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APPENDIX I:

USER'S MANUAL



Wireless Network Systems

CDMA Network Guide

CDMA PicoBTS™ Hardware Description

CDMA? Simply Samsung.



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1 Overview

This document describes the Samsung CDMA Pico base transceiver system (PicoBTS™), model SCBS-Z19P.

This document is intended for personnel who administer, install, provision, configure, maintain, or troubleshoot a PicoBTS™ base station in a Samsung CDMA base station system (BSS), as well as traffic engineers who deal with system sizing and performance.

1.1 Functions

The Samsung PicoBTS™ base station is part of the Samsung CDMA base station system (BSS) (see Figure 1). The PicoBTS™ base station provides a CDMA radio interface between mobile PCS users and the base station controller (BSC).

The Samsung BSS consists of the following elements:

- PicoBTS™ base station
- Base station controller (BSC)
- Gateway communication interconnection network (GCIN)
- Base station manager (BSM)

The BSC controls the base stations, providing configuration, traffic management, maintenance monitoring, and other features. The GCIN provides two interfaces:

- It connects the BSM to the BSC and PicoBTS™ base station
- It provides inter-BSC soft handoff connectivity

The BSM provides the remote user interface to the PicoBTS™ base station.

The air interface complies with J-STD-008 and J-STD-019.
The PicoBTS™ base station backhaul uses superframe (SF), an unchannelized T1 (AMI) and a proprietary protocol.

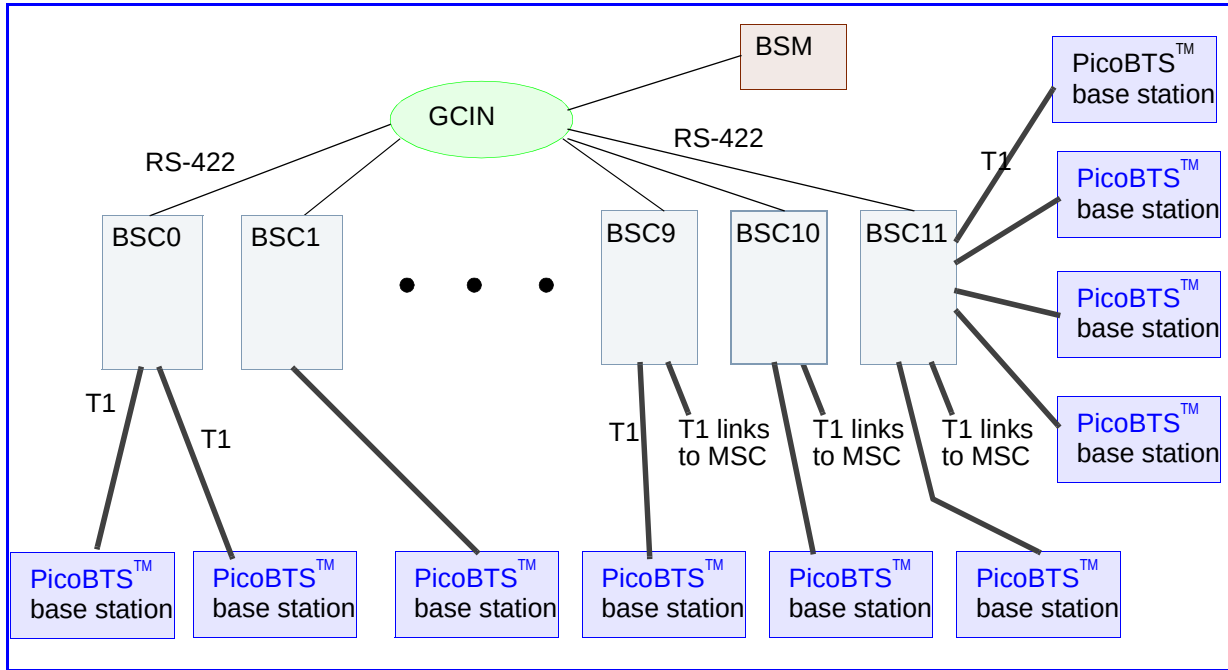


Figure 1 PicoBTS™ base station communication with the BSC and the MSC

1.2 PicoBTS™ base station features

The PicoBTS™ base station was specifically designed to facilitate rapid, low-cost deployment with minimal cable losses between the antenna and the processing subsystem. The PicoBTS™ base station is designed for indoor and outdoor installation in a variety of locations such as rooftops, monopoles, towers, and other locations.

To support these design goals, the PicoBTS™ base station offers the following design features.

- PicoBTS™ main unit (PMU), a light-weight main processor unit that mounts indoors or outdoors pole, wall, or tower.
- PicoBTS™ radio unit (PRU), a light-weight radio unit that mounts at or near the antenna to cut insertion losses. The PRU is available in 5 W or 10 W models.
- The PMU-PRU interface, a heavy-duty, weather-proof PMU-PRU interconnect cable.
- Sectorized or omni configuration:
 - Omni (one PRU per PMU)
 - 2-sector (two PRUs per PMU)
 - 3-sector (three PRUs per PMU)
- A flexible structure using any of the following configurations:
 - Omni, single frequency
 - Omni, two or three frequencies
 - Two-sector, single frequency
 - Three-sector, single frequency
- Antennas flush-mounted to the PRU.
- 64 pooled channel elements.
- Single channel element support for pilot, sync, and access channels for each sector.

1.3 General specifications

Table 1 lists the general PicoBTS™ base station specifications.

Table 1: PicoBTS™ base station specifications

Parameters	Measurements	Vaules
Rack dimensions	PMU (H x W x D)	26.2 in x 24.8 in x 18.6 in
	PRU (H x W x D)	11.4 in x 22.3 in x 5.5 in



Table 1: PicoBTS™ base station specifications

Parameters	Measurements	Vaules
Weight	PMU	115 lb
	PRU	33 lb without brackets
Power	Power	1270 W
	Voltage	100 to 260 Vac
	Input frequency	47 to 63 Hz
	Battery backup input	+48 Vdc External to the PMU
Operating environment	Temperature	-40°C to +52°C (varies with altitude)
	Humidity	10% to 95%
Storage environment	Temperature	-40°C to +70°C
	Humidity	10% to 95%

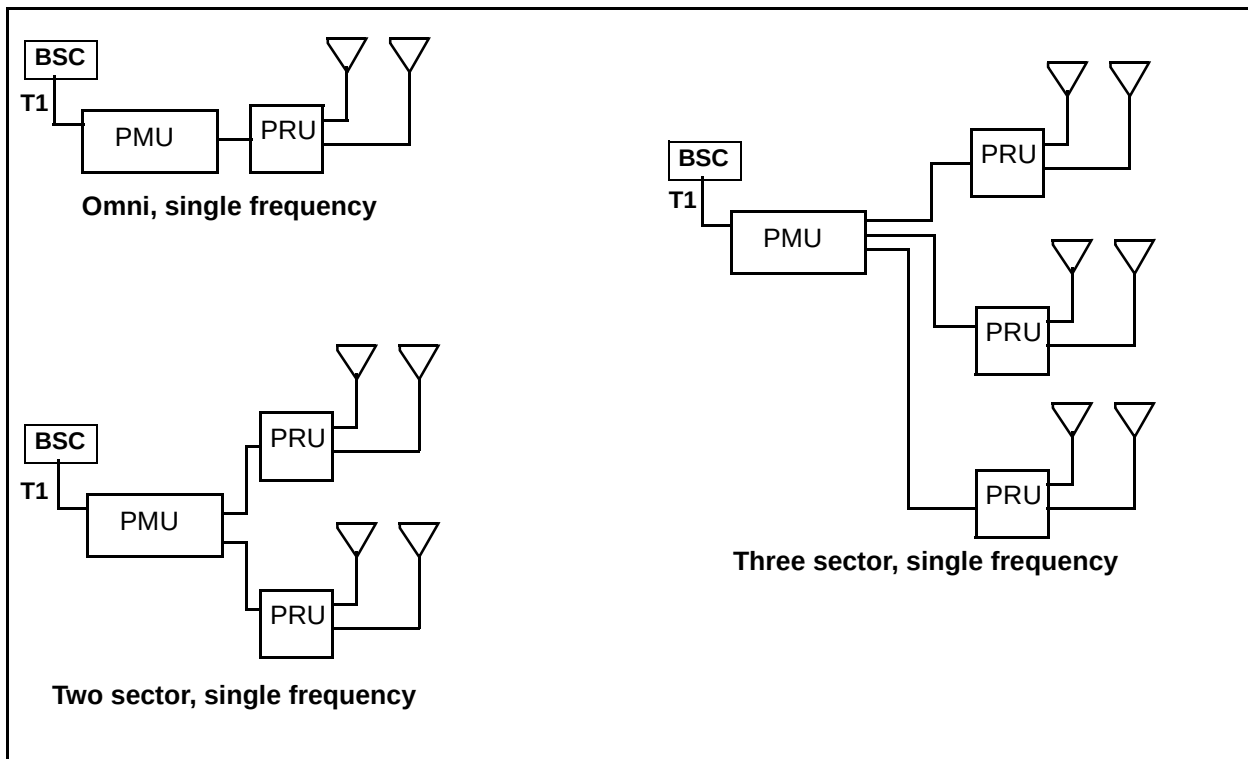


Figure 2 PicoBTS™ base station flexible configurations

2 Operation

This section describes PicoBTS™ base station operation.

2.1 Overview of operation

The PicoBTS™ base station supports registration, synchronization, call setup, origination, and termination as well as handoff for mobile subscriber units. It performs the following functions:

- Completes the air interface with CDMA handsets for signaling, voice, and data
- Transmits non-terminated data and network link services (such as handoff and E911) to the BSC for further processing
- Supports local and remote interfaces for provisioning, troubleshooting, status reporting, program downloads, and other human-machine operations

2.1.1 Air interface with CDMA handsets

The air interface consists of the following channels:

- Pilot channel
- Sync channel
- Paging channels
- Access channel
- Traffic channels

Note: The pilot, sync and access channels share a single channel element per sector.

2.1.2 Components

- The PicoBTS™ base station contains the following components:
- Duplexed antenna port
- Diversity receive antenna port

- PicoBTS™ radio unit (PRU), containing the transceiver
- PicoBTS™ main unit (PMU), containing the controller and channel cards
- PMU-PRU interconnect cable that connects the PRU with the PMU
- T1 link from the PMU to the BSC capable of transmitting voice and data for more than 82 calls, running a Samsung-proprietary version of HDLC

2.2 PicoBTS™ base station main unit (PMU)

Figure 3 is a block diagram of the PMU.

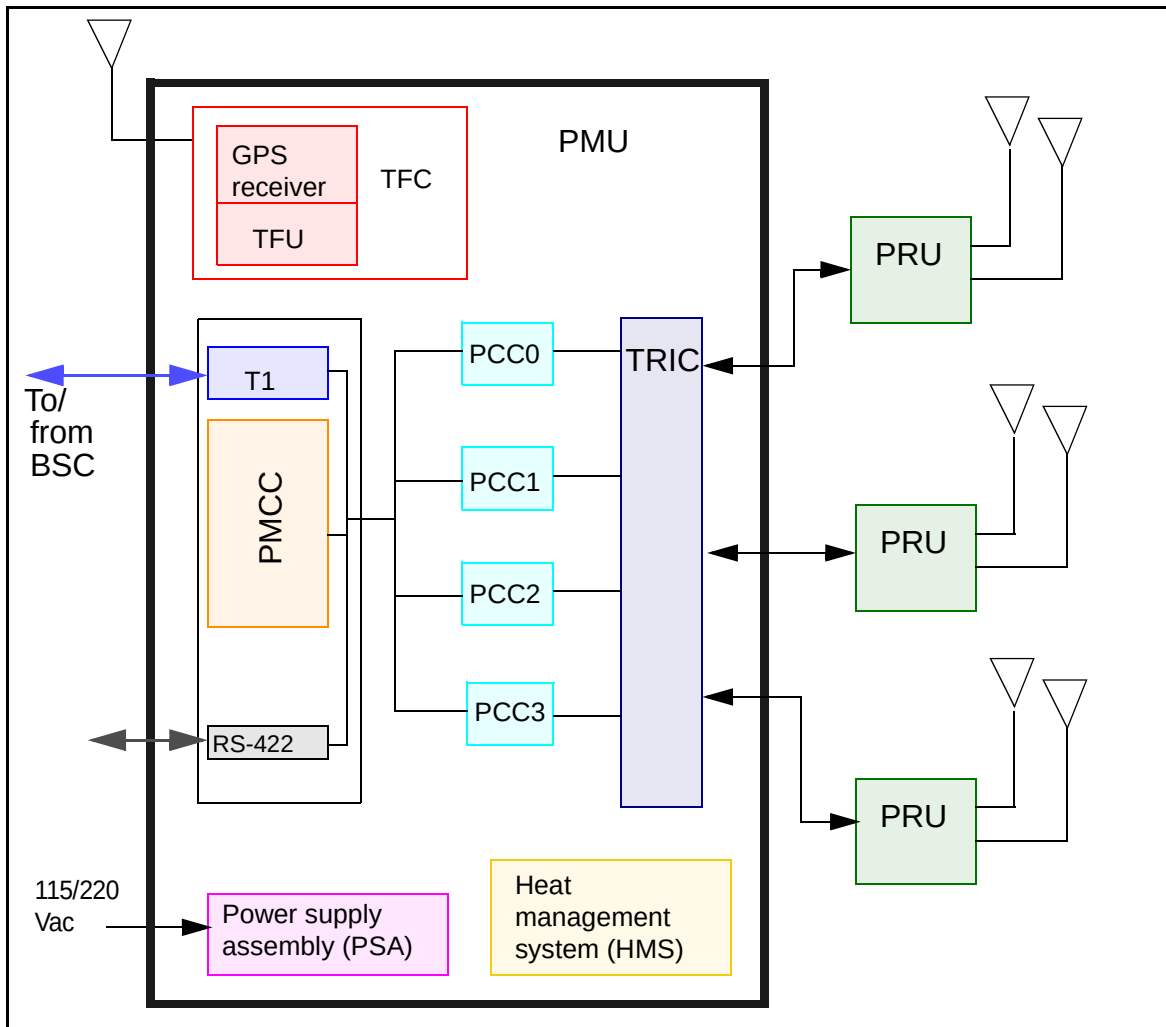


Figure 3 PMU block diagram

The PMU consists of the following modules (see Figure 3):

- PicoBTS main controller card (PMCC)
- PicoBTS channel cards (PCC)
- Transmit and receive interface card (TRIC)
- GPS receiver
- Heat management system (HMS)
- Power system assembly (PSA)

2.2.1 The PMCC

The PMCC performs the following major functions:

- System control
- Fault management
- T1 communication
- Packet management

The interfaces to the PMCC appear in Figure 4. The operations of these interfaces are described in the following paragraphs.

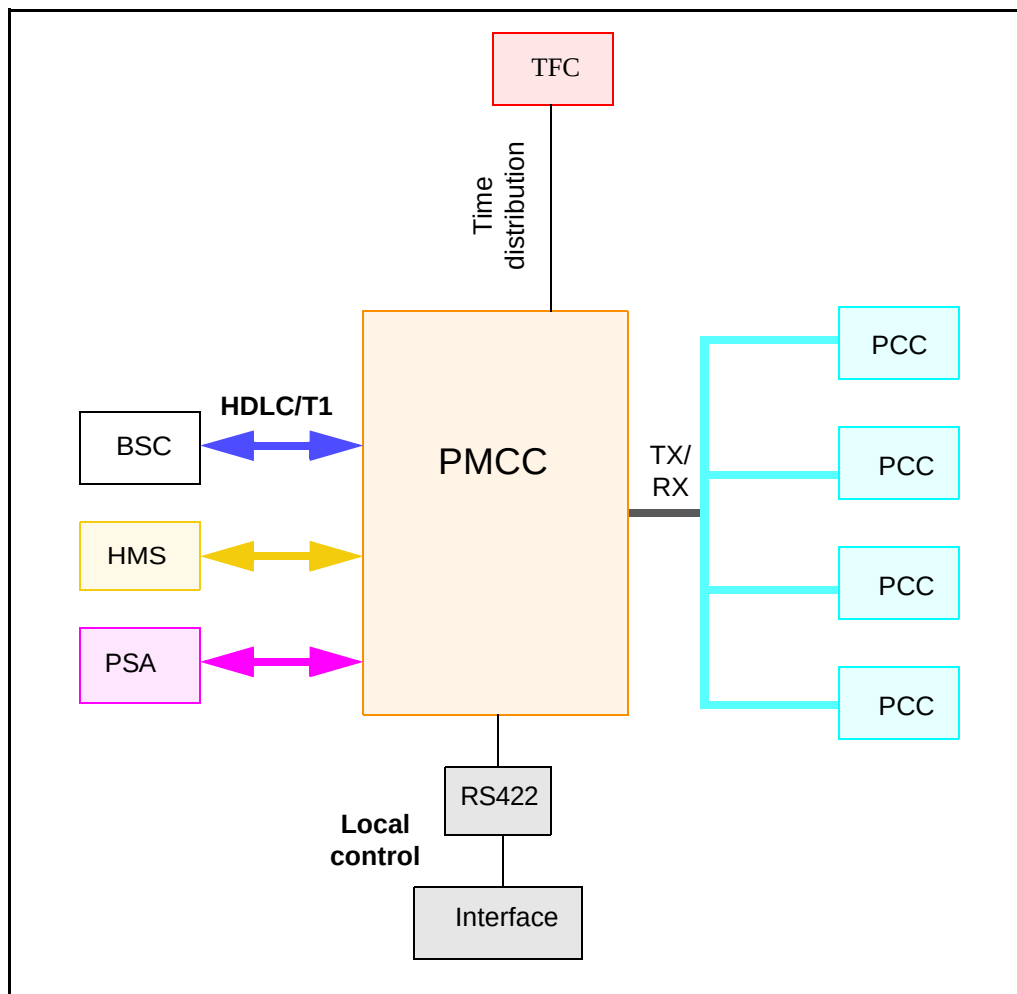


Figure 4 PMCC logical interfaces

2.2.1.1 Start-up

During start-up, the PMCC reads a command from the local interface or the T1 link and initializes itself. During this procedure, the PMCC manages the download of executable software and configuration data to the other PicoBTS devices.

When the PMU internal temperature is $+5\text{ C} < T < 70\text{ C}$, the PSA applies power to the PMCC, GPS, PCCs and TRIC. When the GPS has stabilized, the PMCC loads the application software and initializes other PicoBTSTM devices.

2.2.1.2 Communication with the BSC and BSM

The PMCC is the packet interface for the serial data stream between the BSC and the PCCs. The interface to the BSC is a serial, unchannelized T1/E1 trunk in accordance with ITU G.703.

The PMCC also monitors the performance and operation of the PicoBTS and reports to the BSM.

2.2.1.3 OAM&P interface

To support remote operation, administration, maintenance, and provisioning (OAM&P) operations, including installation, control, monitoring and alarm functions, the PMCC provides the following interfaces:

- Maintenance and administration processor (MAP) termination
- Data control processor (DCP) port interface
- BTS load processor (BLLP) port interface

2.2.1.4 Reliability

The PMCC is designed so that no single point failure of critical components will result in more than 50% reduction in capacity. The one exception to this rule is the interface to the external T1 backhaul line interface. At a minimum, the PMCC incorporates redundant, electrically isolated controller processors and application memory. A redundancy controller failure does not result in the loss of processor access to memory or the T1 interface to the BSC.

2.2.2 PicoBTS™ base station channel card (PCC)

The PMU contains four PCCs which perform channel encoding and decoding. This configuration ensures that a PCC failure does not reduce PicoBTS capacity below 50%.

Each PCC provides 16 channel elements, arranged in two sets of 8 channels. A control digital signal processor (CDSP) controls each set of 8 channel elements. Each channel element can perform any transmit or receive channel function under software control.

2.2.3 PMU transmit and receive interface card (TRIC)

The TRIC provides digital conversion and analog processing for CDMA baseband signals in the transmit and receive paths.

2.2.3.1 TRIC functions

The TRIC monitors the level and balance of the transmit I and Q signals for each sector. Any deviations from allowed ranges are reported as alarms to the PMCC. The TRIC also monitors signal gain in the receive signal and reports deviations from allowed ranges as alarms.

In addition, the TRIC is the distribution matrix for CDMA channels between the PRUs and the channel cards.

The TRIC reports all alarm information, performance data, and fault data to the PMCC.

The TRIC interface to the PRU for the forward link consists of combined I and Q baseband signals. The interface for the reverse link allows for cable attenuation. The TRIC-to-PRU interface compensates for cable attenuation.

2.2.4 PMU time and frequency card (TFC)

The TFC provides the PMU with frequency and time references:

- 10 MHz standard frequency signal to the PRU transceiver board, as well as the TRIC, PCC, and PMCC in the PMU
- Time-of-day (TOD) and even second clock signaling to the PMCC and PCC
- 19.6608 MHz standard frequency to the TRIC

The TFC complies with J-STD-008, based on the global positioning system (GPS) time scale (traceable to and synchronous with universal coordinated time [UTC]).

Note: GPS and UTC differ by an integer number of seconds, specifically the number of leap second corrections added to UTC since January 6, 1980. The TFC provides the leap second corrections to UTC, but does not use these corrections for physical adjustments to the time clocks.

The TFC provides GPS system time, time zone offset, and leap second offset data.

The PMU supports remote location of the GPS antenna for distances as far as 20 dB of total attenuation including cable loss, amplifier gain, and all insertion losses.

The PMU provides a 5V supply on the GPS center conductor to power the antenna and added amplifier. The source can supply as much as 80 mA to support the GPS antenna amplifier and any additional in-line amplifiers.

The TFC reports to the PMCC for alarm and performance monitoring of GPS and standard frequency parameters. The GPS module reports loss of critical functions to the PMCC within two seconds of detecting a fault condition.

2.2.5 PMU heat management system (HMS)

The HMS maintains the internal temperature of the PMU in the range $+5^{\circ}\text{C}$ to $+70^{\circ}\text{C}$ when the external ambient temperature is in the range of -40°C to $+52^{\circ}\text{C}$. The HMS has heating, cooling, and heat transfer components that raise or lower the internal temperature to meet these requirements.

The HMS reports alarms and other performance data to the PMCC.

2.2.6 PMU power supply assembly (PSA)

The PSA converts commercial AC power to $+48\text{Vdc}$ and $+5\text{Vdc}$ for PMU operation and distributes this power to PicoBTS components (PMCC, PCCs, TRIC, TFC and PRU).

2.3 PMU communication with the network

From the PicoBTSTM base station standpoint, the network consists of the T1 network and the BSC rack. A BSC rack controls as many as 48 PicoBTSTM base stations. The T1s terminate at a local communication interconnection network (LCIN). The unchannelized T1 link from a PicoBTSTM base station is hard wired to a port in the LCIN.

2.4 PRU

The PRU performs signal conversion between the CDMA interface and the transmission band RF interface. The PRU provides a radio transceiver and RF front-end to establish the interface to mobile subscribers.

For the transmitted signal, the PRU modulates the PCS band carrier frequency with the I and Q signals from the CDMA interface. In addition, the PRU amplifies the PCS-band RF signal to the RF transmission power level with a maximum of 5 W at the antenna port.

For the received signal, the PRU amplifies and performs IF down-conversion of the PCS-band RF carrier signals received by the primary and diversity antennas.

The transmitter receiver operates over the transmit and receive US PCS Class 1 band frequencies and provides:

- Nominal 50-ohm impedance
- VSWR < 1.5:1

3 Physical characteristics

3.1 PMU assembly

A PMU is shipped from Samsung completely assembled and ready to install.

Figure 5 shows the PMU back panel and the connectors for power, PRUs, and the GPS antenna cable.

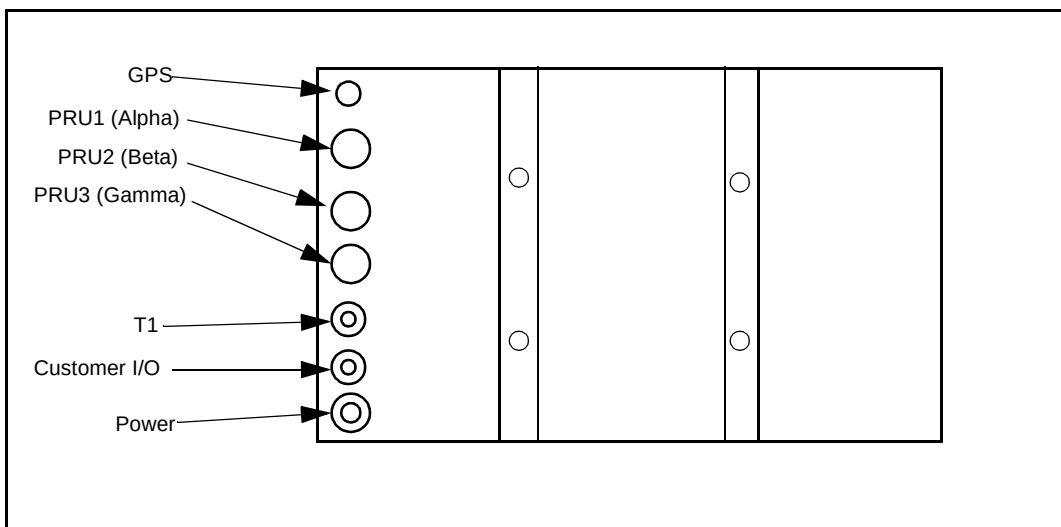


Figure 5 PMU back panel with connectors and mounting hardware

Figure 6 shows the PMU with the service door open. The boards are completely enclosed to maintain the correct operating temperatures inside the PMU. Opening the door exposes the service panel but does not expose the boards.

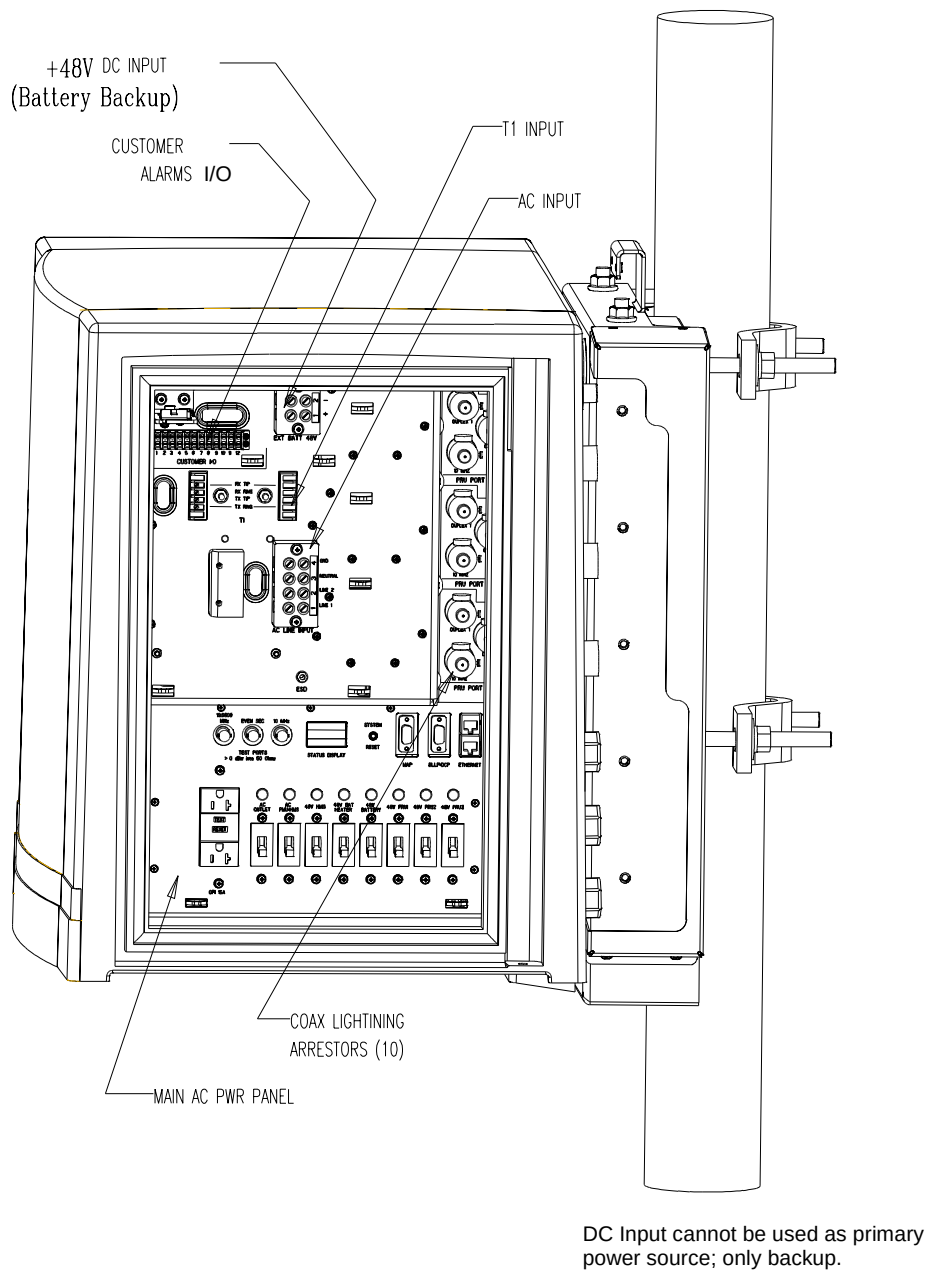


Figure 6 PMU with open service door

Figure 7 shows the inside of the service door. This door can be removed by compressing the spring on the top hinge and removing the hinge.

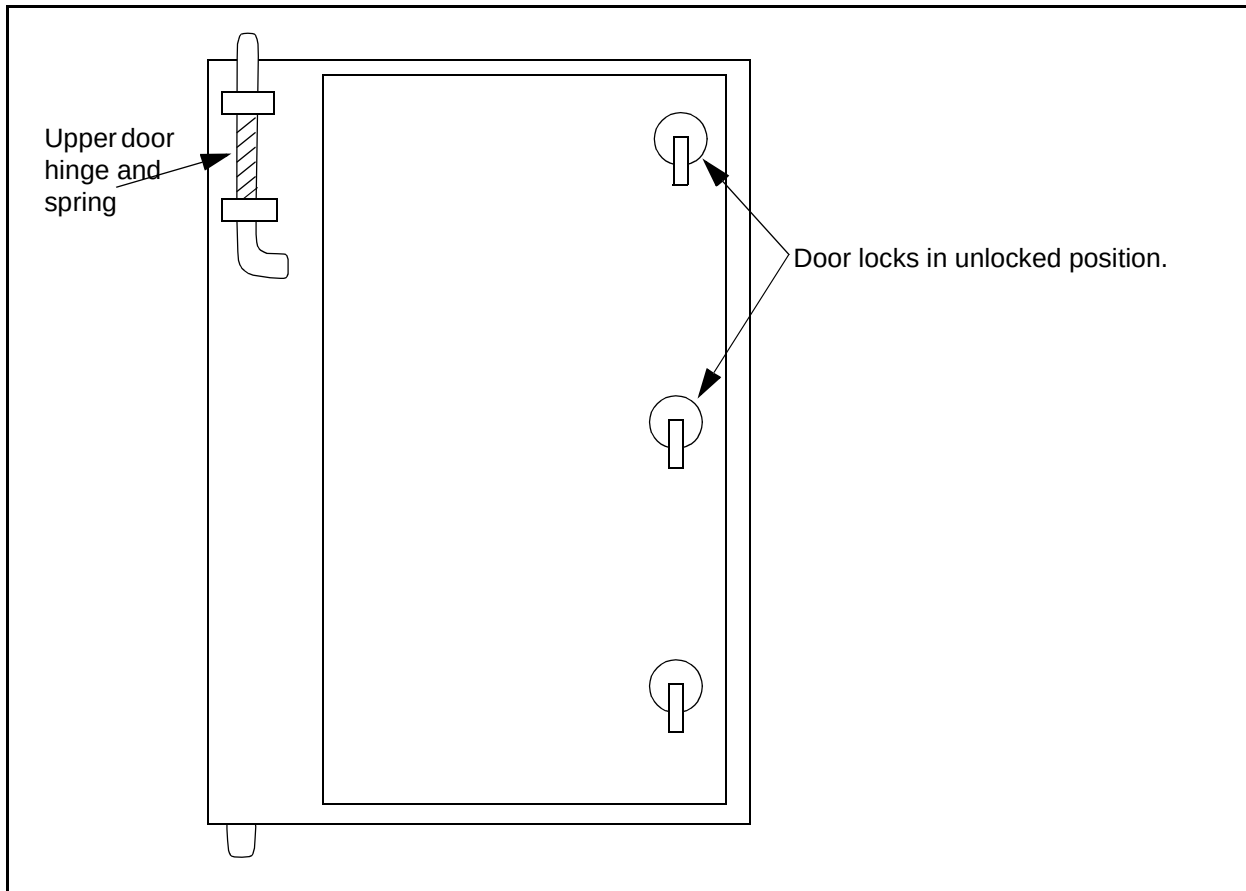


Figure 7 Inside of PMU door

Figure 8 is a detailed view of the service panel showing the following features:

- AC interface
- T1 interface
- Cable connector interfaces
- Power outlet
- Circuit breakers
- LED indicator

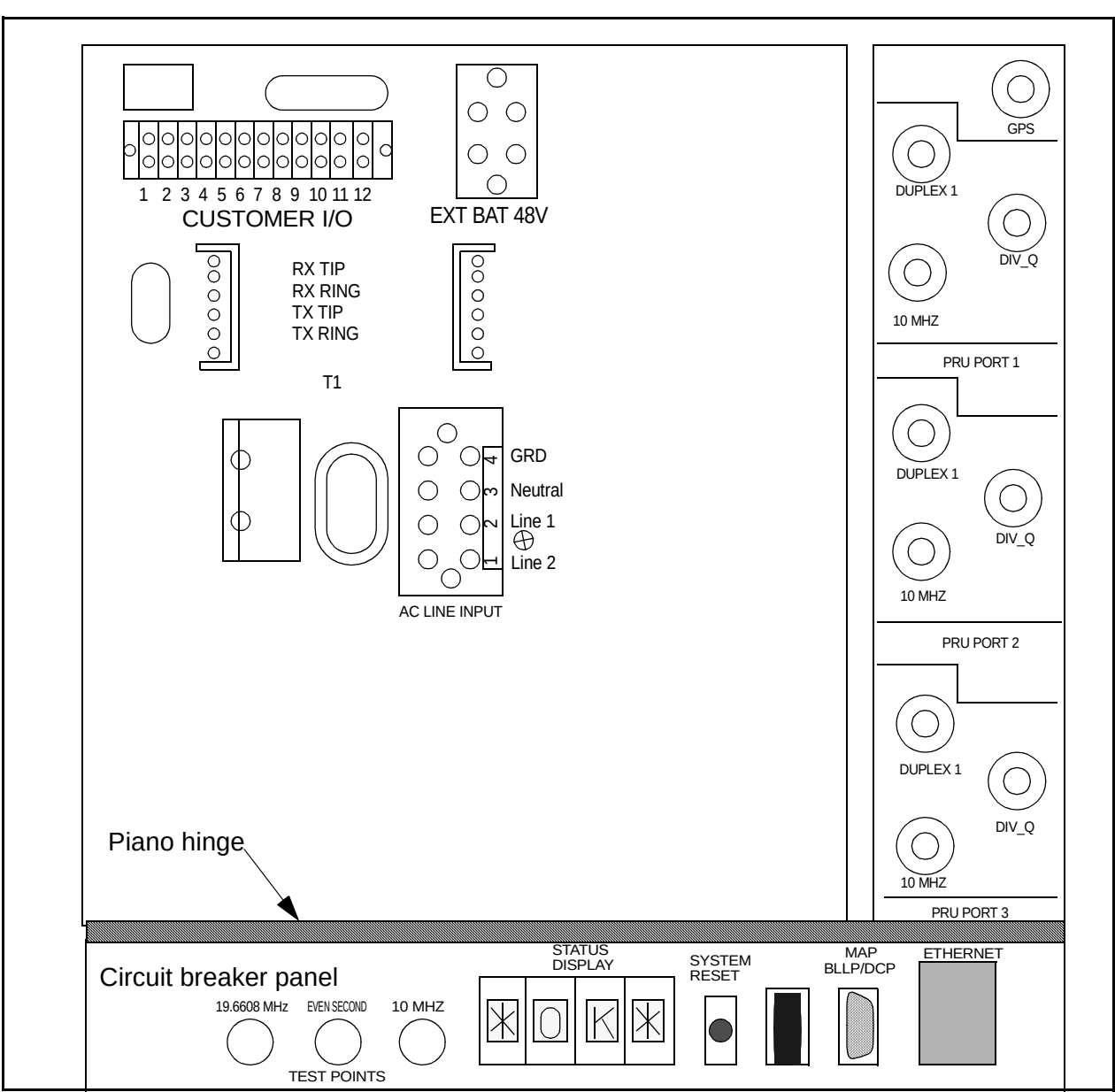


Figure 8 PMU service panel

3.2 PRU physical characteristics

The PRU is a self-contained single unit. Figure 9 shows the PRU as it is shipped from the factory.

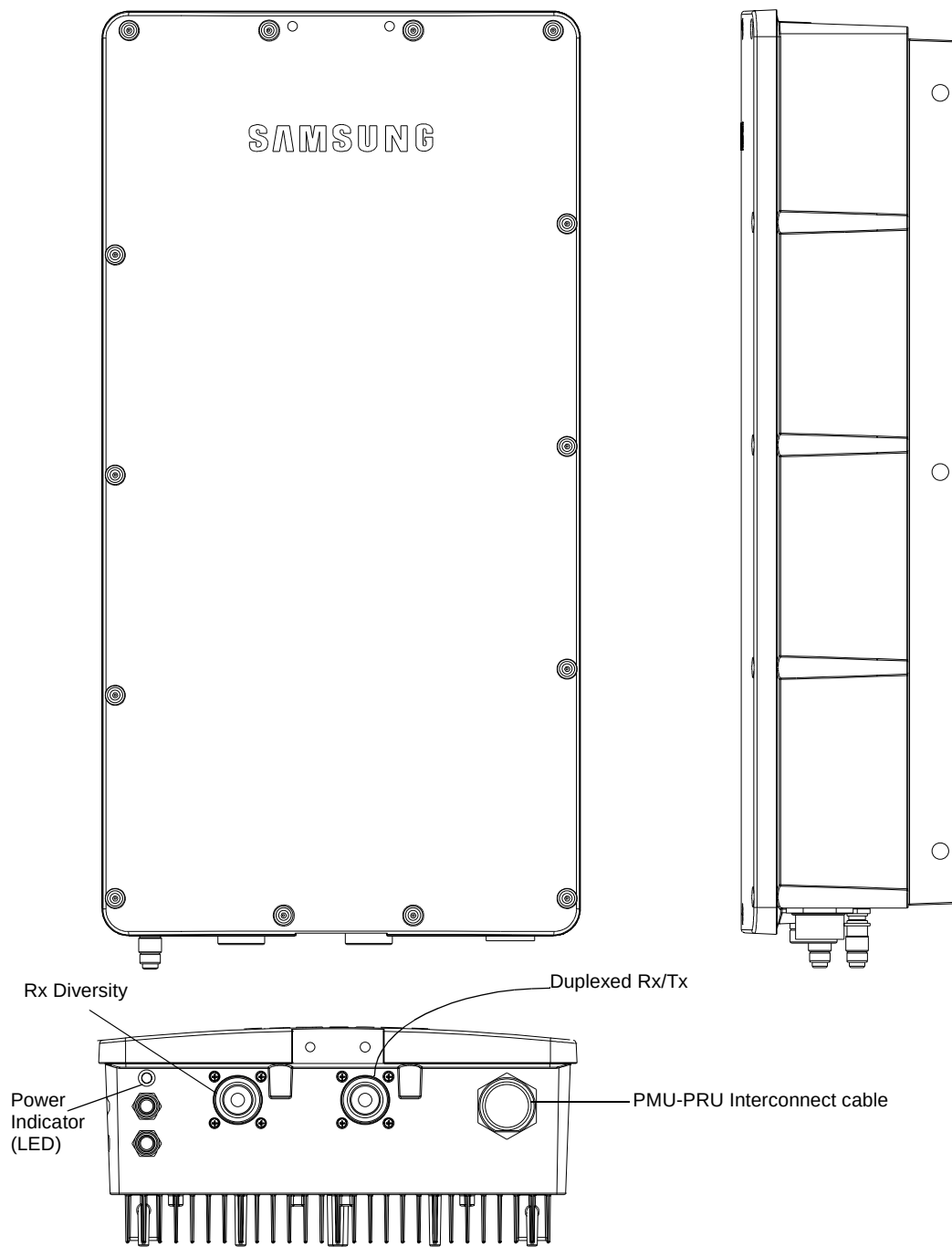


Figure 9 PRU as it is shipped from the factory

4 Maintenance

4.1 Maintenance goals and philosophy

Maintaining a PicoBTS™ base station has four goals:

- Prevent loss of service to the subscribers
- Prevent site visits except as a last resort (replacing a faulty unit)
- Send craft persons to the site with all the equipment required to facilitate replacement
- Reduce spares inventory to an absolute minimum

The Samsung maintenance philosophy is simple replacement of the entire PMU or PRU. Such a philosophy is tenable only when:

- The PicoBTS™ base station is designed for very high reliability, and a very long mean time between failures, and
- Procedures focus on remote status reports, restart and downloading procedures, and a strong preventive maintenance program based on early prediction of potential problems.

Samsung understands that rapid deployment and low-cost installation are highly desirable, but that repeated trips to a site are not. The maintenance philosophy is based on maximizing remote procedures from the BSM in preference to site visits.

4.2 Maintenance planning

4.2.1 Life expectancy

The PicoBTS™ base station is designed to have a life of 10 years.

The mean time between critical failures (MTBCF) is greater than 2.5 years for a three-sector base station and includes all critical functions.

4.2.2 Failure types

A critical failure is a failure that is service critical and requires immediate repair. Specific cases include:

- Capacity reduction by more than 50% (in an omni or sector configuration)
- Failure of one sector (in a sector configuration)

A reliability failure includes any event or inoperable state resulting in a failure by the PicoBTS™ base station to perform a critical function. Critical functions include, but are not limited to the following list:

- Call processing of an emergency call
- Call processing of a call during normal or peak traffic hours

4.3 Performance requirements

4.3.1 Industry compliance requirements

The PicoBTS meets the minimum performance requirements of J-STD-019.

4.3.2 Maintainability

Samsung has designated craft and technical support personnel to perform depot and factory maintenance on the PicoBTS™ base station.

Module replacement at the site is limited to replacing a field replaceable unit (FRU). The PicoBTS™ base station FRUs are the PMU, a PRU, an antenna, or a cable.

If the PicoBTS™ base station is installed in accordance with the clearances prescribed for installation, the PicoBTS™ base station allows easy access to the faulty module for replacement. The PicoBTS™ base station is designed to minimize the number of steps required to remove and replace a module.

4.3.3 Mean time to repair (MTTR)

MTTR applies to the length of time required to replace a FRU) and includes the following operations by field personnel:

- Time required to perform fault detection and isolate the problem to a single FRU
- Time required to disassemble mounting fixtures (if any)
- Time required to replace the failed FRU
- Time required to reassemble mounting fixtures
- Time required to align and check out of the replacement FRU.

At the site level, the PicoBTS™ base station has a MTTR of thirty (30) minutes or less, and a maximum time to repair (MTTR_{MAX}) of ninety (90) minutes or less at the 95th percentile.

Note: MTTR and MTTR_{MAX} do not include the time required to travel to the PicoBTS™ base station site or to climb the tower.

5 Detailed specifications

This section presents detailed specifications for the PicoBTS™ base station. This module also discusses compliance to industry standards.

5.1 Mechanical packaging

Two physical components comprise the PicoBTS™ base station:

- PicoBTS™ main unit (PMU)
- PicoBTS™ radio unit (PRU)

Each unit is not hermetically sealed enclosure that protects the internal electronic equipment from adverse environmental affects and unauthorized access.

The PMU contains a main controller card, channel cards, transceiver interface card, power systems management, and other supporting modules. The PRU contains a transceiver card and supporting components.

The PMU occupies less than 6.1 cubic feet and weighs 115 lb. The PRU occupies less than 0.90 cubic feet and weighs 33 lb.

5.1.1 Mounting

Each PMU and PRU is packaged with appropriate mounting brackets to facilitate installation with conventional tools.

The PMU can be mounted in any of the following locations:

- At the base (pedestal mount) of a pole or tower
- On the side or top of a pole or tower
- On the wall of a building

The PRU is mounted on a frame, monopole, or tower, near its antennas to reduce insertion losses.

The PMU provides maintenance personnel with access to service panels, status indicators, and unit connections.

5.1.2 Cabling and connections

The PMU requires the following cabling and connections.

- Input voltage power of 110/220 Vac, 60/50 Hz, single phase
- T1 data connection
- GPS antenna

5.1.3 Power Consumption

The PMU consumes less than 970 W including all electronics, heat management (exclusive of AC heater), and power supply. The PRU consumes a maximum of 120 W. A fully configured three-sector PicoBTS™ base station with one PMU and three PRUs consumes:

- 1270 W in the worst case mode (three sectors with the heater running at full capacity to compensate for an outdoor temperature of -40°C)
- 875 W in normal operation with three sectors (no AC heater)

The PicoBTS™ base station operates on available AC power anywhere in the world from any AC power source in the following ranges.

- Input voltage: 90 to 260 Vac
- Input frequency: 47 to 63 Hz

The AC must be a directed 30 AMP circuit. The PMU has an AC outlet installed on the inside of the cabinet. this outlet supports test equipment. The outlet provides the same output voltage and frequency as the AC input for the specific site (minimum of 600 W [5 A at 120 VAC]).

5.2 PicoBTS™ Compliance Standards

The PicoBTS™ is tested for 5 W and 10 W compliance to the following standards:

- Code of Federal Regulations, Title 47, FCC Part 15 Radio Frequency Devices, Subpart B Unintentional Radiators (PMU)
- Code of Federal Regulations, Title 47, FCC Part 24 Personal Communications Services, Subpart E Broadband PCS (PRU)