RF Site Survey

Note that in the demonstration document the customer name has been replaced with "Hospital Campus" and "Hospital." All contact names and site photos have been removed.

Hospital Campus

Intermec Corporation
6001 36th Avenue West (PO Box 4280)
Everett, WA 98203-9280
Phone: (206) 348-2600
Fax: (206) 356-1889

Table of Contents

1. Contacts 1
2. Executive Summary 2
3. What is a Site Survey? 4
4. Site Survey Results Summary 5
5. Pre-Installation Notes 6
   - 5.1 Pre-Installation Checklist 7
6. Equipment Placement 8
   - 6.1 Phase I: Equipment Placement 9
     - *6.1.1 Phase I: 9180 Controller (IRM) 9*
     - *6.1.2 Phase I: Base Radio Unit (Building 1) 10*
     - *6.1.3 Phase I: Repeater (Engineering) 13*
     - *6.1.4 Phase I: Repeater (Building 18 Walkway) 15*
     - *6.1.5 Phase I: Repeater (Energy Plant) 17*
   - 6.2 Equipment Placement - Phase II 19
     - *6.2.1 Phase II: Base Radio Unit (D&T) 20*
     - *6.1.2 Phase II: Repeaters (D&T) 21*
     - *6.1.3 Phase II: Repeaters (Nursing Tower) 22*
7. Detailed Equipment Lists 23
   - 7.1 Phase I Equipment List 23
   - 7.2 Phase II Equipment List 24
   - 7.3 Application Equipment List 25

Appendix A -- Wide Band Overview 26
   - A.1 Spread Spectrum Radio Technology 26
   - A.2 RF Product Family 27
   - A.3 RFDC: How it Works 29

Appendix B -- RF Hardware Assembly 30
   - B.1 Single Exterior Antenna Mounting 30
   - B.2 Exterior/Interior Antenna Mounting 30
   - B.3 2-Way Interior Antenna Mounting 31
   - B.4 3-Way Interior Antenna Mounting 31

Appendix C -- Spectrum Analysis Graphs 32

Appendix D -- Additional Site Photographs 33

1. Contacts

Intermec

Jim *(names removed)*
Government Sales Manager

6001 36th Avenue West
Everett, WA 98203
(206) 356-1762 (fax 1889)

Clark
RF Systems Analyst

6001 36th Avenue West
Everett, WA 98203
(206) 348-2853 (fax 9551)

Medallion Service

Call 800-755-5505.for repairs if you purchased Medallion Service contracts for your equipment.

Hospital Campus

Seattle, WA 98108

Contact information removed

2. Executive Summary

Introduction

This site survey describes the Radio Frequency (RF) backbone designed for the Hospital Campus data collection system. This data collection system will track the location and status of equipment used throughout the Hospital Campus. The Hospital may expand the system in the future to track other items such as patient data, prescriptions, consumable items, parts, and inventory.

The Hospital will program the data collection system. Intermec provides the RF network design that transports data between the host computer and the JANUS handheld terminals. Since the Hospital may expand this data collection system in the future, Intermec designed an RF network that covers the majority of the campus. The RF network uses a very modular design to make the system easier to maintain. Minimal repeater hops make the entire RF network transfer data more quickly and efficiently. This modular approach also allows us to add more coverage as the campus expands.

Proposed Equipment

The proposed wireless network uses an assortment of RF communications components including 9180 RF Network Controllers, 9181 Base Radio Units (BRU), and 9183 Repeaters. The Intermec RF JANUS provides the end-user with a handheld, DOS terminal that includes on-board memory and radio. The JANUS communicates directly with the host computer through the RF link. The JANUS stores the data in its internal memory when it cannot communicate with the host. It can then send stored data to the host later either through the radio or directly connected to the host.

Application Overview

The Hospital Campus plans to use Intermec data collection equipment for medical equipment maintenance tracking. Operators scan an equipment ID when removing, calibrating, or replacing hospital equipment. The system sends the data over the RF network to a PC in the IRM computer room. The handheld terminal stores the data if the RF link is unavailable. The PC collects the data (either batch or RF) using Intermec Interscan software. Interscan then transfers this information to the database in the host computer at the Hospital.

Executive Summary, continued

Matching the vendor to the customer

Intermec brings considerable RF and data collection experience to this project. Intermec JANUS handhelds and RF systems routinely operate in a variety of demanding environments including hospitals, manufacturing shops, warehouses, etc. The Portland Hospital uses a similar RF system for automated data collection. Intermec has the experience and equipment required for such a demanding site as the Hospital Campus. Our broad product line also ensures that the Hospital can expand this system to handle future applications.

About Intermec

Intermec manufactures and sells a complete line of data collection products including fixed readers, portables, Radio Frequency (RF) systems, software, printers, and printer media. With this compliment of products, Intermec can address virtually any of data collection requirement (present or future) required by Hospital. Over 75% of the Fortune 500 and over 60% of Fortune 100 companies use Intermec equipment. Many government, military, hospital, and Postal Service organizations also use Intermec equipment. Many of these customers are members of Intermec's 3,500 member users group.

Future migration

Intermec invests over $10 million dollars yearly in the development of new products to stay ahead of our competitors and to continue to be able to offer solutions that match the needs of our customers. As data collection technology advances, you can be assured that Intermec will be able to supply the Hospital with new technology while preserving the value of its existing investment. It is a policy at Intermec to maintain the highest degree of backward compatibility possible.

Conclusion

Intermec has the experience, the equipment, and the support required by the Hospital Campus. We can help the Hospital Campus move to an automated and paperless data collection solution. Intermec looks forward to the opportunity and challenge of bringing automated data collection technology and expertise to the Hospital Campus.

3. What is a Site Survey?

The layout and operating environment of a facility significantly affects a wireless system. Site surveys allow Intermec to understand how the RF system will function under expected operating conditions. This helps insure that the system will operate reliably in a real-world environment. This document summarizes the site survey performed at your facility.

What do Site Surveys Cover?

The radio frequency (channel) we recommend to avoid conflict with other users and noise sources.

The maximum usable range that will assure reliable data communications.

Where to expect dead spots in your facility. Dead spots are areas where radio coverage is not possible.

Complete system equipment list, pre-installation details, and installation details for each piece of equipment.

The three basic components of a site survey are spectrum analysis, site mapping, and equipment placement details:

Spectrum / Frequency Analysis

The spectrum analysis phase checks for RF activity that could interfere with the RF data collection system. A spectrum analyzer monitors all RF activity in the frequency range. Outside RF activity such as other RFDC users or unintentional RF radiators could cause interference. This analysis allows us to select the best possible frequencies for your RFDC system. Intermec analysts may use one channel for the site mapping but we may select another channel for the actual installation. We monitor the RF activity for approximately 24 hours in order to discover any sporadically RF activity (day or night).

Site Mapping

To prepare for a site survey we first divide a floor plan of your facility into a grid. Site mapping requires a 9465 RF Trakker, 9189 RF Gateway, and 9440 Trakker. The Trakker and RF Gateway simulate the proposed Base Radio Unit (BRU). We use the 9465 to check the facility by grid location and record RF signal strength from many points in each grid location. We then use data to evaluate the quality of the communications throughout the desired coverage area.

Equipment Placement

These section include details that describes installation details for each piece of RF equipment. These details include pre-installation, power, cabling, equipment placement, and antenna placement.

4. Site Survey Results Summary

Intermec plans to implement the Hospital Campus wireless system in two phases. Phase I covers half of the campus including Building 1, Engineering Shops, Energy Plant, and the areas behind Building 1. Phase II covers D&T, Building 100, and the Nursing Tower.

Coverage

The Hospital Campus coverage requirements are: Phase 1 - Building 1 (floors B, 1, 2), Engineering Shops, and the Energy Plant; and Phase 2 - D&T, Building 100, and the Nursing Tower. Intermec analysts devised a site plan to provide an RF backbone that covers the targeted areas of the campus. The RF design uses minimal repeater hops to increase data throughput. A modular design makes system diagnostics and debugging easier.

Equipment Placement

Phase I: The 9180 RF Network Controller goes in the IRM computer room. The 9181 Base Radio Unit (BRU) resides in the 9th floor of Building 1. A rooftop repeater (9183) on Engineering provides coverage for Engineering and the face of building 1. An antenna with repeater (9183) on the roof of the walkway between buildings 1 and 18 provides coverage for the back of the campus, the back face of building 1, and links the repeater in the Energy Plant with the BRU. An interior and rooftop antenna with repeater provides coverage for the dock area and the inside of the Energy Plant.

Phase II: Phase II uses the same 9180 RF Network Controller installed in Phase I. A 9181 BRU located in the interstitial space above floor 2 in building 100 provides a link to three interior antennas. Two antennas provide RF coverage for the floors above and below. The third antenna provides an RF link to an antenna in the Nursing Tower. The interstitial floor between D&T and the Nursing Tower provides a clear path between the antennas. Every other interstitial floor in the Nursing Tower contains a 9183 repeater and these repeaters link to one another through antennas mounted in the vacant elevator shaft in the center of the Nursing Tower.

Intentional / Unintentional Radiators

Our analysis showed no evidence of intentional RF radiators and only low level random noise from unintentional radiators in the 902 - 928 MHz range (no significant interference). We observed some noise spikes approximately 5 dB above the ambient noise level which could be caused by transient events such as turning on a large piece of electrical equipment. These infrequent and low energy spikes will have no effect on the RF communications.

Frequency Assignment

Intermec recommends using 924 MHz for the entire campus. Spectrum analysis was performed with an IFR A-7550 Analyzer (results in appendix C). The Hospital can use any of the seven available channels (906, 909, 912, 915, 918, 921, 924 MHz). The completed system uses two 9181 Base Radio Units both operating at 924 MHz.

5. Pre-Installation Notes

This section provides general information about RF equipment placement, limitations associated with equipment placement, and steps required prior to system installation.

Cabling: 9180 to 9181

RS-232 cable runs (without line drivers or modems) shall not exceed 50 feet from the host computer to the 9180. RS-422 cable runs (without line drivers or modems) shall not exceed 4000 feet from the host to the 9180.

Cabling: Supervisory CRT

Intermec recommends using an ASCII asynchronous terminal as an RF network supervisory CRT. The terminal connects to the RS-232 supervisory port of the 9180 Controller. Intermec does not supply this terminal. While any terminal or emulation works, Intermec recommends the following terminals/emulations: Televideo 910/920, Hazeltine 1500, ADM 3A, or VT-100. A PC with a communication program can also function as a supervisory CRT.

Note: Connections from the controller to the host or supervisory CRT can use direct connect, lease line, modems, or line drivers to extend the cable length. Placing the supervisory CRT on a dial line modem allows remote configuration and support of the 9180 RF Network Controller.

Cabling: 9180 to 9181

Each 9181 Base Radio Unit (BRU) connects to the 9180 RF Network Controller through a solid-core copper cable (part# 583326). This cable requires careful handling. Flexing or pinching the cable could break the center conductor wire. The party responsible for installation must terminate the cable.

Important! Cable runs from 9180 RF Network Controller to 9181 Base Radio Units shall not exceed 2000 feet. Special communications devices or circuits could make longer cable runs possible. Please discuss any such cable runs with your Intermec Applications Analyst prior to installation.

AC Power

Each RF device requires a switched dedicated (computer grade) 120 VAC (15 or 20 amp) power outlet with building/earth ground. The duplex outlet must be within five feet of the device. This circuit should be run directly from a power distribution panel, installed with its own breaker switch to ensure the cleanest electrical power possible.

Lightning Arrestors and Grounding

All exterior antennas require lightning arrestors. All lightning arrestors require #4 to #6 AWG copper wire connected to an earth Ground. This grounding along with the lightning arrestor help protect the Intermec RF equipment from damage due to lightning.

5.1 Pre-Installation Checklist

Installing Radio Frequency Data Collection (RFDC) network requires site preparation. Site personnel or an Intermec-recommended contractor can perform these steps prior to system installation.

Radio Mounting

Installation includes preparing a radio mounting surface. This surface can simply be a wall using a sturdy fastener, such as a toggle bolt in a hollow wall, or masonry bolts for concrete block and poured concrete walls.

Radios are usually mounted on the ceiling joists. There are a number of possible mounting techniques. Some customers mount the radio, antenna, and power conditioning equipment to a plywood sheet installed vertically into the ceiling joist. Others use U-bolts or J-bolts to mount the equipment. Site maintenance personnel normally design the mounts based on tools and resources available.

The customer is responsible for the RFDC installation options, and must ensure that the mounting hardware is installed prior to the RFDC network installation.

Customer Responsibilities

The customer must provide these items prior to installation:

1. RF system bench test, certified by Intermec service representative.
2. Access holes through roof or walls with resealing capability.
3. Wire (#4 AWG minimum) from earth ground to lightning arrestor.
4. Power conditioner for 9180 controller.

Customer / Subcontractor Responsibilities

Intermec can arrange for subcontracting these items of customer responsibility. These items must be completed prior to installation:

1. AC (115 VAC) outlet for repeaters and BRUs.
2. Outdoor antenna mounting (includes antenna, pole, and anchoring).
3. BRU/Repeater mounting (including mounting hardware).
4. Coaxial cable routing (from BRUs to antennas).
5. 9180 to 9181 cable routing, installation and termination.
6. Lightning arrestor mounting and grounding.

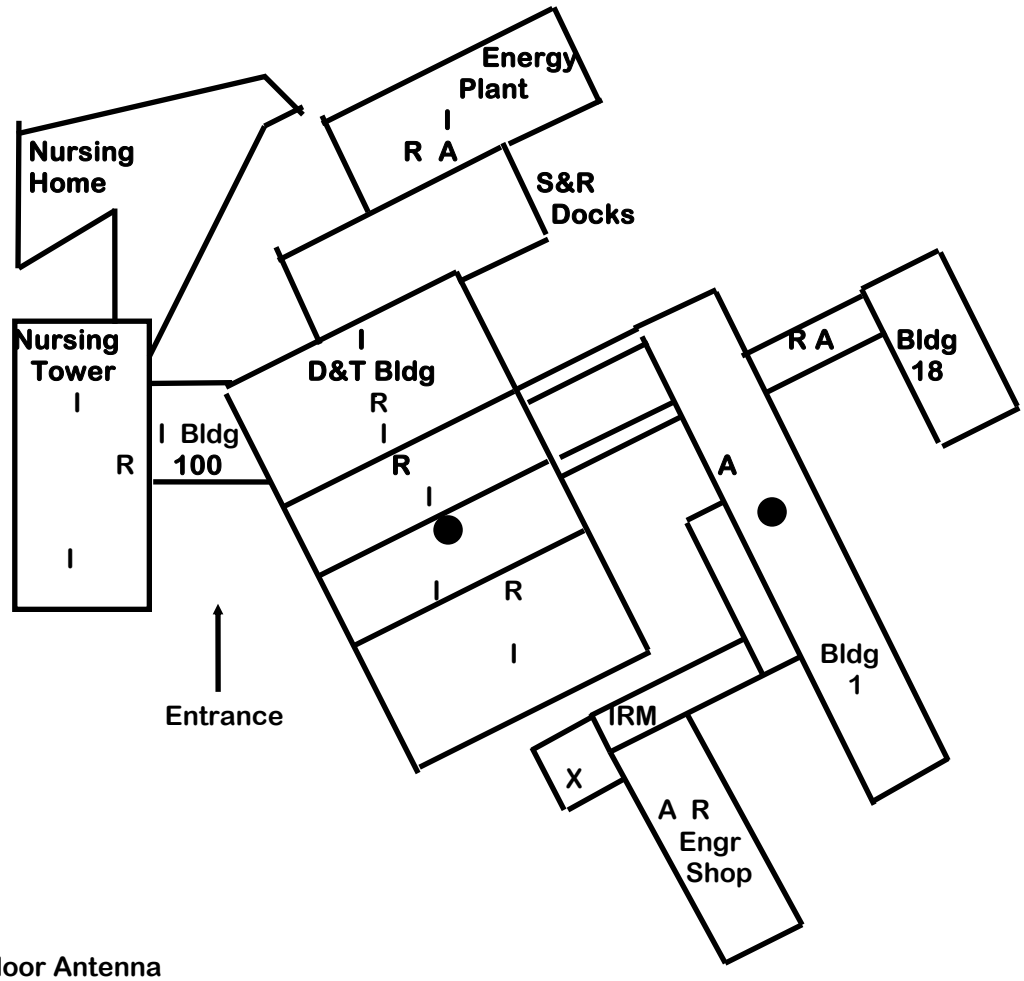
Intermec Responsibilities

Intermec provides the following invoiced services:

1. Coaxial cable termination, and
2. RF system certification.

6. Equipment Placement

This page shows an overview of RF equipment placement for the Hospital Campus. This site plan covers both Phase I and Phase II equipment.



Legend

- I Indoor Antenna
- A Outdoor Antenna
- ● Base
- R Repeater
- X Controller

6.1 Phase I: Equipment Placement

Phase I provides RF coverage to the Engineering Shops, all floors of Building 1, the entire back half of the campus (in back of building 1), the Energy Plant, and the dock area near the Energy Plant. Building 1 was constructed in the 1950s and contains no interstitial floors. The repeaters on Engineering and on the Building 18 walkway provide RF coverage for Building 1. The 9181 Base Radio Unit (BRU) on the top of Building 1 links the repeaters on both side of building 1 (repeaters on Engineering and Building 18 walkway).

6.1.1 Phase I: 9180 Controller (IRM)

The Information Resource Management (IRM) building is located in front of Building 1 near the Engineering Shops. IRM houses the mainframes computers. The 9180 RF Network Controller resides in IRM and connects to the 9181 Base Radio Unit (BRU) on the top of Building 1. The 9181 BRU cable connects to the 9180 DOWNLN1 port. IRM provides a clean and secure operating environment for the 9180 RF Network Controller.

Location The controller will reside somewhere in the IRM equipment room. Hospital staff will determine the exact location based on the locations of connecting cables and power.

Power Clean power is available. Intermec strongly recommends a power conditioner for the 9180 Controller.

Cabling The 9180 to 9181 cable routing uses existing conduits and cable trays from the BRU in Building 1 to IRM. See the sections on Phase I Base Radio Unit for details on the cable runs.

Parts List

PART NO.	QTY	DESCRIPTION
9181B02	1	9180 RF Network Controller with 256K RAM
TBD	1	AC power conditioner
054182	1	9180 power supply (120 VAC)
055003	1	Mil. Spec. connector kit for 9180/9181
047286	1	Cable for supervisory CRT
052477	1	Cable for host connection
054292	1	9180 Network Controller User's Manual

6.1.2 Phase I: Base Radio Unit (Building 1)

Building 1, located roughly in the middle of the campus, consists of nine floors with no interstitial floors. Due to stringent fire codes we cannot run cables in the ceiling. An engineering office on the 9th floor will house the 9181 Base Radio Unit (BRU).

Location

The BRU resides on the 9th floor mounted to the wall between door 903 and the elevator. This minimizes the cable distance between the BRU and the outside antenna. The BRU cable connects to the 9180 RF Network Controller (in IRM) through electrical closet 903-A.

Power

Power outlet is available on the other side of the wall.

Cabling

A cable through existing electrical conduits and cable trays connects the BRU to the 9180 RF Network Controller in IRM. The cable extends from the electrical closet 903-A on top of Building 1 to the closet next to room B-22 (about 150’ drop) in the basement of Building 1. The cable continues from B-22 to IRM through the existing cable trays. The entire cable run should be roughly 300’. This cable connects to the DOWNLD1 port of the 9180 Network Controller.

Antenna

The BRU connects (via coax) to an external, pole-mounted, omni-directional antenna. This antenna links the repeaters (on Engineering and Building 18 walkway) with this BRU via a direct line-of-sight link between antennas. This external antenna mounts on top of Building 1 and connects to the 9180 BRU using existing rooftop cable conduits. The antenna is mounted on the front left corner railing (Puget Sound side) on the roof. This antenna requires a lightning arrestor.

Parts List

PART NO.	QTY	DESCRIPTION	
9181B02	1	9181 RF Base Radio Unit	
053574	1	9181/9183/9189 System Manual	
060284	1	Connector, TNC-female, RG8	***See diagram B.1 in Appendix B***
061475	3	Connector, N-female, RG8	
060587	1	Omni-directional antenna, N-male	
061868	1	Lightning arrestor, N-male	
062531-001	1	Lightning arrestor mounting bracket	
-----	1	To earth ground (#4 AWG Cu)	
583364	80’	RG8 coaxial, BRU to antenna	
583326	300’	cable, BRU to controller	

Photo on Bldg 1 looking down on Engineering	Photo of the face of Building 1. **(Photos removed for this demonstration proposal)**
Building 1 Photographs: Above View from Building 1 antenna location looking down on the roof of the Engineering (direct line-of-sight). Top-Right: View of Building 1 from the roof of the Engineering Shops. Antenna is located on the top level on the railing opposite the ventilation stack. Right: View from Building 1 antenna location looking down on the walkway between Buildings 1 and 18.	Photo on Bldg 1 looking down on Bldg 18 walkwy

Base Radio Unit (Building 1), continued

(Photos removed for this demonstration proposal)	The outside omni-directional antenna mounts to the corner of the railing on the top level of Building 1. The white building on the left in the photo is the Nursing Tower.

	The 9181 BRU mounts to the wall near this hatch. The wall on the other side of this hatch has a power outlet.

6.1.3 Phase I: Repeater (Engineering)

Engineering Shops are located in front of the west side of Building 1. The rooftop antenna for the repeater uses existing cable conduits for the coaxial cable run to the repeater. This repeater provides coverage for Engineering, the north side of building 1, IRM, and the north-west area of the campus.

Location

The 9183 repeater mounts in the shop area to a wall near the rooftop cable access conduits. Inside the shops there is a doorway that leads to engineering offices. The repeater will mount near this door since this provides easy access to both the repeater, the rooftop cable conduit, and to power.

Power

Existing power outlets near the 9183 supplies AC power.

Cabling

The coaxial cable to the rooftop antenna uses the existing conduits in the ceiling. The coaxial cable starts at the antenna, goes through the rooftop conduit, extends across ceiling beams and down the wall to the repeater. This should require roughly 50’ of RG8 coaxial cable.

Antenna

The omni-directional antenna is mounted on a small 8’ - 10’ mast near the rooftop cable conduit and the air conditioning unit. This antenna requires a lightning arrestor.

Parts List

PART NO.	QTY	DESCRIPTION	
9183A02	1	9183 RF Repeater	
060284	1	Connector, TNC-female, RG8	***See diagram B.1 in Appendix B***
061475	3	Connector, N-female, RG8	
060587	1	Omni-directional antenna, N-male	
061868	1	Lightning arrestor, N-male	
062531-001	1	Lightning arrestor mounting bracket	
-----	1	To earth ground (#4 AWG Cu)	
583364	50’	Coaxial, 9183 to antenna	

Repeater (Engineering), continued

(Photos removed for this demonstration proposal)	The outside omni-directional antenna mounts near the 'X' on the raised area of the roof (near the center of the photo). The coaxial cable runs from the antenna through the cable conduit near the air conditioning unit.

	The repeater mounts inside Engineering on the wall near the office doorway. The repeater plugs into an existing AC outlet.

6.1.4 Phase I: Repeater (Building 18 Walkway)

This repeater and antenna is located on the walkway between Building 18 and Building 1. This repeater provides coverage to the back of the campus, to the back face of building 1, and provides a radio link to the Energy Plant. This antenna requires a clear line-of-sight link with the 9181 Base Radio antenna on the top of Building 1 and with the antenna on the outside of the Energy Plant.

Location

Repeater mounts to the concrete wall just inside the door of Stairwell 3 (roof access).

Power

There is a power conduit near the door that needs an AC outlet installed.

Cabling

A coaxial cable connects the repeater to the outside antenna. This connection should use roughly 20’ of coaxial cable. Hospital personnel must drill a hole in the wall of the stairwell shelter to enable us to run the cable from the repeater to the outside antenna.

Antenna

The omni-directional antenna will be anchored to the outside wall of the stairwell shelter with a coaxial cable run from the antenna to the repeater inside the stairwell. The antenna requires a lightning arrestor. This antenna must be in direct line-of-sight with the antenna on top of Building 1 and with the antenna on the roof of the Energy Plant.

Parts List

PART NO.	QTY	DESCRIPTION	
9183A02	1	9183 RF Repeater	
060284 061475 060587 061868 062531-001 -----	1 3 1 1 1 1	Connector, TNC-female, RG8 Connector, N-female, RG8 Omni-directional antenna, N-male Lightning arrestor, N-male Lightning arrestor mounting bracket To earth ground (#4 AWG Cu)	***See diagram B.1 in Appendix B***
583364	20’	Coaxial, 9183 to antenna	

(Photos removed for this demonstration proposal)	The repeater mounts to the wall inside the stairway shelter. The Hospital must drill a hole in this wall for the cable that connects the antenna to the repeater. The roof access door is on the extreme right of the photo.
	The outside omni-directional antenna mounts on top of the stairwell shelter giving it a line-of-sight link with the antenna on the top of Building 1 and with the Energy Plant. The Energy Plant is the white building in the background.

6.1.5 Phase I: Repeater (Energy Plant)

The Energy Plant is a large, high-ceiling building that houses large power equipment. A concrete wall divides the inside of the plant and each section requires RF coverage. The energy plant connects to the RF base station through the repeater on the Building 18 walkway.

Location

The repeater mounts on the wall near the top of the stair shelter (wall facing the roof access door). The coaxial cable from the repeater to the outside antenna is routed through an existing cable conduit to the roof.

Power

An AC outlet is located approximately 8’ below the repeater.

Cabling

A coaxial cable is routed from the outside antenna to the repeater using existing rooftop cable conduits. The coaxial cable routed to the inside antenna goes through the concrete wall that divides the plant (hole must be drilled) and follows the ceiling beams to the antenna (roughly 60’).

Antenna

An external antenna connects the Energy Plant with the repeater on the Building 18 walkway. A two-way splitter connects the repeater to inside and outside omni-directional antennas. The inside antenna provides coverage for the entire Energy Plant and has a 50 dB safety margin.

OUTSIDE: The outside antenna mounts above the metal skirting on the roof of the Energy Plant. The antenna is positioned roughly in the middle of the face of the Energy Plant to provide a line-of-sight link with the antenna on the Building 18 walkway. The cable run from repeater to outside antenna cannot exceed 100 feet.

INSIDE: Internal antenna hangs from an I-beam above the control room. The coaxial cable from the inside antenna to the repeater extends along the ceiling through a concrete wall, and up the stairwell to the repeater.

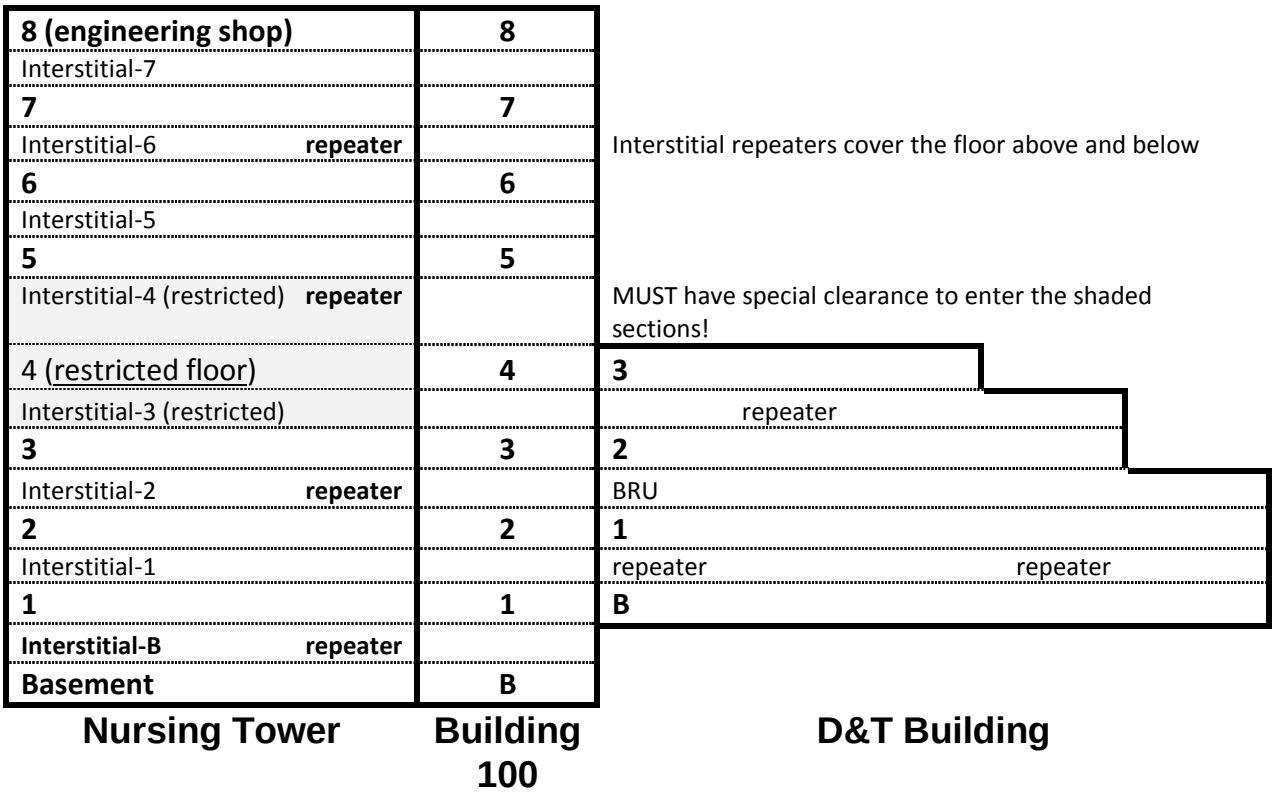
Parts List

PART NO.	QTY	DESCRIPTION	
9183A02	1	9183 RF Repeater	
060284	1	Connector, TNC-female, RG8	***See diagram B.2 in Appendix B***
061475	4	Connector, N-female, RG8	
060587	2	Omni-directional antenna, N-male	
061868	1	Lightning arrestor, N-male	
062531-001	1	Lightning arrestor mounting bracket	
-----	1	To earth ground (#4 AWG Cu)	
059088	3	Connector, BNC-female, RG8/U	
059089	1	2-way splitter, 3dB, BNC-male	
583364	3’	Coaxial, 9183 to splitter (approx. 3’)	
583364	100’	Coaxial, splitter to antennas (approx. 100’)	

(Photos removed for this demonstration proposal)	The repeater inside the stairwell shelter to the wall facing the roof access door. Power is directly below the repeater and the coaxial cable runs through existing rooftop cable conduits to the outside antennas.	
		The outside omni-directional antenna mounts on top of the metal skirting on the roof of the Energy Plant. This antenna must have a direct line-of-sight link with the antenna on the Building 18 walkway. The antenna must also be within a 100' cable run of the repeater.

6.2 Equipment Placement - Phase II

Phase II of the installation consists of adding another 9181 Base Radio Unit (BRU) in the D&T building. The 9181 BRU connects to the existing 9180 RF Network Controller installed for Phase I. Phase II equipment mounts in the interstitial floors of the D&T building and the Nursing Tower. Almost every piece of equipment requires wiring AC outlets, mounting in steel beams or concrete walls, and cable runs through the interstitial areas.



Building 100 is the triangular-shaped building that connects the Nursing Tower to D&T. Notice that the floors in D&T are numbered differently than the floors in Building 100 and the Nursing Tower.

Caution !! **Caution !!** **Caution !!** **Caution !!** **Caution !!** **Caution !!**	Floor 4 of the Nursing Tower contains the bone marrow section. This section houses patients extremely vulnerable to any type of foreign substances including dust and airborne particles. We MUST NOT drill anywhere near this area (including the areas above and below) without special clearance. We also REQUIRE clearance to work in the interstitial areas above and below the bone marrow section.

6.2.1 Phase II: Base Radio Unit (D&T)

The D&T building consists of four floors (basement and 1-3) with interstitial floors. The 9181 BRU resides in the interstitial above floor 1 and links to the interstitial above floor 2 in the Nursing Tower. This 9181 Base Radio Unit (BRU) connects to three antennas and provides an RF link to the Nursing Tower and RF coverage for floors 1 and 2 in D&T. The 9180 RF Network Controller in the IRM computer room cables directly to this 9181 BRU.

Location

The 9181 BRU mounts to beam N103 in the interstitial above floor 1 in D&T. This interstitial connects to the interstitial above floor 2 Nursing Tower. This BRU provides RF coverage for floors 1 and 2 of D&T and provides an RF link to all repeaters in the Nursing Tower. Beam N103 is located in the area between the Nursing Tower and D&T.

Power

The BRU needs an AC power outlet installed.

Cabling

A cable connects the BRU to the 9180 RF Network Controller located in IRM. The cable is run through closet 2d-151c in D&T. This cable run then extends from D&T closet 324 to the closet next to B-22 in the basement of Building 1 through existing cable trays from B-22 to IRM. **NOTE**: This is the same cable closet that connects the BRU in Building 1 to the 9180 in IRM. This BRU connects to the 9180s DOWNLD2 port.

Antennas

This BRU connects to three antennas to provide coverage for D&T and to provide an RF link to the repeaters in the Nursing Tower.

Nursing Tower: An omni-directional antenna mounts in the vacant elevator shaft in the Nursing Tower and provides an RF link to all Nursing Tower repeaters.

D&T: Two omni-directional antennas provide coverage for floors 1 & 2 in D&T. One antenna mounts near BRU and one towards the front of D&T.

Parts List

PART NO.	QTY	DESCRIPTION	
9181B02	1	9181 RF Base Radio Unit (BRU)	
060284	1	Connector, TNC-female, RG8	***See diagram B.4 in Appendix B***
061475	3	Connector, N-female, RG8	
060587	3	Omni-directional antenna, N-male	
TBD	1	3-way splitter, BNC-male	
581925	4	Connector, RG8/U BNC-male (old)	
583364	80’	Coaxial, BRU/antenna (Nursing Tower elevator)	
583364	120’	Coaxial, to 2 antennas in D&T area	
583326	500’	Cable, 9180 RF Network Controller to 9181 BRU	

6.1.2 Phase II: Repeaters (D&T)

The D&T building consists of four floors (basement and 1-3) with interstitial floors. These three repeaters link with the 9181 BRU located in the interstitial above floor 1 of D&T. Repeaters in the interstitial floor provides coverage for the entire floor above and below.

Location Three repeaters in interstitial floors cover all of D&T. Two repeaters on the interstitial above the basement provide coverage for the D&T basement and floor 1. We need two repeaters to cover this area due to heavy shielding around the pharmacy area. Another repeater in the interstitial above floor 2 provides coverage RF coverage for floors 2 and 3. Repeaters mount near the midpoint of the building along the wall. Repeater location depends on power availability.

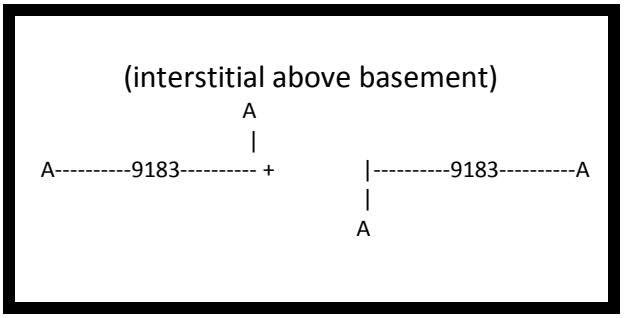
Power Each repeater in the interstitial floors needs an AC outlet installed.

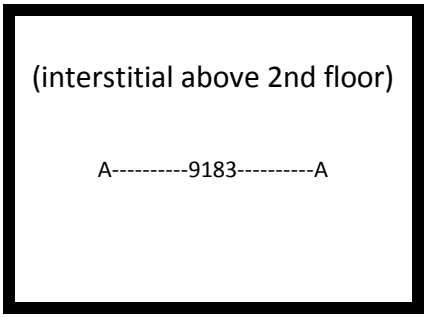
Cabling Each repeater connects to two antennas through a splitter. The coaxial cable extends from the repeater to a center point in each floor.

Antenna Each repeater on the interstitial floors connects to two omni-directional antennas using a two-way splitter. Signal splitting provides more even coverage of the floors above and below.

Parts List

PART NO.	QTY	DESCRIPTION	
9183A02	3	9183 RF Repeater	
060284	3	Connector, TNC-female, RG8	***See diagram B.3 in Appendix B***
061475	6	Connector, N-female, RG8	
060587	6	Omni-directional antenna, N-male	
059088	9	Connector, BNC-female, RG8/U	
059089	3	2-way splitter, 3dB, BNC-male	
583364	9’	Coaxial, 9183 to splitter (approx. 3’ each)	
583364	600’	Coaxial, splitter to antennas (6 runs ~100’ each)	





6.1.3 Phase II: Repeaters (Nursing Tower)

The Nursing Tower consists of eight main floors (basement and floors 1-7) with interstitial floors (16 total floors). The Nursing Tower has an engineering shop on the 8th floor and a bone marrow section on the 4th floor. **We must have special clearance when working around the 4th floor (including in the interstitial floors). Bone marrow patients are extremely sensitive to any contaminants!**

Location

The interstitial repeaters are mounted on every other interstitial floor. These radios provide coverage for both the floor above and below the interstitial floors. The installation requires a set of repeaters and antennas in the interstitials above floors B, 2, 4, and 6. Repeaters mount somewhere near the center of the building depending on where power is most readily available.

Power

Each repeater in the interstitial floors needs an AC outlet installed.

Cabling

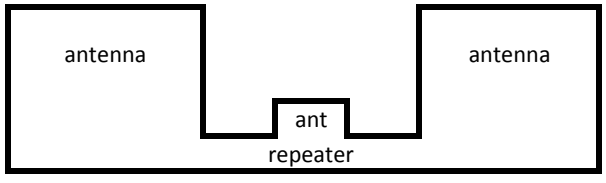
Each repeater connects to three antennas through a splitter. Two long coaxial runs extend from the repeater to the center of each bulge area. One cable run extends to an antenna in the vacant elevator shaft (this run may require drilling on some of the floors).

Antenna

Each repeater on the interstitial floors connects to three antennas. Two antennas provide RF coverage for the floors above and below. One antenna links the repeaters through the vacant elevator shaft.

Parts List

PART NO.	QTY	DESCRIPTION	
9183A02	4	9183 RF Repeater	
060284	4	Connector, TNC-female, RG8	***See diagram B.4 in Appendix B***
061475	12	Connector, N-female, RG8	
060587	12	Omni-directional antenna, N-male	
TBD	4	3-way splitter, BNC-female	
581925	16	Connector, RG8/U BNC-male (old)	
583364	12’	Coaxial, 9183 to splitter (approx. 3’ each)	
583364	800’	Coaxial, splitter to antennas (approx. 200’/repeater)	



Nursing Tower Top View

Repeaters (center of building) connect to 2 antennas in the wings.

Antenna in elevator shaft communicates with other repeaters.

Repeater connects to antenna in the vacant elevator shaft.

7. Detailed Equipment Lists

This section contains a master equipment list. This section includes Phase I equipment, Phase II equipment, and application equipment. The Phase I list includes one manual for each hardware device. The Phase I and Phase II lists contain NO end user devices, or programming manuals.

7.1 Phase I Equipment List

	ITEM #	QTY	PART NO.	DESCRIPTION
Network Controller	A-1	1	9180B01	9180 RF Network Controller
	A-2	1	055003	Mil. spec. connector kit for 9180/9181
	A-3	1	054182	9180 power supply
	A-4	1	TBD	AC power conditioner
	A-5	1	047286	Cable for supervisory CRT
	A-6	1	052477	Cable for host connection
Base Radio	B-1	1	9181B02	9181 RF Base Radio Unit
	B-2	1	053574	9181/9183/9189 System Manual
	B-3	1	TBD	9181 mounting hardware1
Repeaters	C-1	3	9183A02	9183 Repeater
	C-2	3	TBD	9183 mounting hardware1
Antennas	D-1	4	060284	Connector, TNC-female, RG8
	D-2	13	061475	Connector, N-female, RG8
	D-3	5	060587	Omni-directional antenna, N-male
	D-4	4	061868	Lightning arrestor, N-male
	D-5	3	062531-001	Lightning arrestor mounting bracket
	D-6	3	059088	Connector, BNC-female, RG8/U
	D-7	3	-----	To earth ground (#4 AWG Cu)
	D-8	1	059089	2-way splitter, 3dB, BNC-male
Cable	E-1	4	583364	100' Roll RGU/8 coaxial cable (need ~250')
	E-2	1	583326	1000' roll 9180/9181 cable (Belden #89688)
Installation	F-1	4 days		Connection & Certification (Intermec)
	F-2	4 days		Installation (customer or sub-contractor)
	F-3	1 day		Power (customer or sub-contractor)

This list does not include system installation time, technical training, end user training, Medallion Maintenance Service, end devices, or programming tools/manuals.

[1] mounting hardware includes screws, anchors, tie wraps, etc.

7.2 Phase II Equipment List

	ITEM #	QTY	PART NO.	DESCRIPTION
Network Controller	A-1	N/A	9180B01	9180 RF Network Controller
	A-2	1	055003	Mil. spec. connector for 9180/9181
	A-3	N/A	054182	9180 power supply
	A-4	N/A	047286	Cable for supervisory CRT
	A-5	N/A	052477	Cable for host connection
Base Radio	B-1	1	9181B02	9181 RF Base Radio Unit
	B-2	N/A	053574	9181/9183/9189 System Manual
	B-3	1	TBD	9181 mounting hardware1
Repeaters	C-1	6	9183A02	9183 Repeater
	C-2	1	TBD	9183 mounting hardware1
Antennas	D-1	8	060284	Connector, TNC-female, RG8
	D-2	21	061475	Connector, N-female, RG8
	D-3	21	060587	Omni-directional antenna, N-male
	D-4	9	059088	Connector, BNC-female, RG8/U
	D-5	3	059089	2-way splitter, 3dB, BNC-male
	D-6	5	TBD	3-way splitter, BNC-female
	D-7	20	581925	Connector, BNC-male, RG8/U (old)
Cable	E-1	16	583364	100’ Roll RGU/8 coaxial cable (for antennas)
	E-2	N/A	583326	1000’ roll 9180/9181 cable (Belden #89688)
Installation	F-1	12 days		Connection & Certification (Intermec)
	F-2	6 days		Installation (customer or sub-contractor)
	F-3	4 day		Power (customer or sub-contractor)

This list does not include system installation time, technical training, end user training, Medallion Maintenance Service, end devices, or programming manuals.

[1] mounting hardware includes screws, anchors, tie wraps, etc.

7.3 Application Equipment List

	PART NO.	DESCRIPTION
JANUS 2010	JR2010B-011102	JANUS 2010 w/NiCad battery pack, 900 MHz RF back.
	057996	1200 mA hour NiCad Battery Pack
	058744	PCMCIA, 2 meg. SRAM (for applications over 300K)
	1262H01	1262 wand with cable
JANUS Dock	JD2010A	Communications Dock & Battery Pack Charger
	058399	Power supply for 4-Pack Battery Charger / Comm dock (requires power cord below)
	047793	120 VAC, 60Hz cord for power supply
	047569	Dock to PC cable
Software Tools	059812	JANUS Developers Kit
	055917	Interscan (includes one Reference Manual)
	053819	Interscan User's Manual
Manuals	058426	J2020 User's Manual
	059812	J2010 PSK
	058427	Programmer's Reference Manual
	044737	Data Communications Manual
	057596	4100 User's Manual
Other	4100A00000	4100 printer
	048668	4100 printer to PC cable
	F1027	On-site application training

Appendix A -- Wide Band Overview

This section presents an overview of the Intermec wideband RF Data Collection (RFDC) system. Conventional data collection systems may include an array of readers and printers hardwired to a host computer through a central controller. Mobile, hand held devices must eventually send their data to the host computer. These static but reliable hardwired system do not have the flexibility required by many applications.

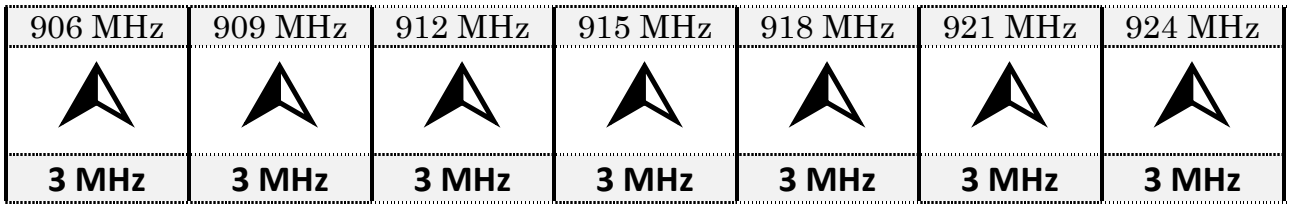
The Intermec Radio Frequency Data Collection (RFDC) system combines flexibility, mobility, and real-time host communications. RFDC systems establish a two-way radio link between remote devices and a central RF Network Controller. This versatility adds tremendous latitude in designing and implementing a data collection system. End users benefit by having the real-time response of a fixed reader with the portability of a hand held.

A.1 Spread Spectrum Radio Technology

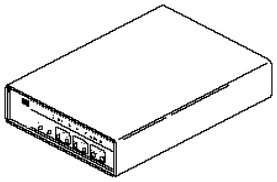
Most familiar RF communication devices, such as cordless telephones or CB radios, operate on a specific frequency. This is referred to as narrow band technology, since the signal occupies a very small part of the RF spectrum. Some wireless data collection systems can use narrow band but its susceptibility to interference makes it unacceptable for many applications.

The Intermec Wide Band RFDC system uses spread spectrum technology (SST) to overcome the limitations imposed by narrow band. Instead of transmitting on a single frequency each SST channel uses approximately a 3 MHz band of RF spectrum. For example, if an end device operates on the 918 MHz channel, it actually uses the range 916.5 to 919.5 MHz. Some of the advantages of SST over narrow band include:

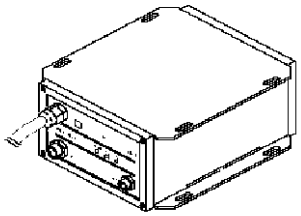
- The FCC does not require an operator's license for SST.
- Maximum data rate of 122 kbps, compared to 9600 BPS full/half duplex for narrow band.
- Fast, "On The Fly" channel changing verses changing crystals.
- Spread Spectrum does not require an RF Modem.
- SST has an attack time (the time it takes the RF carrier to stabilize after the transmitter is turned on) of 0.1 to 2.0 ms, compared with 10 to 30 ms for narrow band.
- Intermec SST can use all CrossBar compatible devices (printers, handhelds, on-line readers, etc.).
- SST is not susceptible to interference as is narrow band.
- Easy use of intelligent repeaters.



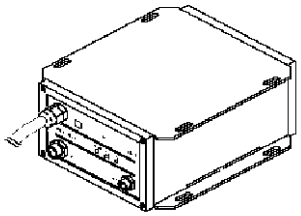
A.2 RF Product Family



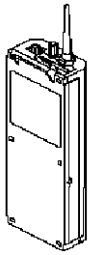
9180 Network Controller: The RF Network Controller is the focal point of the entire RFDC system. It controls the flow of information between the I/O devices and the Host computer. The 9180 RF Network Controller is an asynchronous concentrator capable of connecting the host to a maximum of 128 devices through one host port. This unit can control up to two Base Radio Units (BRU).



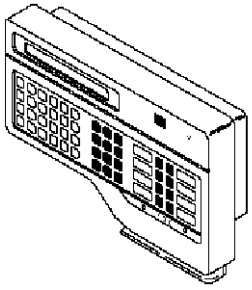
9181 Base Radio Unit (BRU): The 9181 BRU connects to a down-line port of the RF Network Controller. The BRU acts as a receiver and transmitter and provides an RF link between the host computer and the I/O devices.



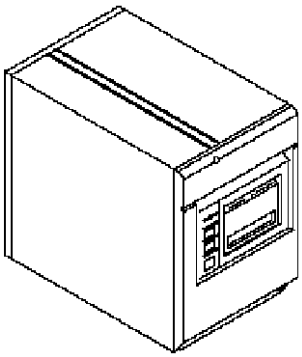
9183 Radio Repeater: The 9183 Repeater acts as a verify and forward device to improve radio coverage. The 9183 is not merely a conventional signal boosting device that merely amplifies and retransmits weak signals. The 9183 is an intelligent, error correcting device. It retransmits uncorrupted data packets and requests retransmission of corrupted packets.



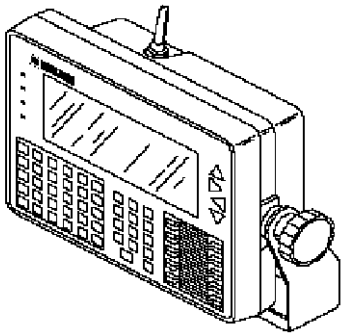
9189 Gateway: The 9189 Gateway is a self contained unit which brings an RF linkage to fixed or hand held I/O devices. The 9189 was designed to give RF capability to any CrossBar compatible device.



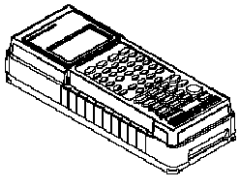
Fixed Readers: These devices mount at fixed locations and can connect to the host system directly or through an RF link (using a 9189). Fixed readers normally act as time and attendance terminals, or as security devices. The 9550 includes a display, keypad, and 64K of RAM; 9560s include an expanded keypad, badge reader, output relays, sense inputs, and 256K of RAM.



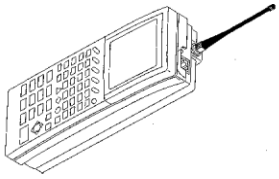
Printers: Intermec offers a variety of industrial quality bar code printers. These printers will print on a variety of media types and sizes. These printer connect with the host computer either directly (hardwired) or via RF (using a 9189). Printers range from medium to heavy duty support both direct thermal and thermal transfer printing.



9450 Vehicle Mount Terminal: The 9450 Vehicle Mount Terminal is functionally similar to an Intermec 9465 RF Trakker. Packaged in a rugged enclosure, it was designed mount on a forklift or other similar vehicle. Power is obtained directly from the vehicle's batteries.



9465 Radio Frequency Trakker: The 9465 internal spread spectrum radio provides bi-directional data communication in an on-line, interactive environment. It requires no FCC or DOC site license. It can run IRL programs, or 5250/3270 terminal emulation when used with the 9185 Controller.



JANUS 2010-RF Data Collection Computer: The JANUS™ J2010 with RF back is a portable 386-based computer. The operating system is PC compatible. The J2010 includes a CGA display, keypad, power supply and internal Type I PCMCIA card slot. The RF back provides spread spectrum radio frequency for data communication in an on-line, interactive environment.

A.3 RFDC: How it Works

Overview

To the end user, the RFDC system provides a transparent link between the end device and the host computer. The system components rapidly and accurately transfer data between devices. The system continuously checks for transmission errors and takes appropriate action when it detects errors.

Data Packets

RFDC system components exchange data in the form of packets. Each packet is a binary string that consists of the following fields:

Field	Bytes	Comment
Sync	1	Marks the beginning of the packet.
Destination	1	The device address where the packet was sent.
Source	1	The address of the sending device.
Repeat Count	1	Sstarts at a specified number and is decremented each time a packet is repeated. A repeater discards the packet when the count reaches zero.
Control 2	1	Specifies the command types for the packet.
Informatio n	<256	The actual message being sent.
CRC	2	Error checking information.
Sync	1	Marks the end of the packet.

Sending Data

When a source device sends a packet it expects an acknowledgment (ACK) from the destination device. The source device resends the packet if it does not receive an ACK within an allocated time. The source device attempts to send the packet up to a specified retry limit, at which the packet is deemed "undeliverable" and an error is reported.

Receiving Data

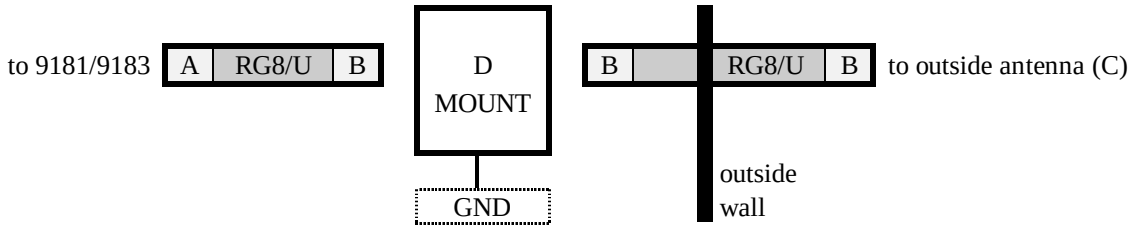
When a Base Radio Unit (BRU) or end device receives a packet (acts as the destination device), it checks the destination address and discards packets that contain a different address. The destination device extracts and process the information field of packets with the address of the destination device.

Repeating Data

Repeaters handle packets differently than Base Radio Units or end devices. Repeaters receive a data packet and check the repeat count. If the repeat count is greater than zero, the repeater decrements the repeat count and repeats (resends) the packet. Repeaters discard packets with repeat counts of zero. This repeat count prevents packets from forever bouncing between repeats in an "infinite loop."

Appendix B -- RF Hardware Assembly

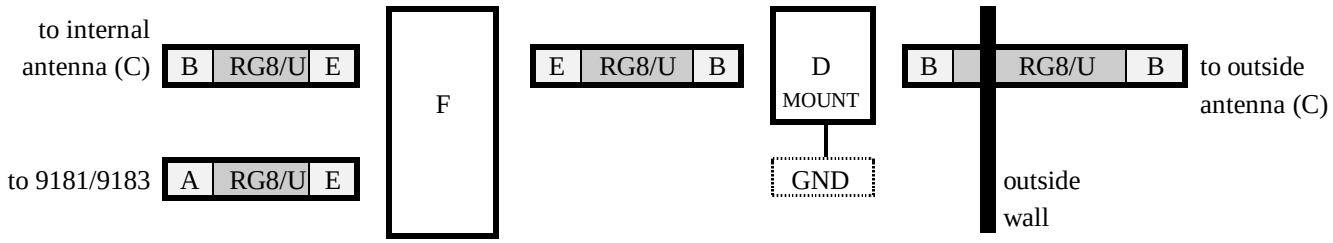
B.1 Single Exterior Antenna Mounting



Parts List

LEGEND	PART NO.	QTY	DESCRIPTION
A	060284	1	Connector, TNC-female, RG8
B	061475	3	Connector, N-female, RG8
C	060587	1	Omni-directional antenna, N-male
D	061868	1	Lightning arrestor, N-male
RG8/U	583364	TBD	RG/8 coaxial cable
GND	-----	1	To earth ground (#4 AWG Cu)
MOUNT	062531-001	1	Lightning arrestor mounting bracket

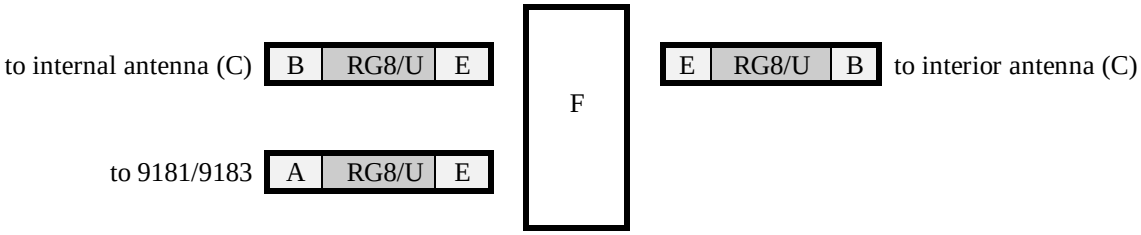
B.2 Exterior/Interior Antenna Mounting



Parts List

LEGEND	PART NO.	QTY	DESCRIPTION
A	060284	1	Connector, TNC-female, RG8
B	061475	4	Connector, N-female, RG8
C	060587	2	Omni-directional antenna, N-male
D	061868	1	Lightning arrestor, N-male
E	059088	3	Connector, BNC-male, RG8/U
F	059089	1	2-way splitter, 3dB, BNC-male
RG8/U	583364	TBD	RG/8 coaxial cable
GND	-----	1	To earth ground (#4 AWG Cu)
MOUNT	062531-001	1	Lightning arrestor mounting bracket

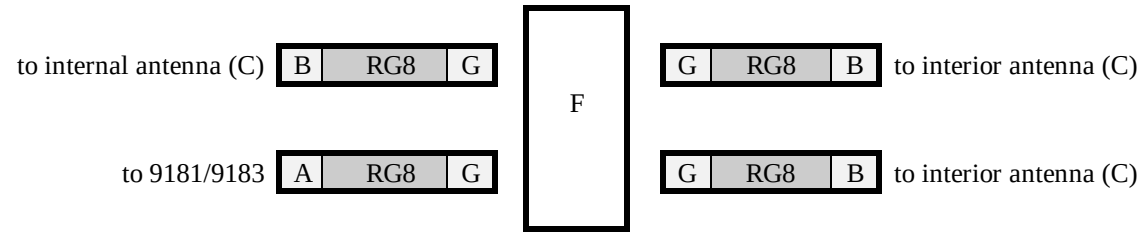
B.3 2-Way Interior Antenna Mounting



Parts List

LEGEND	PART NO.	QTY	DESCRIPTION
A	060284	1	Connector, TNC-female, RG8
B	061475	2	Connector, N-female, RG8
C	060587	2	Omni-directional antenna, N-male
D	-----	---	----------
E	059088	3	Connector, BNC-male, RG8/U
F	059089	1	2-way splitter, 3dB, BNC-male
RG8/U	583364	TBD	RG/8 coaxial cable

B.4 3-Way Interior Antenna Mounting



Parts List

LEGEND	PART NO.	QTY	DESCRIPTION
A	060284	1	Connector, TNC-female, RG8
B	061475	3	Connector, N-female, RG8
C	060587	3	Omni-directional antenna, N-male
D	-----	---	----------
E	-----	---	----------
F	TBD	1	3-way splitter, BNC-female
G	581925	4	Connector, BNC-male, RG8/U (old)
RG8/U	583364	TBD	RG/8 coaxial cable

Appendix C -- Spectrum Analysis

(Spectrum analysis charts removed from this demonstration proposal)	**Spectrum Analysis - 906 MHz**
Spectrum Analysis - 909 MHz	**Spectrum Analysis - 912 MHz**
Spectrum Analysis - 915 MHz	**Spectrum Analysis - 918 MHz**
Spectrum Analysis - 921 MHz	**Spectrum Analysis - 924 MHz**

Appendix D -- Additional Site Photographs

(Photos removed for this demonstration proposal)	A panoramic view of the Seattle skyline, the King Dome, Puget Sound, and the Nursing Tower. This is the view from the antenna position on the top of Building 1.

	A view from the parking lot looking at the Nursing Tower, the triangular Building 100, and the tiered D&T Building (right side of the photo).

Additional Site Photographs, continued

	This photo, taken from the roof of Engineering, shows the tiered D&T Building with Building 100 and the Nursing Tower in the background.

	This photo shows the tiered D&T Building (left) and the nine floor Building 100.