	LED (Green)	Indicates Radio Channel Unit is transmitting
	Screw Slot	Potentiome-ter	Adjusts Output Level of Radio
Clock & Tone Board TN170	Fail	LED (Red)	Indicates Board Failure
	Act	LED (Green)	Indicates Active (On Line)
Radio Test Unit ED-2R837-30	Auto/Off	Switch	Switches Radio Channel Unit On/Off
	Fail	LED (Red)	Indicates Radio Channel failure
TDMA Radio Test Unit ED-2R921-30	Auto/Off	Switch	Switches Radio Channel Unit On/Off

The following paragraphs describe the major functions performed by the RCF.

Series II Cell Site Radio Control Complex (RCC) Buses

The Radio Control Complex (RCC) Figure 8-3 can accommodate up to three Time Division Multiplexed (TDM) buses. The ones currently used are TDM bus 0 and TDM bus 1, which are installed "red stripe up." TDM bus 2 is for future growth.

Each P-RCF is equipped with the following:

- One Radio Control Complex (RCC) shelf
- Carriers and backplane boards for the four Radio Channel Unit (RCU) shelves
- Carrier and backplane for the Radio Test Unit (RTU) shelf

- Backplane wiring for the six shelves.

The backplane wiring includes all cabling, terminating boards, and adapter boards required to make the TDM bus interconnections between shelves and between frames.

In Cell Sites having only a P-RCF, communication between the RCC and all the circuits under its control is by TDM bus 0. In Cell Sites having a P-RCF and one or two Growth RCFs, communication is by TDM buses 0 and 1.

Radio Channels Units (RCUs) communicate with either side of the RCC by TDM buses 0 or 1. Each bus is connected to the Core Processor Unit (CPU) by a Network Interface (NCI) circuit board and the associated system bus.

For each side of the RCC, one NCI circuit is needed with each TDM bus. Only two NCI circuit boards are needed in each side of the RCC to accommodate 200 radio channels. The P-RCF can handle up to 56 channels and each of two Growth RCFs can handle up to 72, for a total of 200.

The backplane slot assignments and the TDM bus fixed addresses for the RCC shelf assembly are shown in Table 8-3.

Table 8-3. Time Division Multiplex Bus Addresses

EQL	Board Type	TDM Bus	TDM Bus Address (Hex)
66-012	Power Converter	N/A	N/A
66-022	Alarm/FITS Interface	N/A	N/A
66-030	Reserved	2	7D
66-036	NCI	2	6D
66-042	Reserved	1	5D
66-048	NCI	1	4D
66-054	Reserved	0	3D
66-060	CPI	0	2D
66-066	NCI	0	1D
66-072	Memory	0	0D
66-082	Core Processor	N/A	N/A
66-094	Core Processor	N/A	N/A
66-102	Memory	0	4D
66-108	NCI	0	5D
66-114	CPI	0	6D
66-120	Reserved	0	7D

Table 8-3. Time Division Multiplex Bus Addresses (Contd)

EQL	Board Type	TDM Bus	TDM Bus Address (Hex)
66-126	NCI	1	0D
66-132	Reserved	1	1D
66-138	Reserved		2D
66-144	Reserved		3D
66-154	Alarm/FITS Interface	N/A	N/A
66-162	DS-1	1	7F
66-170	Power Converter	N/A	N/A

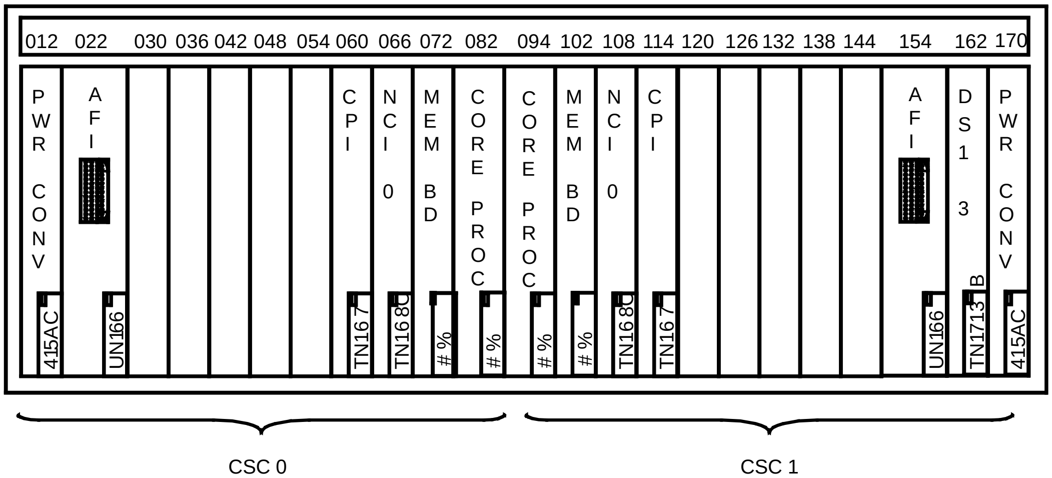
The Update bus is the means by which the Core Processor in the active side of the RCC updates the memory and diagnoses problems in the standby or mate side. When the active processor places the mate in the update mode, all the memory write operations are copied to the mate over the Update bus. A series of buffers on the Core Processor board provide the Update bus with an interface to the System bus.

Each side of the RCC has a dedicated System bus. Each of the two System buses links its CPU with a number of peripheral circuit boards. The basic peripheral circuits include the following:

- Memory
- Communication Processor Interface (CPI)
- NCI
- Alarm/FITS Interface (AFI).

For each side of the RCC, the minimum configuration requires only one CPU and one AFI and at least one of the following: Memory, CPI, and NCI boards. The update bus is the means by which the Core Processor in the active side of the RCC updates the memory and diagnoses problems in the standby or mate side. When the active processor places the mate in the update mode, all the memory write operations are copied to the mate over the Update bus. A series of buffers on the Core Processor board provide the Update bus with an interface to the System bus.

The Update bus is the means by which the Core Processor in the active side of the RCC updates the memory and diagnoses problems in the standby or mate side. When the active processor places the mate in the update mode, all the memory write operations are copied to the mate over the Update bus. A Series of buffers on the Core Processor board provide the Update bus with an interface to the System bus.



\# UN524 CPU and TN1710 MEMORY used together (Original configuration)
% UN530 CPU and TN2245 BIB used together must also have NCI = TN168C Version 2:2
(CDMA applications)

Figure 8-3. Radio Control Complex (RCC) - Shelf 0 ED-2R832-30

Series II Cell Site Radio Control Complex, Shelf 0 ED-2R832-30

The Radio Control Complex (RCC) is the Cell Site controller and is equipped with two identical sides — side 0 and side 1. The on-line side receives/sends control and data information from/to the Mobile Switching Center (MSC) and from/to Cell Site units. The off-line side tracks what the on-line side is doing, so that it may come on-line as needed. Only one side is on-line at a time. Circuit packs within the RCC are listed and described below.

Power Converter 430AB +5V

One power converter unit is used with each side to convert battery voltage from +24 to +5 volts.

The 430AB is a higher capacity version of the 415AC. The output current rating on the 415AC converter is 35 amperes. It has a built-in programmable over-current protection circuit. If or when the total current drain exceeds the programmed level by more than 20 percent, the converter shuts down.

Alarm/FITS Interface (AFI) UN166

The alarm and Factory Installation Test Set (FITS) interface circuit pack provides the interfaces required to store/process Cell Site alarms back to the MSC. In addition, this circuit pack contains the circuitry necessary to interface the FITS to the Cell Site. The FITS provides a number of diagnostic tests used to initially check out the Cell Site after installation.

This circuit board provides the interfaces needed between the associated Core Processor Unit (CPU) and the following alarm devices:

- User-defined alarm devices (up to 18)
- The Primary and Growth Radio Channel Frame (RCF) alarm devices
- The Antenna Interface Frame (AIF) alarms
- The Linear Amplifier Frame (LAF) alarms

Alarm Adapter Interface for Increased Cell Alarms AYD10

The Alarm Adapter Interface board AYD10 is installed on the cable tray assembly on top of the Series II Primary or Growth Frame to provide 24 additional user-definable alarm inputs to the RCC backplane. The introduction of the AYD10 board takes advantage of the large number of TTL inputs provided by the AFI circuit board, which contains more of these TTL inputs than generally required. The AYD10 board, which provides optical isolation for each alarm input, converts the alarm inputs to TTL-comparable signal inputs for RCC backplane delivery via the AFI. When the AYD10 board is used, the alarm inputs are configured for either open-on alarm or close-on alarm through the RCC software.

The Alarm Adapter Interface board AYD10 contains two multi-pin connectors, J1 and J2, and three terminal block connectors, J3, J4, and J5. All connections between the AYD10 board are interfaced through terminal block connectors J3, J4, and J5. Alarm inputs are received through connector J2.

Network Control Interface (NCI) TN168C

The NCI synchronizes control channel messages between the CPU and the distributed network of port circuit packs that are connected to the Time Division Multiplexed (TDM) bus, which is always installed "red stripe up." The NCI interfaces with the CPU through a 512-byte System Dual Port Memory. The NCI has been provided with the “Archangel” functionality. This means that it functions as a full-duplex message switch between the CPU and the microprocessors in the port boards (“Angels”). Besides being the mediator of the CPU, the Archangel monitors the sanity of all the Angels and reports any changes it detects to the CPU. TN168C replaces TN168B which, in turn, replaces TN168.

NOTE:
The High Capacity Processor Unit (HCPU) configuration on the RCC shelf, requires this NCI card to be a TN168C version 2:2 or later.

Communications Processor Interface (CPI) TN167

The CPI board is part of the core processor complex. The CPI is a multiprocessor circuit that provides the data connectivity between the RCC and any of the other terminating entities in the cellular system. The CPI manages two point-to-point programmable, full-duplex, independent data links that implement the X.25 protocol. The number of CPI circuit boards used in each side of the RCC depends on the number of data communication channels required. As stated above, each CPI can accommodate up to two data channels.

8-Megabyte Memory (MEM) Board TN1710

One memory board is used with each side of the RCC. The memory circuit pack has a storage capacity of 8 Mbytes. It contains a 1-Mbyte by 36 Dynamic Random Access memory (DRAM) memory array which includes a 32-bit data array with one parity bit for every eight bits of data. The memory and interrupt control logic-write-protect and parity error latching functions are contained in each circuit pack, which provides independent operation on a per-pack level.

NOTE:
The High Capacity Processor Unit (HCPU) configuration places the 8 Mbyte memory provided by the TN1710 board onto the CPU board. The slot occupied by the TN1710 board is replaced by a TN2245 Bus Interface Board (BIB).

Core Processor Unit (CPU) UN524 or HCPU UN530

Core Processor Unit (CPU) UN524 - One core processor board is used with each side of the RCC. The core processor controls the core processor complex which is made up of the Alarm, Failure Interface board, Network Control Interface (NCI) board, Memory (MEM) board, and the Communications Processor Interface (CPI) board. One CPU is used in each of the two identical sides of the RCC. This arrangement comprises a duplex controller that provides reliability through redundancy. In this arrangement, the CPU in one side (active side) is always in control of the call processing, while the CPU in the other side (the mate) is kept in a dormant state, and its memory is continually being updated. In the event of a component failure in the active side of the RCC, this mode allows an immediate transfer of control from the active CPU to the mate with a minimum loss of control information. On each side of the RCC, the CPU uses the system bus to communicate with the other circuit boards on the same side.

NOTE:
For the High Capacity Processor Unit (HCPU) configuration, the UN524 CPU board is replaced by the UN530 HCPU board, this board contains both the processing and memory functionality.

Digital Service (DS1) TN171

The DS1 card supplies the digital interface for the DS1 (Digital Signal - Level 1) interface facility. This signal interface is bipolar return-to-zero at a 1.544-Mb/s rate. A DS1 signal consists of 24 DS0 (Digital Signal - Level 0) channels. The Cell Site data communication links are capable of operating at 9.6- or 56-kb/s rates. Up to 14 DS1 boards are used in an RFS. TN171has been replaced by TN1713B (below).

Digital Facilities Interface (DFI) TN1713B

The DFI card supplies the digital interface for the Conference of European Postal and Telecommunications (CEPT) facility. This signal interface is high density binary three at a 2.048-Mb/s rate. A CEPT signal consists of 31 digital signal channels. Up to 14 DFI boards are used in an RFS. Dip switches on the DFI card must be set to either 75-Ohm (coaxial cable) or 120-Ohm (twisted pair).

The DS-1/E1 board currently supplied at the factory is the TN1713B, which is a cost reduced TN3500.

The TN3500 has been upgraded to a TN3500B, which is backwards compatible with the TN3500, and can be used for CDMA applications.

Series II Cell Site Radio Channel Unit Shelves ED-2R833-30

One dual-height Radio Channel Unit (RCU) is used on the Primary Radio Channel Frame (P-RCF). It consists of two RCU shelves sharing a common backplane. The units contained on each shelf are listed and described below.

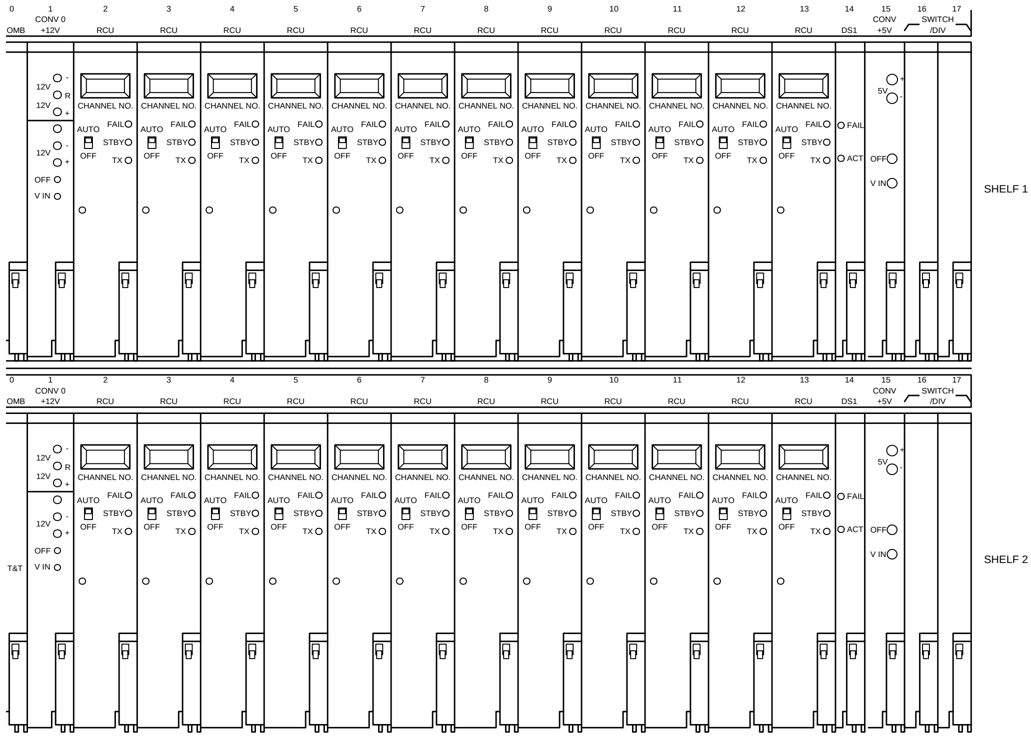


Figure 8-4. Radio Channel Unit - Shelf 1, Shelf 2 ED-2R833-30 (Figure 1 of 2)

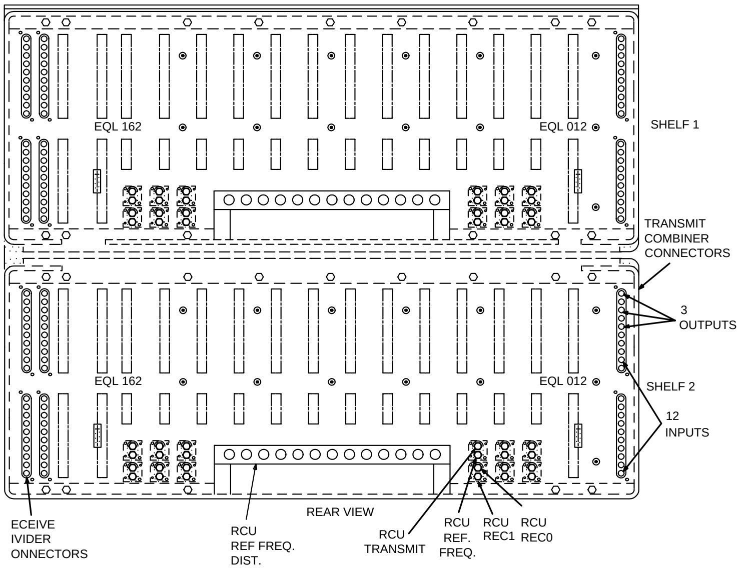


Figure 8-5. Radio Channel Unit (Rear View) - Shelf 1, Shelf 2 ED-2R833-30 (Figure 2 of 2)

Transmit Combiner BBN-2

One of these units is used to combine the transmit Radio Frequency (RF) outputs of 12 RCUs into 3 groups of 4 RCUs. Each group has a common RF output cable.

Receive Divider BBN-1

One of these units is used to divide the Receive RF input into 3 groups of 4 RCUs. Each group has a common RF input cable.

Receive Switch BBM-1

One of these units is used to allow the RCU to switch it's receive input to any of the Receive Antenna systems at the Cell Site.

Clock and Tone (CAT) Board TN170

One CAT board is located on shelf 1 and another CAT board is located on shelf 2. This board provides the clock signals necessary for the transfer of data on the Time Division Multiplexed (TDM) bus, which is always installed "red stripe up." Tones generated by this board are used during testing. Two CAT boards are used on the P-RCF. The TN170B is a valid replacement for this board.

Power Converter 419AE (+12V)

One +24-volt to +12-volt power converter is used on this shelf.

Radio Channel Unit ED-2R836-30

Twelve RCUs are used on a shelf. The RCU contains baseband signal processing circuits and a transceiver. The RCU can be used for setup, locate, or voice channel service. Control outputs are provided from the RCU to dynamically switch received inputs.

Digital Radio Unit ED-2R920-30

The DRU is the digital radio used with the Time-Division Multiple Access (TDMA) system. The DRU occupies 2 slots on a shelf. Given that the DRU occupies 2 slots, the number of DRUs that can be housed in the P-RCF is half the number of RCUs, which is 28 DRUs. For the 2 Growth RCFs, the number of DRUs that can be housed is also half the number of RCUs, that is, 36 DRUs apiece. Altogether, an RFS fully-configured with DRUs can house 99 DRUs, including voice and locate radios. Call setup is done by the DCCH with no setup radios required.

Enhanced Digital Radio Unit 44WR8

The EDRU is an enhanced version of the DRU that is fully backward compatible with the DRU. Like the RCU, the EDRU occupies 1 slot on a shelf. Two EDRUs can be installed for every DRU. Due to software limitations, the maximum number of EDRUs supported is 23 EDRUS per RCF0, 40 EDRUs per RFC1, and 16 EDRUs per RCF2. The total number of EDRUs per cell should not exceed 79.

Radio Shelf Power Upgrade

The radio shelf power delivery system may require upgrading as a function of the number of DRUs and EDRUs installed.

Installing the TRTU and DRU(s)

This section provides installation instructions for the TRTU and DRU(s). Diagnostic testing should be performed on each installed modular component (TRTU and DRU). Although a cell may be populated with both DRUs and EDRUs, it may not house both a TRTU and a T-EDRU. That is, a cell can have either a TRTU or a T-EDRU installed, but not both.

The diagnostic test for the TRTU should be run before testing the DRU(s). The diagnostic test for the DRU(s) may be run separately after each component is installed, or collectively after a group of components are installed.

In Series II Classic cells, insert the TRTU (ED 2R921-30) into RCF 0, Shelf 3 (EQL 132), Slots 11 and 12. In Series IIm and Series IImm cells, insert TRTU in slot 22 of radio shelf in primary cabinet.

Insert the DRU(s) (ED 2R920-30) into the RCF slots. Each DRU uses two shelf slots. Lucent Technologies recommends installing these radios in even numbered shelf slots only (i.e., positioned in slots 2-3, 4-5, 6-7, etc.).

Verify that the RCF penthouse is wired correctly for each DRU installed.

Installing the T-EDRU and EDRU(s)

This section provides installation instructions for the T-EDRU and EDRU(s). Diagnostic testing should be performed on each installed modular component (T-EDRU and EDRU). Although a cell may be populated with both DRUs and EDRUs, it may not house both a TRTU and a T-EDRU. That is, a cell can have either a TRTU or a T-EDRU installed, but not both.

Installing a Test EDRU (T-EDRU)

To replace a TRTU with a T-EDRU:

1. The TRTU is removed from service
2. The TRTU is physically replaced with the T-EDRU
3. The T-EDRU personality is dowloaded into the T-EDRU

Placed the T-EDRU in the left hand slot of the two slots occupied by the TRTU. The test radio output must be +4dBm, but the T-EDRU's unadjusted output power is +10 dBm. A front panel adjustment can vary the output power by +3 to –4 dB. To accommodate this difference, the cell software automatically lowers the T-EDRU output power by one VRAL step for a difference of -4dB. This changes the T-EDRU output to +6dBm. Then, manually calibrate the output level to +4 dBm. This calibration must be performed any time a T-EDRU is placed into service.

CAUTION:
Any time a T-EDRU is installed or replaced for any reason, the power setting procedures in this section must be performed BEFORE allowing the T-EDRU to perform diagnostics.

The following procedure is performed at the cell site to replace a TRTU or a defective T-EDRU with a T-EDRU. The cell site technician should be equipped with a PC and a dial-in connection to the OMP. If a PC dial-in connection to the OMP is not available, the cell site technician should be in verbal contact with an operator at the MSC who can enter and read commands and messages to and from the OMP.

To remove a TRTU or a defective T-EDRU, perform the following:

1. Remove the TRTU or the defective T-EDRU from service by entering the following command at the OMP:

rmv:cell *a*, trtu;ucl <Enter>

Where *a* is the cell number. The ECP responds with:

IP all specified cell ACT

M 30 RMV:CELL *a* TRTU, COMPLETED
DEVICE - tty+

MM/DD/YY HH:MM:SS #*nnnnnn*

*30 OP:CELL *a* TRTU, MANUAL, RMVD
DEVICE - tty+

MM/DD/YY HH:MM:SS #*nnnnnn*

2. Remove the TRTU or the defective T-EDRU from radio shelf slot 11 and insert the new EDRU in its place. In Series II Classic cells, insert the T-EDRU (44WR8) into RCF 0, Shelf 3 (EQL 132), Slot 11. In Series IIm and Series IImm cells, insert the T-EDRU in slot 22 of the radio shelf in the primary cabinet.
3. On the ceqcom2 RC/V form, verify that T-EDRU equipage is as follows:
   - TDMA RTU -Status (Indicating that the primary cabinet is equipped with a T-EDRU radio). Set to e
   - TDMA RTU- Slot (Indicating radio shelf slot location). Set to either 11 or 12 (11 Recommended)
   - TDMA RTU - DVCC (Specifies digital verification code of cell). Generally cell number is use except for 3, 45, 136, and 162.
   - Radio type edru
4. Download new generic software for T-EDRU by entering the following at the OMP:

dnld:cell a trtu <Enter>

ECP responds with:

PF

A 34 REPT:CELL a NVM UPDATE MAIN CONTROLLER COM-PLETED

UNIT SUCCESSFULLY UPDATE TRTU

DEVICE - tty+

MM/DD/YY HH:MM:SS #*nnnnnn*

5. Diagnose the T-EDRU to ensure that it is working properly by entering the following at the OMP:

   dgn:cell a, trtu <Enter>

   ECP responds with:

   IP all specified cell ACT
   ALL TESTS PASSED

6. On the T-EDRU's front panel, set the TX switch to OFF.
7. Enter the follow configuration commands at the OMP:

   - **cfr:cell *a*, trtu;start <Enter>**

   ECP responds with:

   IP all specified cell ACT

   M 30 CFR:CELL *a* TRTU, ALL WENT WELL
   DEVICE - tty+

   - **cfr:cell *a*, trtu;config 150:chanl e <Enter>**

   Note:
   Channel number must be specified to configure T-EDRU

ECP responds with:

IP all specified cell ACT

M 30 CFR:CELL *a* TRTU, ALL WENT WELL
DEVICE -tty+

- **cfr:cell *a*, trtu;xmit 300 <Enter>**

ECP responds with:

IP all specified cell ACT

M 30 CFR:CELL *a* TRTU, ALL WENT WELL
DEVICE -tty+

8. Set up and calibrate power meter to measure power in the 4 dBm range.
9.
10. The cable that carries the T-EDRU transmitter input is located at the front panel of the RTU Switch Panel where the test radio gains access to the transmit and receive paths. Disconnect that cable. The jack designation for a Series II classic cell is J1. Using the appropriate adapter, connect the power meter sensor to the cable.
11.
12. Estimate the length of cable, in feet, from the back of the T-EDRU to the point where the power meter is connected to the cable. Multiply that cable length in feet by 0.25 dB to compensate for cable loss. Subtract the resulting quantity from +4dBm. This is what the power meter should read when the T-EDRU power is adjusted in step 12, below. For example, the cable length for a PCS TDMA Minicell is approximately 2 feet, so the estimated cable loss is 0.5 dB, and the measured output at the power meter should be +4 dBm – 0.5 dB = +3.5 dBm.
13. Set TX switch on T-EDRU front panel to AUTO. TX green LED should light.
14. Using potentiometer on T-EDRU front panel, adjust radio transmit output power to the power level determined in step 10.
15. Set TX switch on T-EDRU front panel to OFF. TX green LED should go off.
16. Remove the power meter from the cable and reconnect the switch panel cable.
17. To turn off the configuration command, enter the following on the OMP :

- **stop:cfr;cell *a*, trtu <Enter>**

ECP responds with:

IP all specified cell ACT

M 35 CFR:CELL *a* ABORTED, OVERRIDE HIGHER
PRIORITY
DEVICE - tty+
MM/DD/YY HH:MM:SS #*nnnnnn*

18. Set TX switch on T-EDRU front panel to AUTO. TX green LED should light.
19. Restore T-EDRU to operational status by entering either command on the OMP:

init:cell a:sc <Enter> OR rst:cell a, trtu;ucl <Enter>

20. Restore T-EDRU to service by entering the following at the OMP:

rst:cell *a*, trtu;ucl <Enter> (*to restore the test radio*)

OR

init:cell a:sc <Enter> (*to restore all radios*)

The diagnostic test for the T-EDRU should be run before testing the EDRU(s). The diagnostic test for the EDRU(s) may be run separately after each component is installed, or collectively after a group of components are installed.

Installing EDRUs

Insert EDRU(s) into the slots of the RCF(s) or of the radio shelf in the Series IIm/IImm cabinet. When installing in the Series IIm/IImm cabinet, EDRUs (44WR8) require two shelf slots. Lucent Technologies recommends equipping these radios in even numbered shelf slots only (i.e., positioned in slots 2-3, 4-5, 6-7, etc.).

If five or more EDRUs are to be installed in a radio shelf or a single RCU shelf, verify that shelf power supply system is upgraded. Power upgrade required for installing EDRUs is a function of the number of EDRUs to be installed, and the cabinet type in which the EDRUs are installed.

Power to the radio shelf is supplied by +5-volt and +12-volt power converter units (PCUs). If five or more EDRUs are to be installed in a radio shelf or on a single RCU shelf, verify that shelf power supply system is upgraded. The power upgrade is done by replacing +5-volt and +12-volt PCUs and their corresponding circuit breakers with PCUs and with circuit breakers having a higher current capacity.

Verify that the RCF penthouse is wired correctly for each EDRU installed.

Series II Classic Radio Frame

Two Series II classic radio frames are supported; Series II-01 (J-41660A-1) and Series II-02 (J-41660A-2). Regardless of the cabinet type and the number of EDRUs to be installed, the +5-volt PCU 415AA should be replaced with +5-volt PCU 430AB.

The two primary difference in the radio shelf power supply system between the two frame types are the current capacity of the 5-volt circuit breaker and the +12-volt PCU.

When to Replace +5V CONV Circuit Breaker

The +5-volt (+5V CONV) circuit breaker in the Series II-01 frame is rated at 12.5A and will permit the operation of up to eight EDRUs and two analog RCU. If nine or more EDRUs are to be installed, replace the +5V CONV circuit breaker with a 25A circuit beaker.

The +5V CONV circuit breaker in the Series II-02 frame is rated at 15A and will permit the operation of up to nine EDRUs. If ten or more EDRUs are to be installed, replace the +5V CONV circuit breaker with a 25A circuit beaker.

When to Replace +12-Volt PCU

The +12-volt PCU (419AA), installed in the Series II-01 (J-41660A-1) frame, permits the operation of up to eight EDRUs and two analog RCU. If nine or more EDRUs are to be installed, replace 12-volt PCU (419AA) with PCU (419AE).

The 12-volt PCU (419AC), installed in the Series II-02 (J-41660A-2) frame, permits the operation of up to eight EDRUs. If nine or more EDRUs are to be installed, replace 12-volt PCU 419AC with PCU 419AE.

Power Converter Unit and Circuit Breaker Replacement

Replacement of the +5-volt PCU and associated circuit breaker on J41660A-1 and J41660B-1 bays are required for each radio shelf when four or more DRUs or up to eight EDRUs are to be installed on the shelf. .If a power supply upgrade is not necessary, proceed to the next section.

To replace +5 volt circuit breaker on RCF ED-2R826-31 Circuit Breaker Panel (bottom of bay), perform the following:

1. On power distribution bay, set all circuit breakers assigned to the RCF 0, 1, and 2 (as equipped) to OFF.

2. Set all circuit breakers on RCF circuit breaker panel to ON. Wait 30 seconds for any residual charge in RCF capacitor panel to discharge, then set breakers to OFF.
3. Remove four machine screws from front four corners of circuit breaker panel and remove top cover. It may be necessary to clip (remove) cable ties that secure power wires in order to provide additional installation space.
4. Remove two machine screws from shelf +5V CONV circuit breaker for shelf being modified.
5. Remove circuit breaker from panel. Remove two 5/16 nuts from circuit breaker power terminals and disconnect power wires.
6. Install new 15A circuit breaker, for DRU/EDRU installation.
7. Ensure that circuit breaker is oriented correctly, and that line and load power wiring is correctly replaced on circuit breaker.
8. Ensure that circuit breaker power terminal nuts are adequately torqued.
9. Using an 1/8-inch stamp and white ink, stamp “15A” on the front and side (90 degrees) of the replacement breaker.
10. Replace all required circuit breakers on panel being modified.
11. Reinstall top cover on panel; reinstall circuit breaker panel in RCF.
12. Ensure that power wiring is not kinked or pinched when sliding panel back into RCF.
13. Secure panel using four machine screws.
14. Re-install cable ties that were previously removed.
15. Repeat this procedure on all RCF bays as required.

Replace Shelf Designation Labels (Customer Option)

1. Replace two shelf designation strips per shelf to include TDMA circuit packs:
   - Front label on shelf designation bar identifies circuit pack nomenclature and slot numbering.
   - Back label on shelf designation bar identifies circuit pack locations and associated ED number.
2. Attach new shelf designation labels directly over original labels on RTU Shelf 3 (RCF 0) and all RCU shelves in the cell under test as follows:
   - RCF 0 Shelf 0 (RCC shelf)
     - FRONT No Change
     - BACK No Change
   - RCF 0 Shelf 1, 2 and RCF 1 Shelf 4, 5 (CAT shelf)

  - — FRONT C846908291
  - — BACK C846908309
- RCF 0 Shelf 3 (RTU shelf)
  - — FRONT C846909489
  - — BACK C846909497
- All other RCU shelves
  - — FRONT C846908069
  - — BACK C846932978

Series II Cell Site Fan Panel Assembly ED-2R824-31

The fan panel assembly contains six variable-speed cooling fans that operate from +24 volts. Three fans are mounted facing the front and three are mounted facing the rear. Each fan has an over-heat alarm circuit.

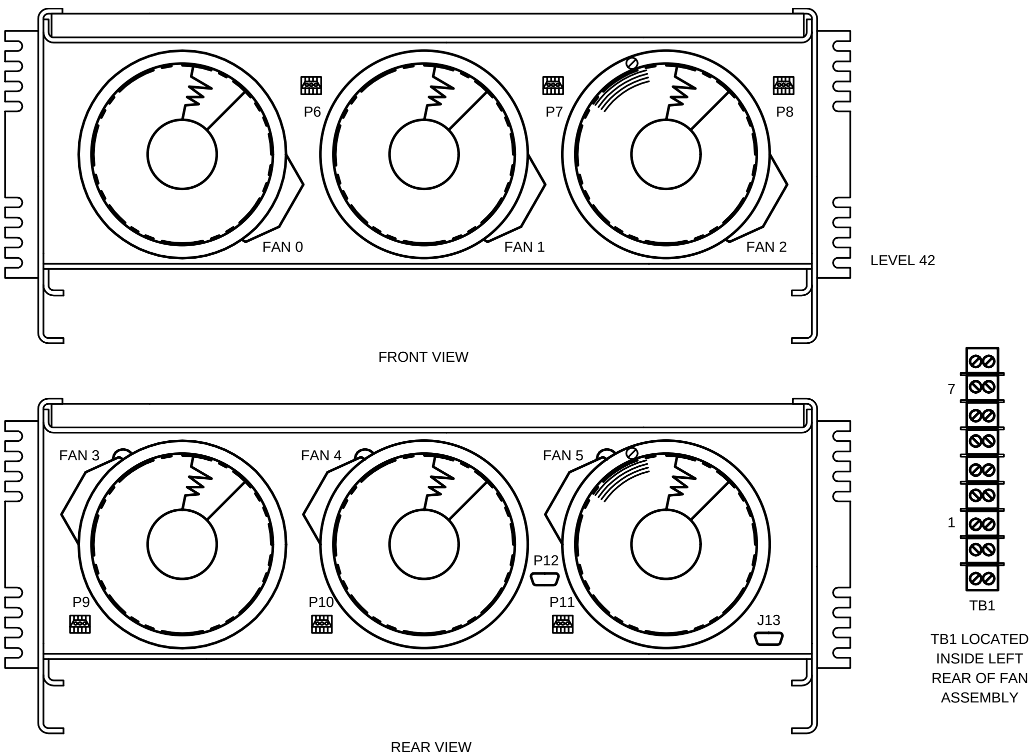


Figure 8-6. Fan Panel Assembly ED-2R824-31

Series II Cell Site Radio Test Unit Shelf 3 ED-2R835-30

One Radio Test Unit (RTU) is used (see Figure 8-7). This shelf differs from the ED-2R833-30 shelf in that it has eight Radio Channel Units (RCUs) in place of 12. It also has a DS1 (Digital Signal - Level 1) or Digital Facilities Interface (DFI) board in place of the Clock And Tone (CAT) board, and it has one RTU. The RTU is described below.

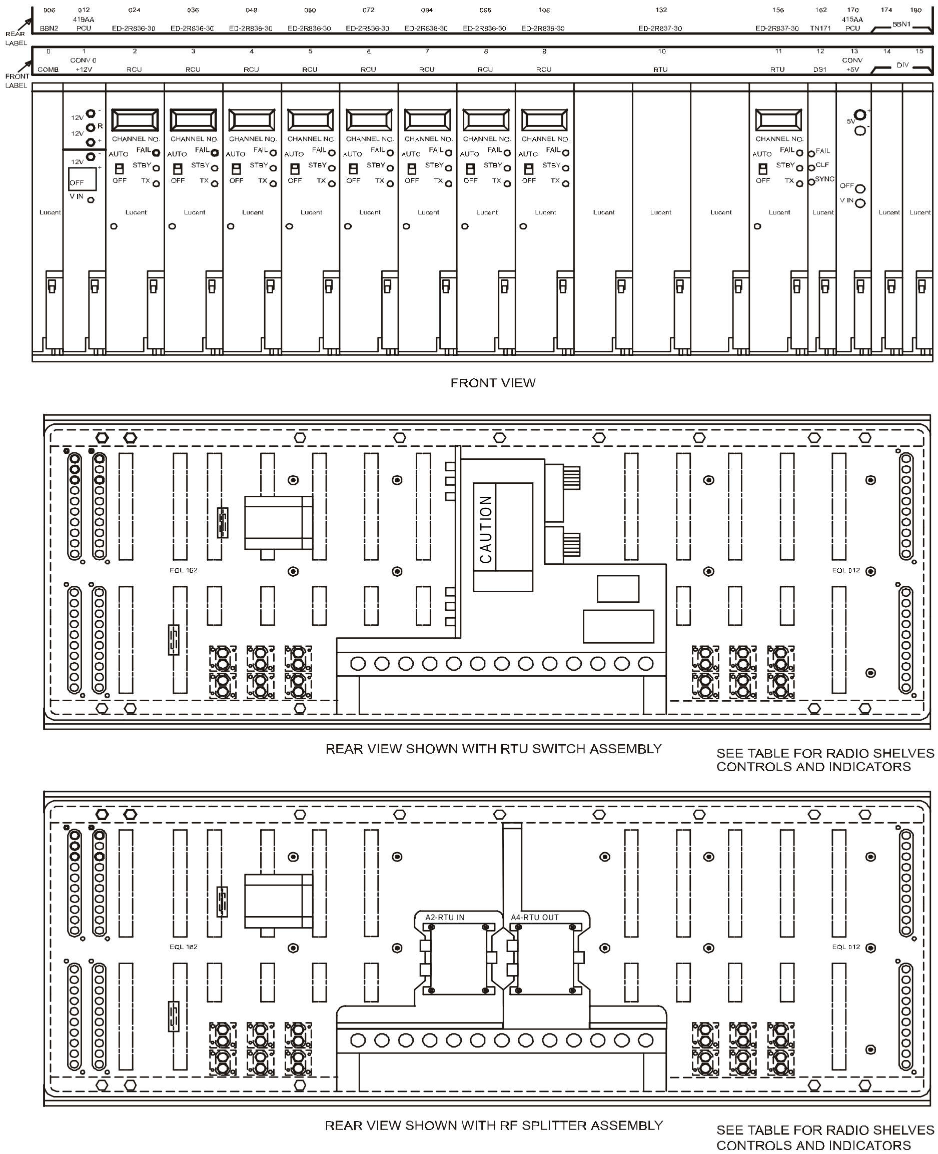


Figure 8-7. Radio Test Unit (RTU) - Shelf 3 ED-2R835-30

Radio Test Unit ED-2R837-30

The RTU is a transmitter and receiver used to test the Cell Site RCU transmit and receive paths. The RTU works with the RTU switch located in the Antenna Interface Frame (AIF). The RTU transmits on the mobile transmit frequencies and receives on the Cell Site transmit frequencies.

TDMA Radio Test Unit ED-2R921-30

The TDMA Radio Test Unit is used to test Digital Radio Units.

Series II Cell Site Radio Channel Unit Shelves 4 and 5 ED-2R834-30

Two of these shelves are used. Each shelf (see Figure 8-8) has 12 Radio Channel Units (RCUs) and has a DS1 (Digital Signal - Level 1) or Digital Facilities Interface (DFI) card in place of the Clock And Tone (CAT) board (EQL 162)..

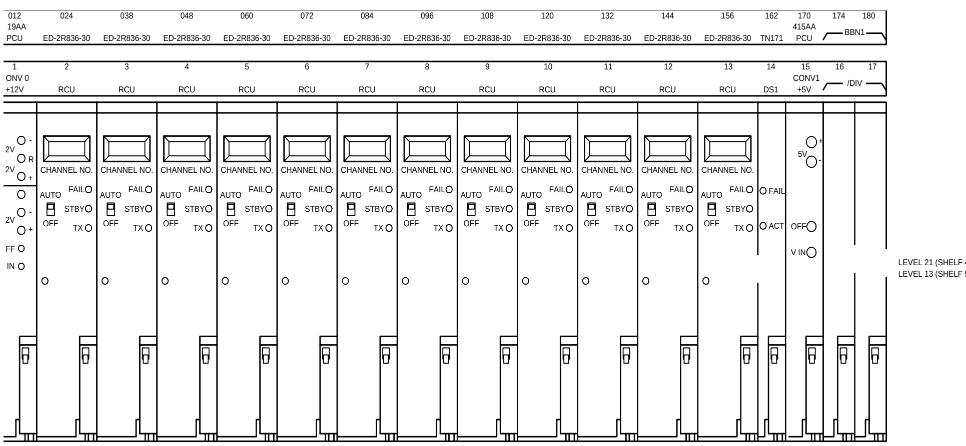


Figure 8-8. Radio Channel Unit - Shelf 4, Shelf 5 ED-2R834-30

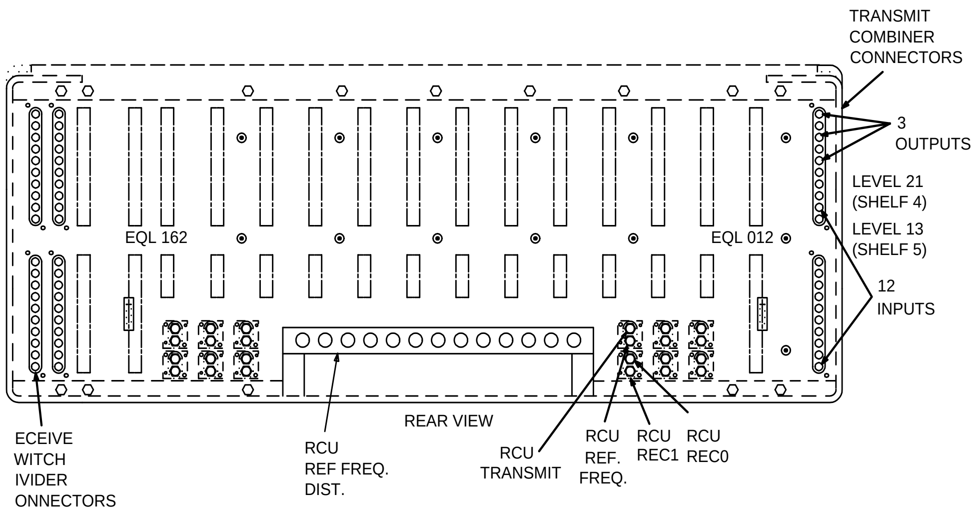


Figure 8-9. Radio Channel Unit (Rear View) - Shelf 4, Shelf 5 ED-2R834-30

Series II Cell Site Interconnection Panel Assembly ED-2R831-30

The G1 interconnection panel assembly provides the coax-connector interface to and from the Primary Radio Channel Frame (P-RCF). The G2 interconnection panel assembly (see Figure 8-11) provides the coax-connector interface to and from the growth RCFs. These interfaces include the following:

- The transmit and receive Radio Frequency (RF) signals to and from the Antenna Interface Frame (AIF) and the Linear Amplifier Frame (LAF)
- The 15-MHz reference frequency input from the AIF
- Test radio RF to and from the AIF

In addition to the above interfaces, the interconnection panel assembly contains up to 21 RF power dividers used to combine transmitter outputs and to divide and distribute receive RF to the Radio Channel Units (RCUs). Also, the interconnection panel assembly contains one power divider used to distribute the 15-MHz reference frequency used by the RCUs.

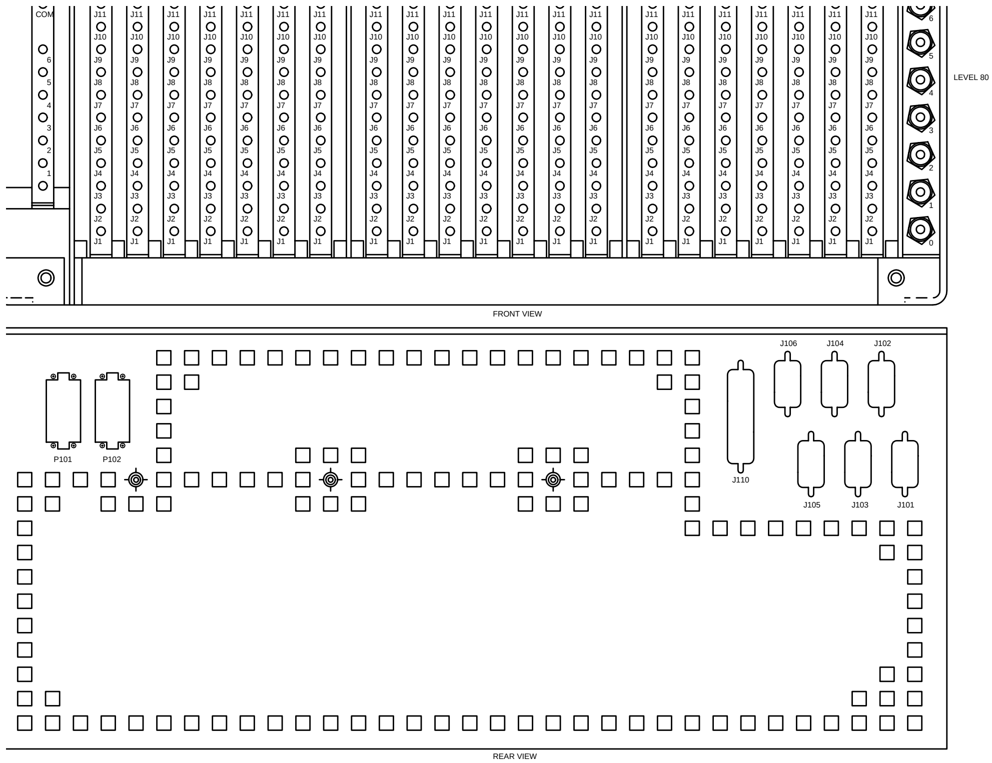


Figure 8-10. Interconnection Panel ED-2R831-30

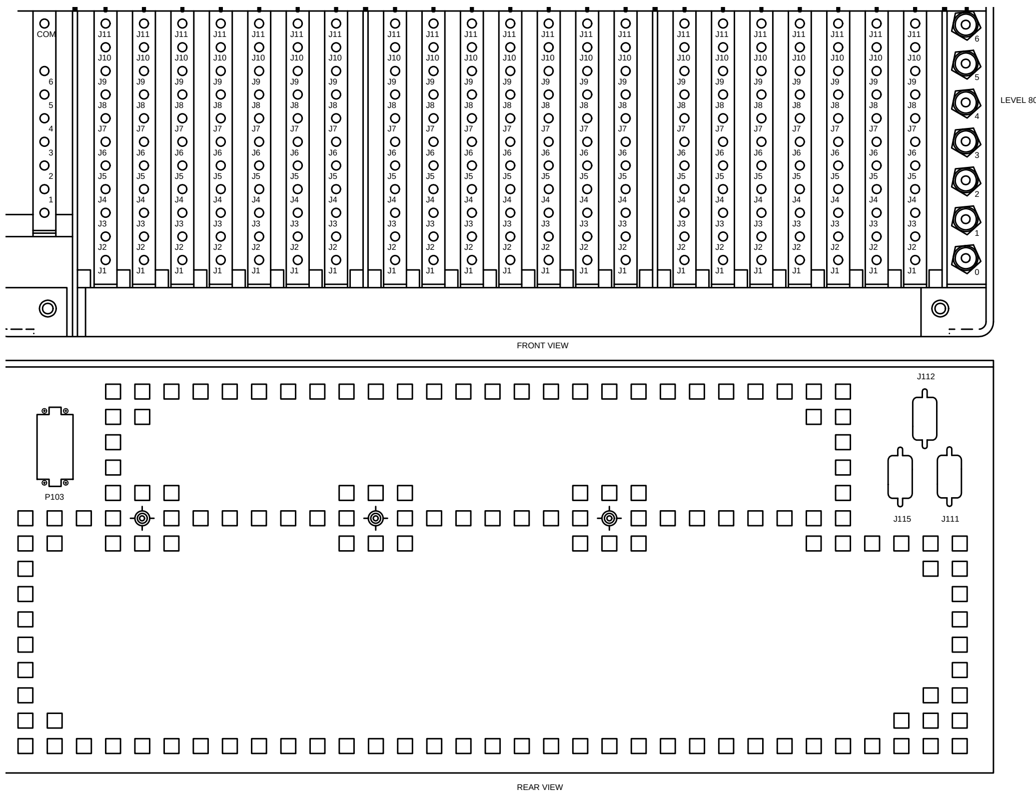


Figure 8-11. Interconnection Panel ED-2R831-30

The tables that follow identify the Interconnection Panel connectors.

Table 8-4. Radio Channel Frame Interconnection Panel (ED-2R831-30) Connector Identification

Jack (Plug)	Conn Type	Function
REF	TNC	15 MHz Reference Input
SET UP 0†	N	Set Up Antenna (for future use)
RTU IN†	N	Radio Test Unit Input
RTU OUT†	N	Radio Test Unit Output
TRANSMIT ANTENNA OUTPUTS		
0	N	Tx Antenna 0