WMS Data RF-Conductor!™ Controller Product Description

This document contains:

Introduction to Motorola's WMS Data RF-Conductor! Controller

The WMS Data RF-Conductor! controller (WMS Data RF-C!) is Motorola's advanced technology solution for a high-speed, high-capacity paging system controller. The WMS Data RF-C! allows the use of the SuperStream^{TM} outbound link protocol—the most efficient paging data link available anywhere in the world—and offers the flexibility and features that make it ideal for data-intensive paging system applications

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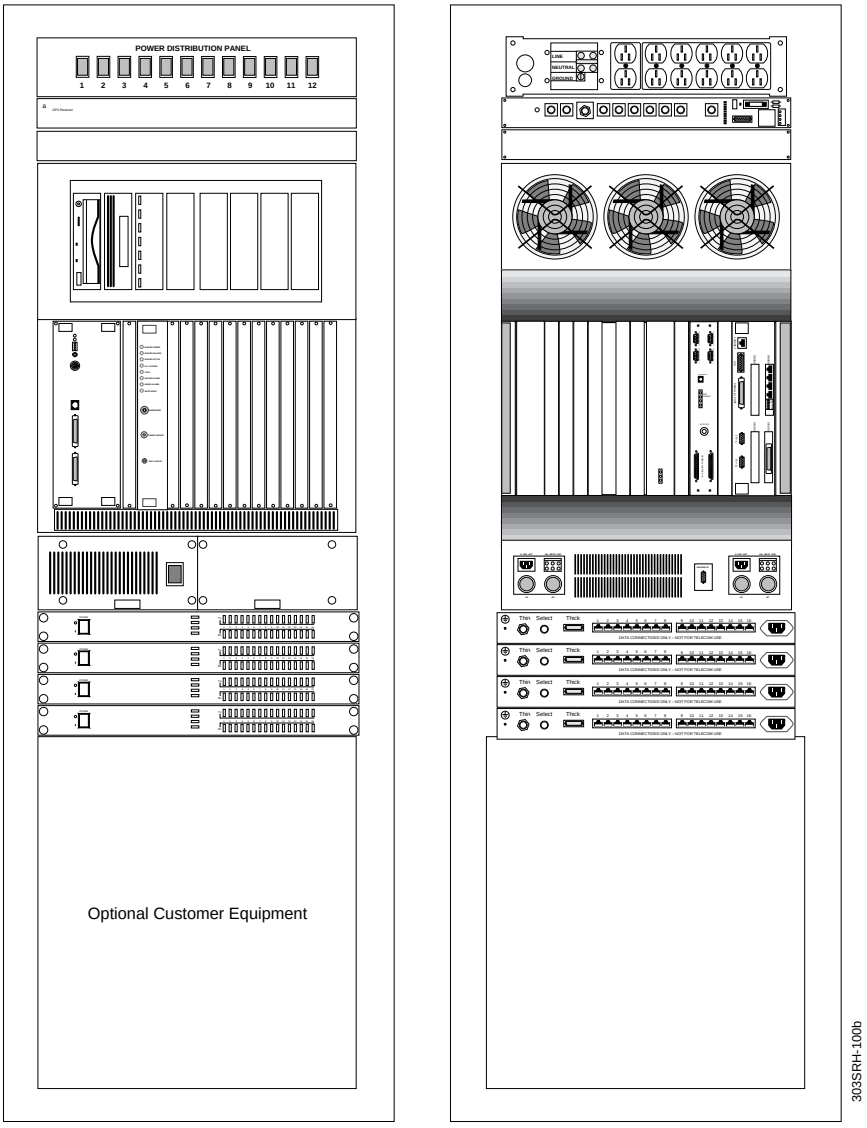

Front View Rear View

Figure 1: WMS Data RF-Conductor! Controller

Using WMS Data RF-C! with Existing Infrastructure

The WMS Data RF-C! controller can be added to an existing paging system in a way that maximizes the value of existing infrastructure assets. Figure 2 shows a paging system in which an existing C-NET Controller has been replaced with the WMS Data RF-C!. When added in this way, the WMS Data RF-C! works with existing switches and transmitters without requiring additional components. (If not already equipped with dual-flash memory, the Nucleus transmitters will need to be upgraded.)

Notice that it is not necessary to upgrade the entire paging system at one time. The new controller can work in parallel with older generation controllers. When additional capacity is needed, more WMS Data RF-C! controllers can be brought on-line.

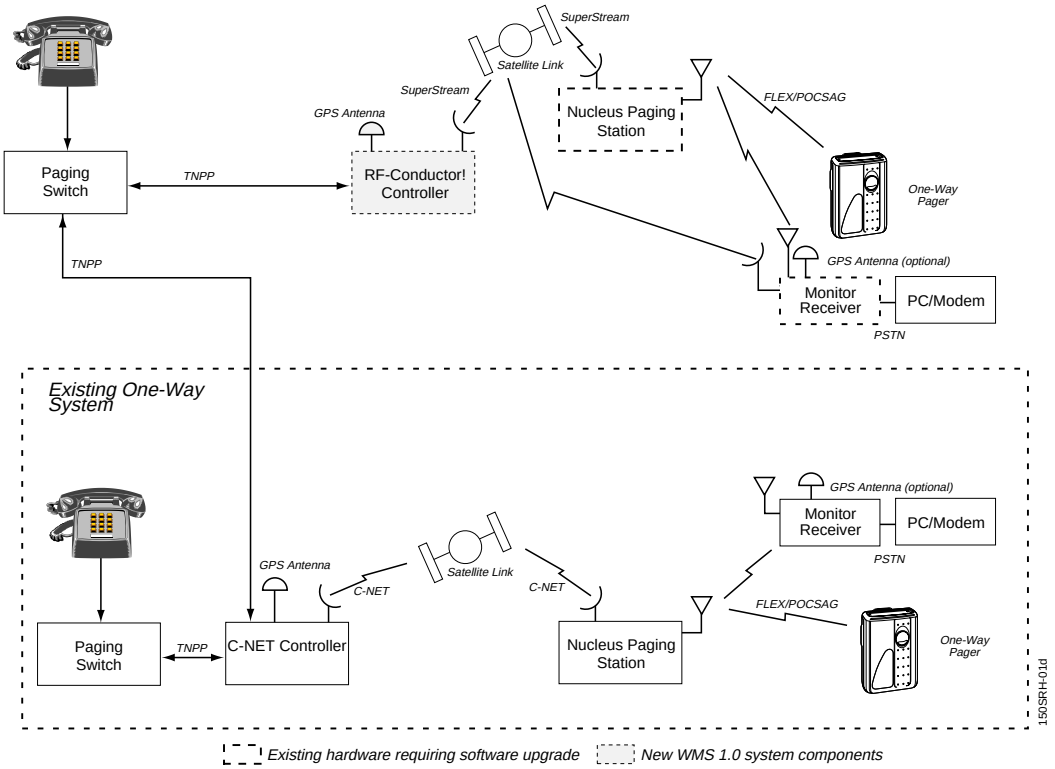

Figure 2: Example of a Paging System with RFC! WMS Data 1.0 Upgrade

Features

The following paragraphs summarize the functional characteristics of the WMS Data RF-C!.

SuperStream

The WMS Data RF-C! supports Motorola's SuperStream outbound link protocol. The SuperStream protocol is a synchronous protocol with a maximum transmission rate of 76 kbps–the highest available anywhere for paging applications.

The SuperStream protocol, like the C-NET protocol, utilizes two unique messaging formats known as Infrastructure Command Messages (ICMs) and Page Data Messages (PDMs). ICMs are general-purpose infrastructure commands that have been adapted for transmission using SuperStream. They are transmitted as stream messages from the control point and are identified and processed sequentially as they arrive at the Network Interface Unit(NIU). ICMs control paging parameters such as data polarity, unit reset, alarm clearing, and maintenance group parameters. PDMs represent the actual paging data or paging payload meant for transmission over the RF messaging channel. A PDM carries all the data needed for a single, continuous transmission on the messaging channel. A PDM contains messaging data, but can also contain other types of transmissions such as station ID broadcasts.

The main efficiency advantage of the SuperStream protocol, in comparison to the C-NET protocol, lies in the ability of the SuperStream protocol to take advantage of the redundant information already present in the paging data, such as the Forward Error Correction (FEC) bits contained in the FLEX and POCSAG code words. In addition, the SuperStream protocol utilizes a bandwidth efficiency concept known as distributed (site) encoding, in which the FLEX and POCSAG protocol synchronization is encoded at the NIU location with the paging transmitter.

Simulcast Systems

The WMS Data RF-C! controller using the SuperStream protocol simultaneously supports up to 120 simulcast systems.

Time-Slotted Super Systems and Dynamic Scheduling

A dynamic encoder capable of scheduling both POCSAG and FLEX is supported in the WMS Data RFC! controller. Each NIU can support up to nine systems of time slotted data in a super or conflicting system configuration.

A few examples of how the super stem feature can be used are shown in Figures 3, 4, and 5. Super Systems are especially useful to carriers that want to offer tiered "local" and "extended" geographical coverage.

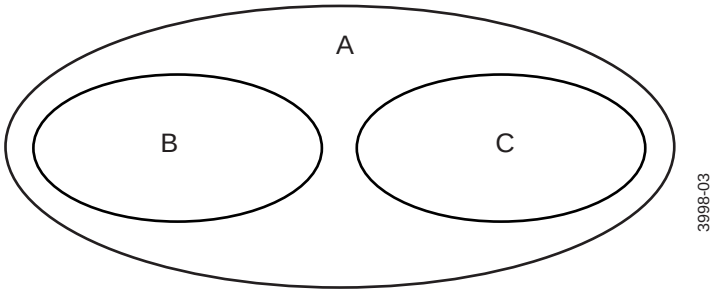

Figure 3: Basic Super System

Figure 3 is a representation of a basic super system. Coverage is provided by three systems, A (which includes B and C), B, and C. Systems B and C are isolated in terms of RF energy. Because the WMS Data RF-C! supports super systems, two different pages can be transmitted by systems B and C at the same time. This has the effect of increasing throughput.

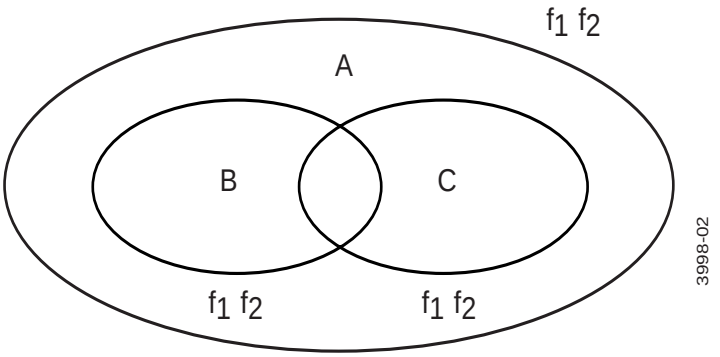

Figure 4: Multi-frequency Conflicting System

In Figure 4, we have an example of a multi-frequency conflicting system. Transmitters in each zone in this example transmit on two frequencies, f_1 and f_2. The WMS Data RF-C! avoids interference in the area where zones B and C intersect by treating A, B, and C as separate systems and using time-slotting to ensure RF transmissions to B and C occur at separate times. Within the time slots for zones A, B, and C, scheduling of f_1 and f_2 transmissions occurs dynamically.

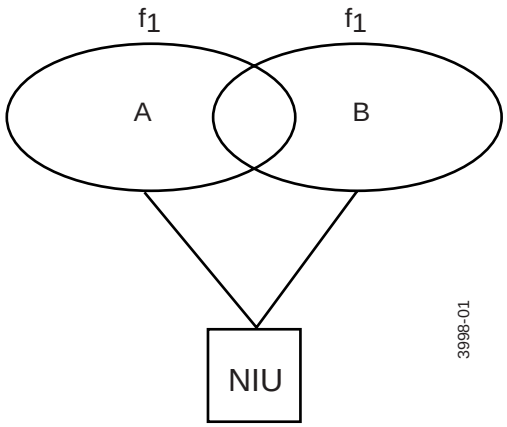

Figure 5: Figure 5 Two Transmitters Controlled By The Same NIU

Figure 5 shows two single-transmitter zones that are controlled by the same NIU. Here, the solution is to make A and B zones of a single system. The WMS Data RF-C! schedule transmissions to A and B dynamically, based on traffic load.

System Synchronization

The WMS Data RF-C! supports both direct synchronization and GPS synchronization as described below:

Direct Synchronization

Direct synchronization is a method of synchronizing transmitters to each other in a simulcast system by sending timing information through the SuperStream data stream. Monitor receivers receive the synchronization data also. All information needed to perform the synchronization is embedded in the outgoing SuperStream data stream. Since the Superstream data stream is a synchronous data stream, the physical distribution scheme must have a constant known delay.

GPS Synchronization

In a GPS synchronized system, all SuperStream transmitters and SuperStream monitor receivers receive their synchronization pulse frequency, pulse phase, and pulse number from signals received from the GPS receiver.

Paging Protocols

The WMS Data RF-C! supports:

- POCSAG—512, 1200, and 2400 bus Bps
- FLEX—1600 2-level, 3200 2-level, 3200 4-level, and 6400 4-level

Messaging Channels

The WMS Data RF-C! supports up to eight messaging channels (or frequencies) per simulcast system.

Transmitters

The RF-C! WMS-Data supports the Nucleus 928–941 MHz transmitter for both the 100-W and 300-W versions. RF-C! WMS-Data also supports an external (generic) NIU interface for the Glenayre® GL 8000 series transmitter (GL8500 and GL8600).

Monitor Receiver Configuration

The RF-C! WMS-Data supports an interface to the Nucleus transmitter internal diagnostic monitor receiver and also supports an interface to external SpectraTac and Micor monitor receivers.

VT100 User Interface

The RF-C! WMS-Data makes use of a VT100 user interface for loading system configuration data, viewing maintenance data, and viewing statistics.

Redundancy Option

The WMS Data RF-C! is available in an optional configuration in which all major systems are duplicated, thus ensuring that in the event of a failure operation can continue without loss of pages. Switchover to the redundant system is controlled by a Universal Redundancy Switch (URS).

Maintenance Groups

The WMS Data RF-C! supports up to 64 maintenance groups.

Remote Software Downloading to Station Control Module and Network Interface Unit

The WMS Data RF-C! supports remote software downloading to system Network Interface Units (NIUs) and Station Control Modules (SCMs). This feature makes is possible to load software changes without visiting transmitter sites.

FLEX Fragmentation

The FLEX fragmentation feature allows subscribers to receive long messages more quickly. In a typical application, a pager is set to receive one FLEX Frame every four minutes. With FLEX fragmentation, if the amount of data being sent exceeds the amount that can be sent in one frame, the protocol is overridden and the pager receives additional FLEX frames.

TNPP v3.6 Inputs From the Terminal

WMS-Data RF-C! supports TNPP v3.6 packets from the paging terminal.

System Overview

The WMS Data RF-C! controller is a high-speed, high-capacity paging system controller. It includes a SPARC® 10 microcomputer that provides local control across a standard VME bus.

Software control for the RF-C! controller is provided by the UNIX® V-compatible Solaris™ operating system.

The WMS Data RF-C! components mount in an industry-standard, 19-inch chassis with two VME-compatible backplanes and eight additional slots for vertically-mounted peripheral devices (see Figure 6 and Figure 7).

The WMS Data RF-C! controller (nonredundant model) contains:

- A lightweight, aluminum chassis comprised of two internal VME backplanes that provide a 10-slot, slide-mount enclosure.
- A 125-MHz SPARC 10 microprocessor
- Four synchronous outputs, each capable of 76.8 kbps, that use the SuperStream™ protocol
- A 2.1-GB internal SCSI hard disk drive
- A 4-GB digital audio tape (DAT) drive
- A quad-spin CD-ROM drive
- From one to four terminal servers
- A GPS receiver
- An SSC Board
- An I/OT Board
- An SBus Carrier Board
- A Power Supply
- A Fan Assembly

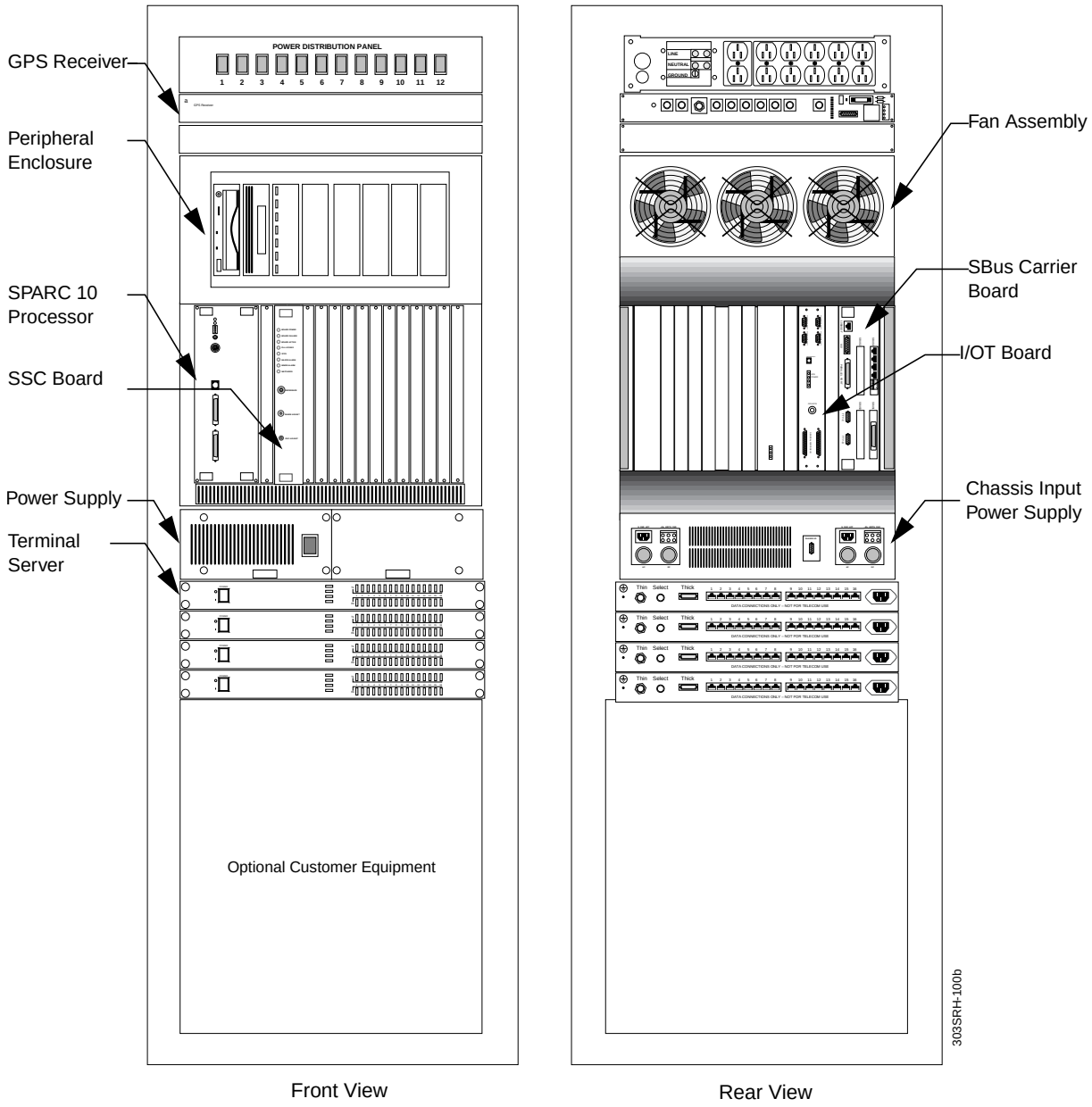

Figure 6: Nonredundant RF-C! Controller

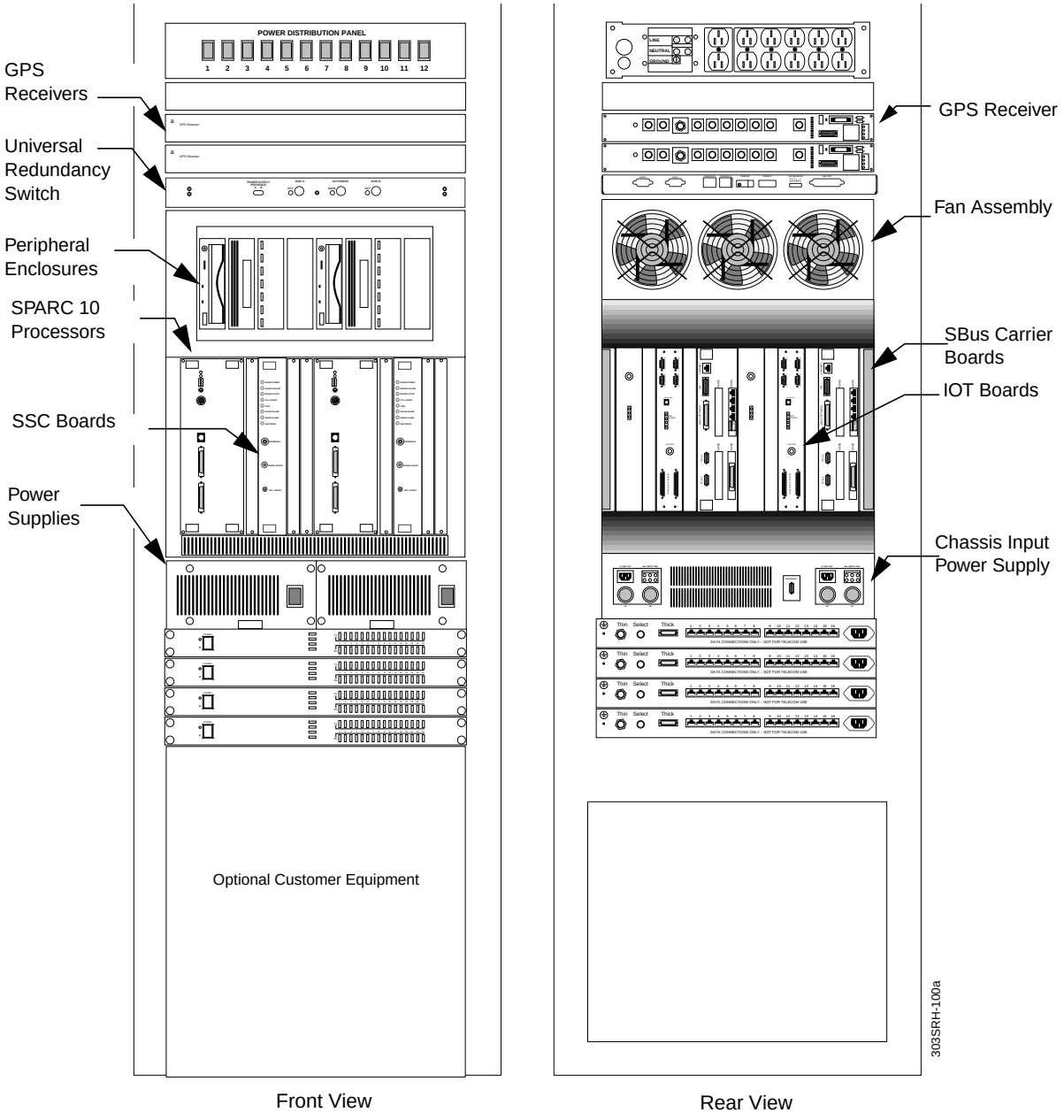

Figure 7: Redundant RF-C! Controller

Specifications

This section describes the mechanical, electrical, and environmental specifications for the WMS Data RF-C! controller. (Data provided is for redundant configuration)

Table 1: Internal Physical Specifications

Item	Description
Physical dimensions	Height: 26.25 in. (66.68 cm) Width: 19 in. (48.26 cm) Depth: 20.5 in. (52.07 cm)
Total weight (fully loaded)	105 lb (47.63 kg)
Mounting	Standard 19-in. chassis with flanges
Power supply	A plug-in, front-accessible power supply
Board slots	Twenty slots capable of accepting twenty 160-mm vertical plug-in boards (ten slots for the primary side, ten slots for the backup side)
Peripheral slots	Two enclosures for eight 5 1/4-in. drives vertically mounted over the subchassis
Fans	Three; 130 cfm (0 in. H2O static pressure)

Table 2: Peripheral Device Physical Specifications

Item	Description
Universal redundancy control	Height: 1.75 in (4.45 cm)
GPS receivers (2)	Height: 1.75 in (4.42 cm) each
16-port terminal servers (2-4)	Height: 1.75 in (4.42 cm) each

Table 3: Electrical Specifications

Item	Description
Input voltage	-48 Vdc, +/-10 percent
Total power consumption	700-W maximum
Power protection	Over-current and over-voltage protection
Line regulation	All output voltages regulated to +/- 5 percent
Surge protection	Circuitry provided to limit initial peak inrush current
Ripple and noise	One percent peak-to-peak or 100-MV, whichever is greater (50-Mhz bandwidth)

Item	Description
Remote sensing	Circuitry compensates for 500-MV of total line drop; open-sense lead protection (on 5-V only)
Overload protection	Outputs protected against overload and shorts

Table 4: Environmental Specifications

Item	Description
Cooling	Provided by three fans in an evacuation cooling scheme
Air flow	Top rear air exhaust from bottom front
Operating temperature	40^{o} to 95^{o} F (15^{o} to 35^{o} C)
Transport and storage temperature	-4^{o} to 185^{o} F (-20^{o} to 85^{o} C)
Relative humidity	20 to 80 percent (no condensation)

System Operation

This section describes the basic signal flow and the redundancy performance of the WMS Data RF-C! controller.

Basic Signal Flow

Incoming page requests are processed and validated by the paging terminal. Valid requests are then sent to a terminal server in the form of RS-232 TNPP packets (see Figure 8).

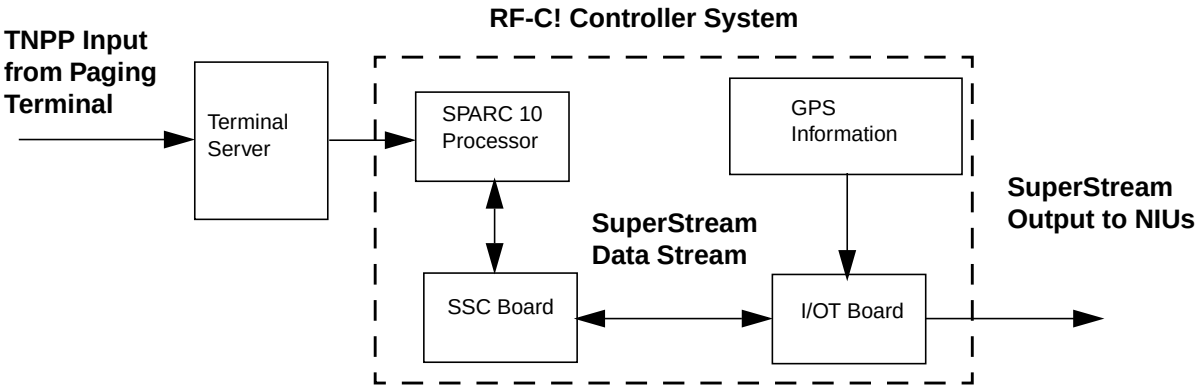

Figure 8: Basic Signal Flow

The terminal server then translates the RS-232 inputs into outputs compatible with the WMS Data RF-C! controller and forwards them over the ThinNet (10b2 Ethernet).

The WMS Data RF-C! controller accepts the TNPP packets from the terminal server at an Ethernet connection on the SPARC 10 paddle board located on the back of the controller chassis. The paddle board then passes the information across the backplane to the SPARC 10 processor board.

The SPARC 10 processor board, in conjunction with the Synchronous Serial Communications Board (SSCB), queues, batches, schedules, and encodes the TNPP information into a SuperStream data stream for movement on the link distribution channel. The SuperStream data stream also contains embedded transmitter control commands and error corrections.

Important characteristics of the SuperStream protocol include:

- Efficient multiplexing of multiple paging channels to a single distribution link
- Forward Error Correction
- Interleaving for distribution link protection from bit errors

In the final phase, the Input/Output Transition Board (I/OTB) updates the SuperStream data stream with GPS information from the GPS receiver and sends the data stream to the Network Interface Units (NIUs) over the link distribution channel.

Redundancy Option

With the redundancy option, maximum system availability through the use of two identical controller component groups housed in the same chassis.

One of the WMS Data RF-C! controllers acts as the operating controller (called the primary controller); the other controller acts as the standby (called the redundant controller). The primary controller manages all normal TNPP traffic processing, page queuing, batching, scheduling, distribution link control, and console interaction. The redundant WMS Data RF-C controller operates in a standby mode, ready to become primary if needed. Both the primary and redundant controller systems are connected to the Universal Redundancy Switch (URS), which provides manual and automatic switchover capabilities.

Both WMS Data RF-C! controller systems share database information through a common Ethernet connection. Operator configurations and system management information are not lost during a redundancy switchover. Also, each side of a redundant controller system has its own GPS receiver. This eliminates clock synchronization delays during a switchover.

Several events can trigger a switchover (see Table 5)

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Table 5: Switchover Events

Switchover Event	Description
A hardware or software failure on the primary controller	If the primary controller detects an internal critical hardware or software failure, it automatically passes control to the backup WMS Data RF-C! controller.
Operator switchover request through a console interface	Operators can send a switchover request instructing the primary WMS Data RF-C! controller to relinquish control to the redundant RF-C! controller, or they can send a switchover request to the redundant RF-C! controller instructing it to take control from the primary RF-C! controller. These actions can be overridden only through a console command or by manually initiating a switchover using the URS (see next event description).
Switch action at the URS	The three switches located on the URS front panel are for manually triggering switchover events. Whenever the AUTO/MAN switch is set to the manual mode (MAN LED on), the other two switches on the front panel, labeled SIDE A and SIDE B, become active. Pressing the SIDE A switch (its ACT LED on) forces the RF-C! controller connected to the A side to take control. Pressing the SIDE B switch (its ACT LED on) forces the RF-C! controller connected to the B side to take control.

System Components

Each nonredundant WMS Data RF-C! controller contains

the components listed below. (Redundant controllers contain two each of these components.)

- A SPARC 10 processor board
- A Synchronous Serial Communications board
- An Input/Output Transition board
- A paddle board breakout panel
- An SBus Carrier Board
- Power Supply
- A hard disk drive
- A digital audio tape (DAT) drive
- A CD-ROM drive

Internal Peripheral devices also located in the WMS Data RF-C! controller cabinet are:

- Universal Redundancy Switch (redundant models only)
- GPS receiver and antenna (redundant models contain two GPS receivers)
- One to four terminal servers

Peripheral devices outside of the cabinet are:

- Video display terminals (VDTs)
- Screen-recording printers
- Logging printers

SPARC 10 Processor Board

The primary component of the WMS Data RF-C! controller is the 125-MHz dual SPARC 10 processor board (see Figure 9). Features of the SPARC 10 processor board include:

- 32 MB of RAM
- 512 Kbyte of EPROM
- Eight Kbytes of NVRAM (stores boot configurations for the VME bus devices)
- A rear-accessible AUI Ethernet port

- Support for SCSI II devices
- Two RS-232 / 422 rear-panel serial ports
- A high-performance master / slave VME controller

The SPARC 10 processor board front panel contains LEDs for status indications and connectors (see Table 6).

Table 6: SPARC 10 Processor Board Front Panel Features

Item	Description
RUN LED	Lights whenever the board is operating normally
FAIL LED	Lights whenever a board failure is detected
User LEDs (0,1,2,3)	Reserved for future use
ABORT/RESET switch	Push-button switch—for factory use only
KBD/MOUSE connector	Accepts standard Sun keyboard and mouse DIN connector inputs—reserved for future use
10BASE-T connector	Accepts 8-pin, RJ-45 type twisted pair Ethernet connections—reserved for future use
TTY A/B and AUI connector	Provides two serial ports and an AUI Ethernet interface through a 40-pin connection—reserved for internal use
SCSI connector	50-pin SCSI connection—reserved for internal use

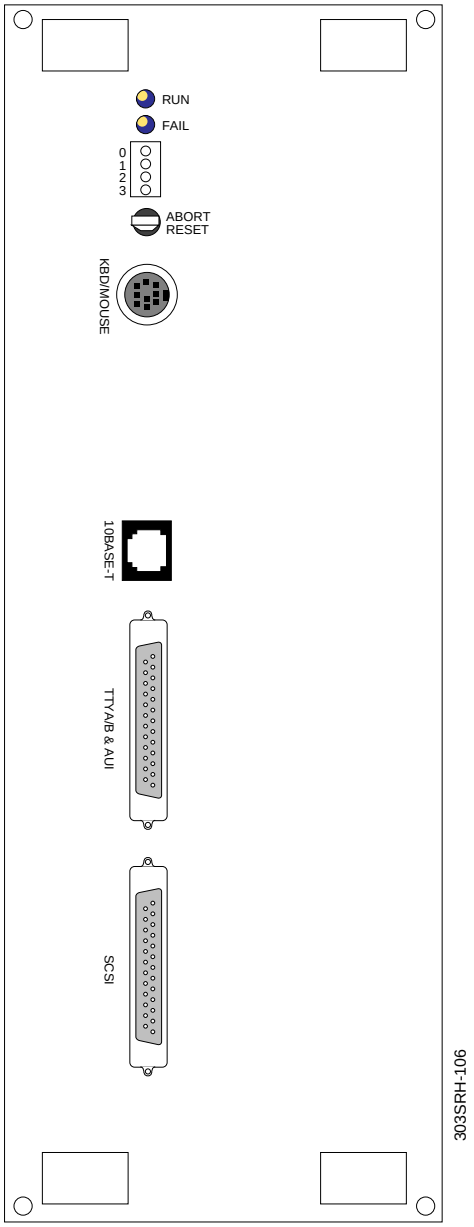

Figure 9: Sparc 10 Processor Board

Synchronous Serial Communications Board

The Synchronous Serial Communications Board (SSC Board) provides control and output synchronization for the controller system's distribution links and the I/O connections (see Figure).

The SSC board has eight LEDs (see Table 7).

Table 7: SSCB Front Panel Components

LEDs		
Component	**Reading**	**Description**
BOARD POWER	Steady green	Both +5 V and 12 V power are available
	Off	Either the +5 V or 12 V power, or both, are not present
BOARD FAILURE	Steady red	SSCB failure
	Off	No board failures detected
BOARD ACTIVE	Steady green	Paging traffic is transferring
	Flashing green	Nonpaging traffic is transferring
PHASE-LOCKED-LOOP (PLL) LOCKED	Steady green	PLL locked
	Flashing green	PLL is locking
	Off	PLL not in use
1PPS	Flashing green	Incoming 1pps GPS signals
	Off	GPS failure
MAJOR ALARM	Steady red	Major alarm exists
	Off	No major alarms
MINOR ALARM	Steady red	Minor alarm exists
	Off	No minor alarms
WATCHDOG	Red	In the absence of normal system communication, flashes just before system is reset
	Off	Normal system communication is present

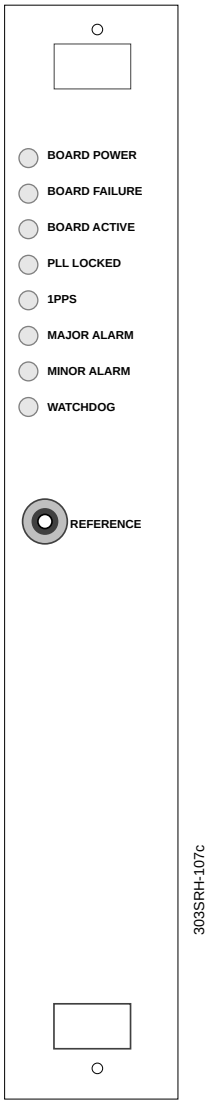

Figure 10: SSC Board

Input/Output Transition Board

The I/OTB, located on the back of the cabinet, provides I/O functions for the SSC board. It also provides a direct external interface to the distribution link(s) and the General Purpose Input/Output (GPI/O) cables (see Figure 11).

The I/OT board has ten connectors (see Table 8).

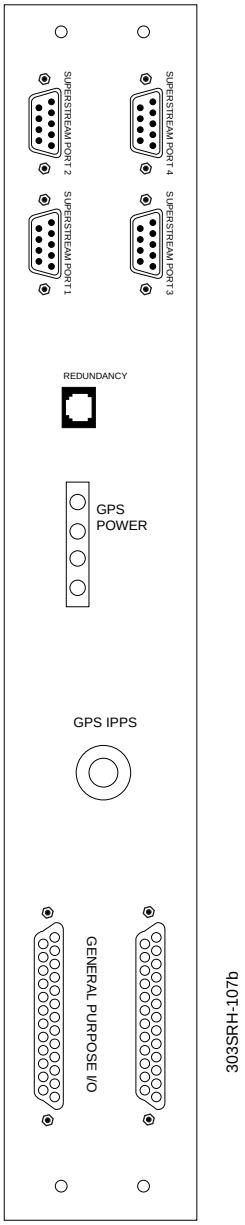

Figure 11: I/OT Board

Table 8: I/OTB Front Panel Connector Functions

Connector Name	Type	Purpose
LINK PORTs 1,2, 3, 4	DB-9 connectors	Connects I/O channels 1,2, 3, and 4
REDUNDANCY	RJ-45 connector	Provides control over the redundancy switch
GPS POWER	Power connector	Supplies power to the GPS receiver
GPS 1PPS	Coaxial connector	Used for the 1pps timing input

Table 8: I/OTB Front Panel Connector Functions

Connector Name	Type	Purpose
U18 (internal; not shown)	96-pin ribbon connector	Interfaces the I/OTB with the SSCB
GENERAL PURPOSE I/Os	Two DB-25 connectors	General purpose

Paddle Board Breakout Panel

The PBBP is an extension of the SPARC paddle board and provides connections to external peripherals such as the system VDTs. It is installed in the controller chassis behind the SPARC processor board in the backplane of the controller chassis (see Figure 12).

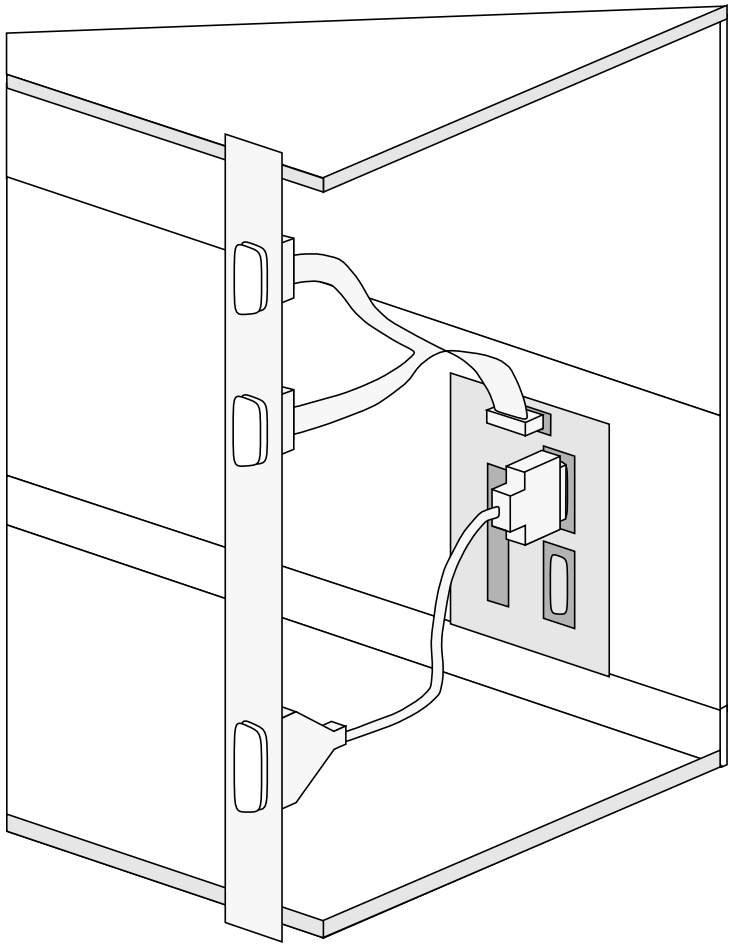

Figure 12: Paddle Board Breakout Panel

SBus Carrier Board

The SBus carrier board is an extension of the SPARC 10 processor board. The SBus carrier board provides the communications between the Central Processor Unit (CPU) and any SBus boards. The SBus carrier board provides rear access serial, parallel, and Ethernet connections. It connects to the VME chassis backplane through the paddle board. The SBus carrier board is located behind the SPARC 10 processor board (see Figure 13).

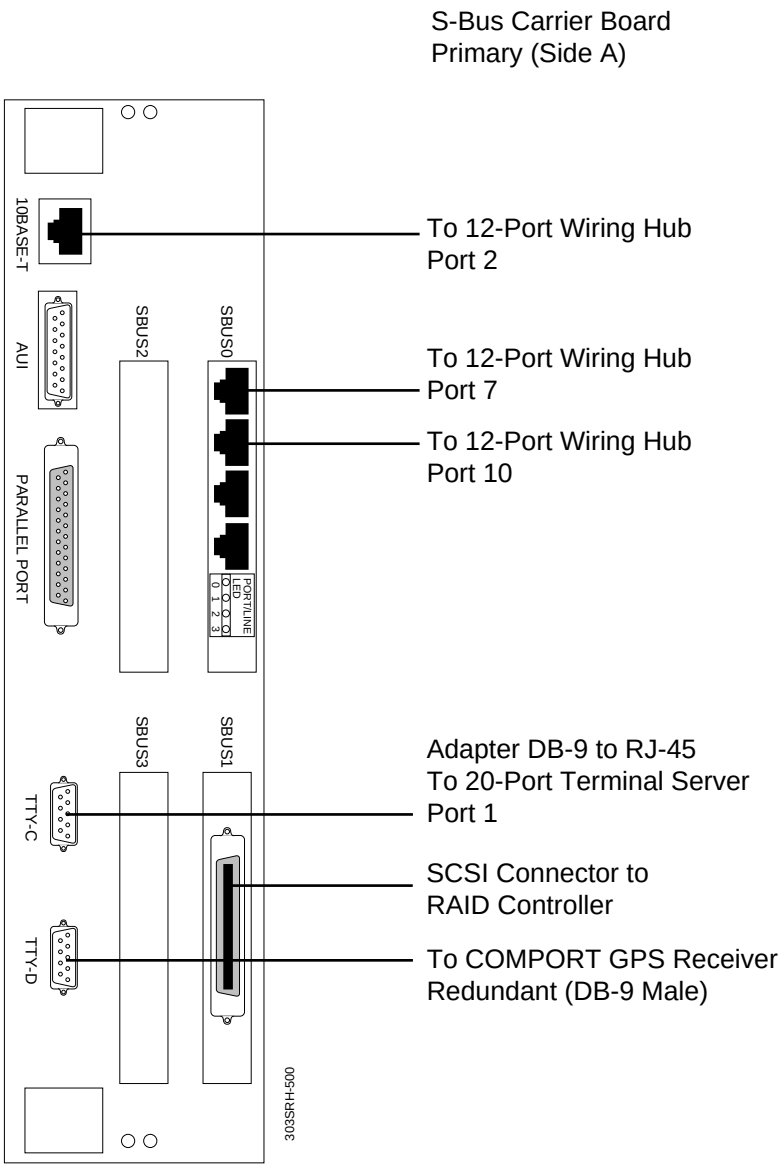

Figure 13: SBus Carrier Board

Peripheral Components in the Enclosure

Hard Disk Drive

The WMS Data RF-C! controller uses a 2.1-GB internal SCSI hard disk drive for storing files, databases, and configuration information. It is installed in the peripheral enclosure in the top of the cabinet (see Figure 14).

Digital Audio Tape Drive

The WMS Data RF-C! controller uses a 4-mm digital audio tape (DAT) drive for the backup storage of databases, statistics, and software updates. It is installed in the peripheral enclosure in the top of the cabinet (see Figure 14).

CD ROM Drive

The WMS Data RF-C! controller uses a quad-spin CD ROM drive for entering operating system updates and for rebooting the operating system when necessary. It is installed in the peripheral enclosure in the top of the cabinet (see Figure 14).

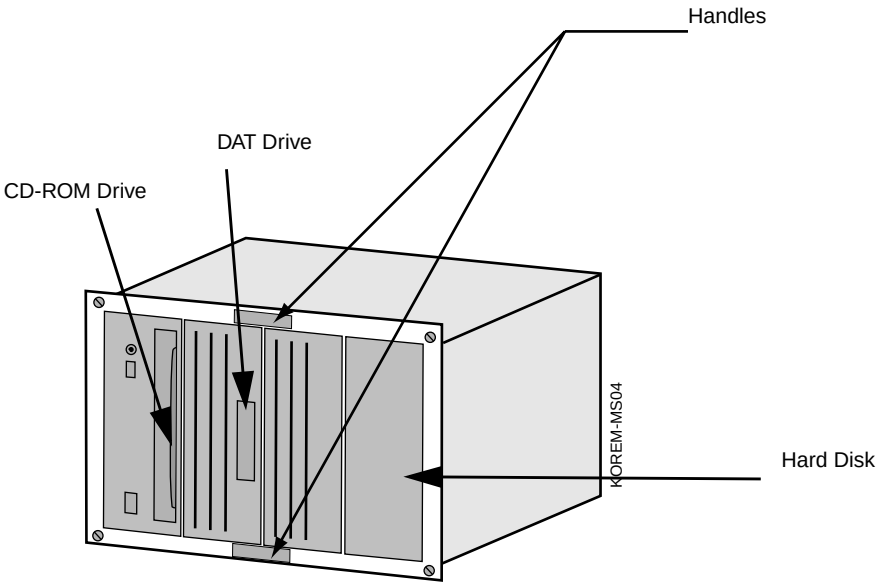

Figure 14: Peripheral Enclosure and Components

Internal Peripheral Devices

The WMS Data RF-C! controller's internal peripheral devices include:

- A GPS receiver with its own antenna
- One to four terminal servers
- The Universal Redundancy Switch

Global Positioning System Receiver

The WMS Data RF-C! controller contains a GPS receivers with its own antenna (see Figure 15).

Note: Redundant models contain two GPS receivers each with its own antenna.

Figure 15: The Global Positioning System Receiver

The GPS receiver provides the 1pps and time-of-day (TOD) information necessary for paging synchronization. Power for the GPS receiver is provided by its I/OT board. The receiver is located in the WMS Data RF-C! controller cabinet.

Terminal Servers

The WMS Data RF-C! controller contains one to four terminal servers (see Figure 16).

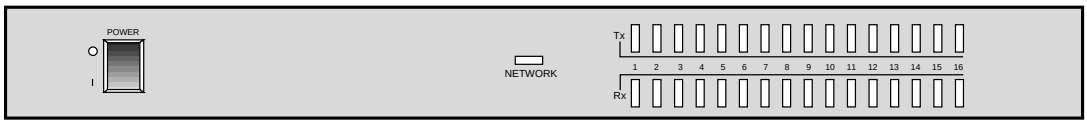

Figure 16: The Terminal Server

Through RS-232 inputs (RJ-45 connections) located in the rear of the cabinet, the terminal server accepts asynchronous 19200-baud TNPP serial inputs from the paging terminal. When the terminal server detects the end of the TNPP message, it sends the TNPP message, via the ethernet, to the controller system.

Status indicators on the front of the unit display power, network, and the port connections that are active.

Universal Redundancy Switch

WMS Data RF-C! controllers with the redundancy option have the Universal Redundancy Switch (URS). The URS provides automatic and manual redundancy control and status indications for the primary and redundant controllers (see Figure 17).

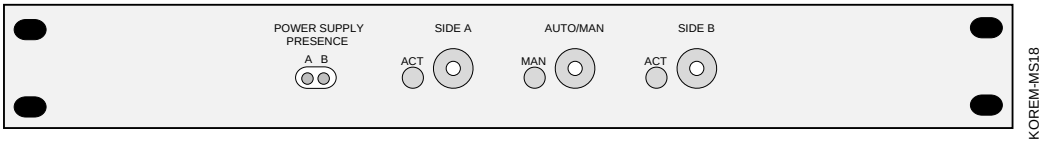

Figure 17: Universal Redundancy Switch

A switchover occurs under the following conditions:

- If the primary controller detects an internal critical hardware or software failure, it automatically passes control to the redundant controller.
- Operators can send a switchover request instructing the primary controller to relinquish control to the redundant controller, or they can send a switchover request to the redundant controller instructing it to take control from the primary controller. These actions can be overridden only through a console command or by manually initiating a switchover using the URS (see next event description).
- The three switches located on the URS front panel are for manually triggering switchover events. Whenever the AUTO / MAN switch is set to the manual mode (MAN LED on), the other two switches on the front panel, labeled SIDE A and SIDE B, become active. Pressing the SIDE A switch (its ACT LED on) forces the controller connected to the A side to take control. Pressing the SIDE B switch (its ACT LED on) forces the controller connected to the B side to take control.

For more information, see the subsection “Redundancy” on page 15.

Optional Peripheral Components

The following optional peripheral equipment items are offered.

Terminal

A standard VT100 terminal (Esprit Model PTRN 4251A) is offered. Any terminal that is VT100 compliant can be used with the WMS Data RF-C controller.

Printers

Dot matrix printers (120 column) are offered as optional equipment. Both 110-Vac and 220-Vac models are available (Okidata models NLN3575A (110Vac) and NLN3576A (220 Vac).