Preliminary

ADCP-75-132
Preliminary Issue 2C
August 2006

Digivance®Indoor Coverage Solution 1900 MHz Single- or Multi-Mode Fiber System Installation and Operation Manual

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1371881 Rev 1

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REVISION HISTORY

ISSUE	DATE	REASON FOR CHANGE
Issue 1	10/2002	Original
Issue 2	03/2004	Deleted all references to the LIU, inserted new references to the HPCP, added air quality specifications and warnings, and updated phone numbers and email addresses.
Issue 2C	08/2006	Updated to include new specifications for the RF output signal level at the DRU.

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ABOUT THIS GUIDE

This installation and operation manual provides the following information:

- An overview of the Digivance Indoor Coverage Solution (ICS)
- A description of the basic system components including the Digital Host Unit (DHU), Digital Expansion Unit (DEU), and the Digital Remote Unit (DRU).
- System requirements for planning the Digivance ICS installation.
- Procedures for installing the DHU.
- Procedures for operating and maintaining the Digivance ICS.
- Product warranty, repair, return, and replacement information

The procedures for installing the DEU and DRU are provided in other publications which are referenced in the Related Publications section and at appropriate points within this manual.

RELATED PUBLICATIONS

Listed below are related manuals and their publication numbers. Copies of these publications can be ordered by contacting the ADC Technical Assistance Center at 1-800-366-3891, extension 73476 (in U.S.A. or Canada) or 952-917-3476, (outside U.S.A. and Canada).

Title/Description	ADCP Number
Digivance ICS Digital Expansion Unit Installation Instructions Provides a description of the DEU and procedures for installation.	**75-111**
Digivance ICS Digital Remote Unit Installation Instructions Provides a description of the DRU and procedures for installation.	**75-112**
Digivance ICS 800 and 1900 MHz High Power Conditioning Panel User Manual Provides a description of the 800 and 1900 MHz High Power Conditioning Panel (HPCP) and procedures for installation.	**75-175**
Digivance ICS Single Band Remote Interface Unit (800 and 1900 MHz Systems) User Manual Provides a description of the RIU and procedures for installation.	**75-178**

ADMONISHMENTS

Important safety admonishments are used throughout this manual to warn of possible hazards to persons or equipment. An admonishment identifies a possible hazard and then explains what may happen if the hazard is not avoided. The admonishments — in the form of Dangers, Warnings, and Cautions — must be followed at all times. These warnings are flagged by use of the triangular alert icon (seen below), and are listed in descending order of severity of injury or damage and likelihood of occurrence.

⚠ **Danger**: *Danger is used to indicate the presence of a hazard that **will** cause severe personal injury, death, or substantial property damage if the hazard is not avoided.*

⚠ **Warning**: *Warning is used to indicate the presence of a hazard that **can** cause severe personal injury, death, or substantial property damage if the hazard is not avoided.*

⚠ **Caution**: *Caution is used to indicate the presence of a hazard that **will** or **can** cause minor personal injury or property damage if the hazard is not avoided.*

GENERAL SAFETY PRECAUTIONS

The following general admonishments apply throughout the procedures in this manual.

⚠ **Warning**: *Wet conditions increase the potential for receiving an electrical shock when installing or using electrically-powered equipment. To prevent electrical shock, never install or use electrical equipment in a wet location or during a lightning storm.*

⚠ **Warning**: *Do not install the DRU in marine, industrial, or Intrinsic Safety (IS) environments without an engineering review of the air quality including the presence of other constituent gasses and dusts. Contact ADC for application assistance if necessary.*

⚠ **Warning**: *The DRU is powered by 48 VDC power which is supplied over customer-provided wiring. To prevent electrical shock when installing or modifying the DRU power wiring, disconnect the wiring at the power source before working with uninsulated wires or terminals.*

⚠ **Danger**: *This equipment uses a Class 1 Laser according to FDA/CDRH rules. Laser radiation can seriously damage the retina of the eye. Do not look into the ends of any optical fiber. Do not look directly into the optical adapters of any digital unit or exposure to laser radiation may result. An optical power meter should be used to verify active fibers. A protective cap or hood MUST be immediately placed over any radiating adapter or optical fiber connector to avoid the potential of dangerous amounts of radiation exposure. This practice also prevents dirt particles from entering the adapter or connector*

⚠ **Danger**: *Do not look into the ends of any optical fiber. Exposure to laser radiation may result. Do not assume laser power is turned-off or the fiber is disconnected at the other end.*

⚠ **Danger**: *Always allow sufficient fiber length to permit routing without severe bends. Fibers may be permanently damaged if bent/curved to a radius of less than 2 inches (50 mm).*

STANDARDS CERTIFICATION

FCC: This equipment complies with the applicable sections of Title 47 CFR Part 24.

Caution: Modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Part 15.5 General conditions of operation:

a. Persons operating intentional or unintentional radiators shall not be deemed to have any vested or recognizable right to continue use of any given frequency by virtue of prior registration or certificate of equipment.

b. Operation of an intentional, unintentional, or incidental radiator is subject to the conditions that no harmful interference is caused and that interference must be accepted that may be caused by the operation of an authorized radio station, by another intentional or unintentional radiator, by industrial, scientific and medical (ISM) equipment, or by an incidental operator.

c. The operator of a radio frequency device shall be required to cease operating the device upon notification by a Commission representative that the device is causing harmful interference. Operation shall not resume until the condition causing the harmful interference has been corrected.

UL/CUL: This equipment complies with UL and CUL 60590 Standard for Safety for Information Technology Equipment, Including Electrical Business Equipment.

NEC/CEC: The DRU is suitable for use in environmental air space in accordance with Section 300-22(c) of the National Electrical Code, and Sections 2-128, 12-010(3), and 12-100 of the Canadian Electrical Code, Part 1, C22.1.

FDA/CDRH: This equipment uses a Class 1 LASER according to FDA/CDRH Rules. This product conforms to all applicable standards of 21 CFR Part 1040.

IC: This equipment complies with the applicable sections of RSS-131. The term "IC:" before the radio certification number only signifies that Industry Canada Technical Specifications were met.

LIST OF ACRONYMS AND ABBREVIATIONS

The acronyms and abbreviations used in this manual are detailed in the following list:

A	Amperes
AC	Alternating Current
AGC	Automatic Gain Control
AMPS	Advanced Mobile Phone Service
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
CDRH	Center for Devices and Radiological Health
CEC	Canadian Electrical Code
CUL	Underwriters' Laboratories of Canada
DAS	Distributed Antenna System

DC	Direct Current
DEU	Digital Expansion Unit
DHU	Digital Host Unit
DRU	Digital Remote Unit
EIA	Electronic Industries Association
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
FCC	Federal Communications Commission
FDA	Food and Drug Administration
HPCP	High Power Conditioning Panel
ICS	Indoor Coverage Solution
MM	Multi-Mode
NEC	National Electrical Code
NOC	Network Operations Center
PWR	Power
RIU	Remote Interface Unit
RF	Radio Frequency
RSSI	Received Signal Strength Indication
RX	Receive or Receiver
SM	Single-Mode
TDMA	Time Division Multiple Access
TX	Transmit or Transmitter
UL	Underwriters' Laboratories
UPS	Uninterruptible Power Supply
V	Volts
VAC	Volts Alternating Current
VDC	Volts Direct Current
WECO	Western Electric Company

1 SYSTEM FUNCTIONAL OVERVIEW

The Digivance ICS is a digitally distributed antenna system that provides in-building coverage for digital (TDMA and CDMA) phone systems operating within the 1900 MHz frequency bands. Large buildings typically interfere with the transmission or reception of cellular phone system signals by imposing high attenuation losses on RF signals. The Digivance ICS is designed to overcome the attenuation losses that make cellular communications within buildings or structures difficult or impossible. With the Digivance ICS, cellular phone RF signals can be distributed to the interior areas of any building or structure to eliminate dead spots and improve reception.

1.1 Basic System Components

The basic components of the Digivance ICS and their functions are shown in Figure 1. The basic system consists of the Digital Host Unit (DHU), Digital Remote Unit (DRU), and when additional capacity or longer fiber runs are required, the Digital Expansion Unit (DEU). In addition, two accessory items, the High Power Conditioning Panel (HPCP) and the Remote Interface Unit (RIU) may be used as needed to interface the DHU with the cellular system Base Transceiver Station (BTS).

1.2 Interface With BTS

The DHU interfaces, either locally or remotely, with the BTS. As referenced in this publication, the BTS could be either a microcell or a cell site base station. When the BTS is co-located (microcell interface) with the DHU, a local interface over coaxial cable is possible. An interface device, such as the HPCP, may be used to provide the proper input RF signal level to the DHU. When the BTS is not co-located (cell site base station interface) with the DHU, a remote interface using a donor antenna is required. An interface device, such as the RIU, is used to provide the proper input and output RF signal levels between the donor antenna and the DHU.

In the forward path, the DHU receives RF signals from the BTS. The DHU digitizes the RF signals and then converts them to digital optical signals for transport to the DEU's and DRU's. In the reverse path, the DHU receives digital optical signals from the DRU's and DEU's. The DHU converts the optical signals back to the original RF signal format for the interface with the BTS.

1.3 Interface With Cellular Phones

The DRU interfaces (through an external antenna) with the cellular phones. In the reverse path, the DRU receives RF signals from each cellular phone. The DRU digitizes the RF signals and then converts them to digital optical signals for transport to the DHU. In the forward path, the DRU receives digital optical signals from the DHU. The DRU converts the optical signals back to the original RF signal format for transmission to the cellular phones. A small external antenna is connected to the DRU to transmit and receive RF signals to and from the cellular phones.

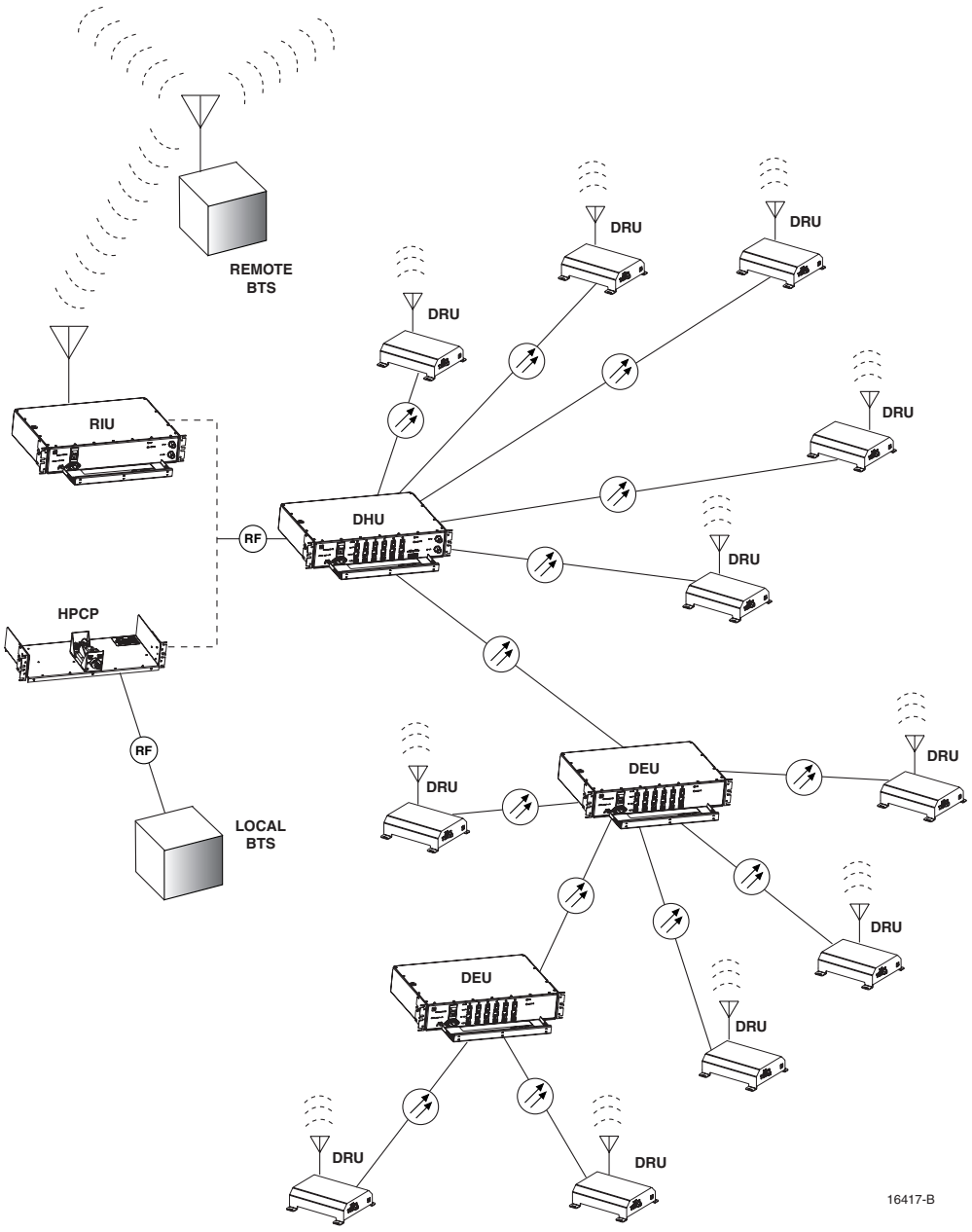

Figure 1. System Overview Functional Block Diagram

1.4 Digital Fiber Optic Transport

The DHU is connected to each DRU unit over a pair of multi-mode or single-mode (depending on the type of optical transceiver specified) optical fibers. One fiber is used to transport the forward path optical signal. The other fiber is used to transport the reverse path optical signal. Because the optical signal is digital, no adjustments to the optical signal level are required at the DRU or the DHU as long as the BER is adequate. Either 62.5 or 50 micron core multi-mode optical fiber; or 9 micron core single-mode optical fiber may be used for the

optical transport connection. With 62.5 micron core multi-mode fiber , the optical path may be up to 500 meters in length. With 50 micron core multi-mode fiber, the optical path may be up to 750 meters in length. With 9 micron core single-mode fiber, the optical path may be up to 10 kilometers in length. Single- and multi-mode fibers may be used in the same system. The optical fibers must be terminated with duplex LC connectors for connection with the DHU, DEU's and DRU's.

1.5 Capacity for Expansion and Extended Runs

The DEU enables 6-way expansion of any optical port. This makes it possible to add more DRU's without having to install additional DHU's. Each DHU is equipped with six optical ports. If more than six DRU's are required by the application, a DEU may be connected to one of the DHU optical ports which expands that port to six ports. If still more optical ports are required, then a second DEU may be connected to the DHU; or a second DEU may be connected to the first DEU. The ability to cascade DEU's in parallel or in series provides unlimited flexibility. It is physically possible to connect an unlimited number DRU's to the DHU through the installation of DEU's. The maximum number of DRU's that can connected to the DHU is limited only by the cumulative noise effect caused by antenna combining.

1.6 Power Requirements

The DHU, DEU, and RIU are each powered by 120–240 VAC, 50/60 Hz, 2 Amp power which is supplied through a standard three-conductor AC power cord. The DRU is powered by 34–48 VDC which is supplied by either the DHU, DEU, or an AC/DC wall-mount style converter. When the DRU is powered by the DHU or DEU, the power is fed through a category 3 or 5 cable terminated with male RJ-45 connectors.

1.7 Fault Detection and Alarm Reporting

LED indicators are provided on the front panel of the various units to indicate if the system is normal or if a fault is detected. In addition, normally open and normally closed alarm contacts (for both major and minor alarms) are provided at the DHU for connection to a customer provided external alarm system. This could be a local system or automatic call-out system.

2 DIGTAL UNIT DESCRIPTION

This section provides a description of the functions and features provided by the units that comprise the ICS system, a listing of terms used and their definition, and a table of specifications.

2.1 Digital Host Unit Description

The DHU, shown in Figure 2, serves as the BTS servicing unit for the Digivance ICS. The DHU provides the following basic functions:

- RF inputs and outputs
- Optical interface to the DRU's or DEU's

- Digitizing of the cellular forward path RF signal
- Distribution of the digitized forward path RF signals into six digitized optical signals
- Conversion of up to six reverse path digitized optical signals to six digitized RF signals
- Combining of the six digitized RF signals into a single composite digitized RF signal
- Conversion of the combined digitized RF signal to a composite RF signal
- DC power for powering the DRU's
- Relay contact closures to provide alarm information to an external alarm system

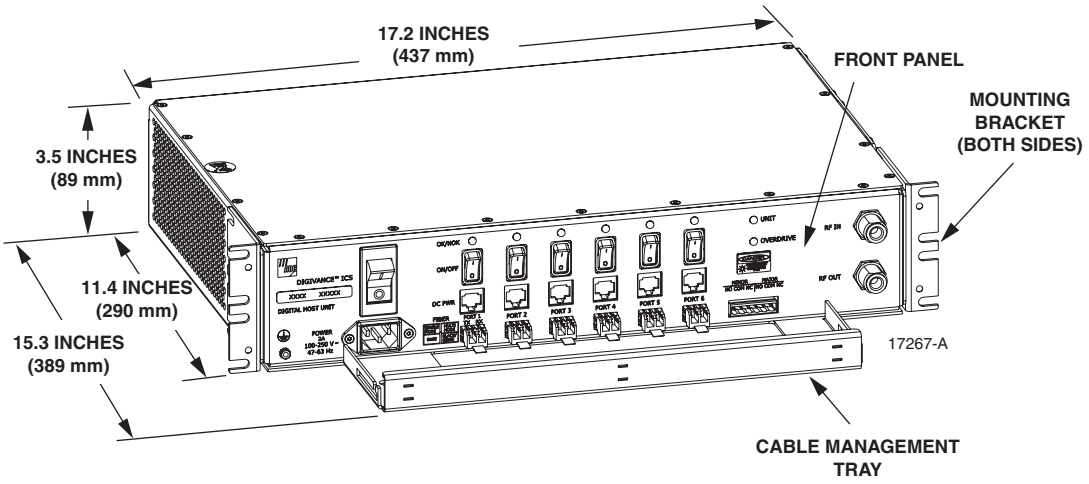

Figure 2. Digital Host Unit

2.1.1 Primary Components

The DHU consists of two electronic circuit board assemblies, a power supply assembly, and a fan assembly that are mounted within a powder-coated sheet metal enclosure. The metal enclosure provides a mounting point for the electronic assemblies, serves as a heat sink, and controls RF emissions. Except for the fan units and optical transceivers, the DHU components are not field replaceable. The DHU is designed for use within a non-condensing indoor environment such as inside a wiring closet or cabinet. All controls, connectors, and indicators are mounted on the DHU front panel for convenient access. Cable management functions for the power and fiber optic cables are provided by a cable management tray that extends outward from the DHU front panel.

2.1.2 Mounting

The DHU may be used in both rack-mount and wall-mount applications. For rack mount applications, a pair of reversible mounting brackets is provided that allow the DHU to be mounted in either a 19-inch or 23-inch EIA or WECO equipment rack. When rack-mounted, the front panel of the DHU is flush with the front of the rack and the cable management tray extends 3.9 inches (99 mm) beyond the front panel. For wall-mount applications, a pair of holes is provided in the cable management tray which allow the DHU to be mounted on any flat vertical surface. The DHU should be oriented with the front panel facing upward when wall-mounted. Fasteners are provided for rack-mount applications.

2.1.3 Fault Detection and Alarm Reporting

The DHU detects internal circuitry faults and optical port faults. Various front panel Light Emitting Diode (LED) indicators turn from green to red or yellow if a fault is detected or an optical input is lost. A set of alarm contacts (normally open and normally closed) are also provided for reporting an alarm to an external alarm system when a fault is detected. Both major alarm (all fault conditions except high temperature) and minor alarm (high temperature fault condition) contacts are provided.

2.1.4 RF Signal Connections

The RF signal connections with the BTS are supported through two type N female connectors. One connector is used for coaxial cable connection of the forward path RF signal. The other connector is used for coaxial cable connection of the reverse path RF signal. In most installations, the DHU will not connect directly to the BTS but will be connected to an interface device such as the RIU or the HPCP. Additional information concerning the DHU to BTS interface is provided in the Digivance ICS Remote Interface Unit User Manual (ADCP-75-178) and in the Digivance ICS 800 and 1900 MHz High Power Conditioning Panel User Manual (ADCP-75-175).

Maximum output at the DRU antenna port is obtained when the level of the composite forward path RF signal input to the DHU is 1 dB below the DHU overdrive level. The maximum signal level the DHU will accept is determined by the DHU overdrive limiter. If the input signal level is above a specified level, the overdrive limiter will incrementally insert attenuation. The overdrive limiter protects the system against excessive inputs but does not function during normal operation. The level of the RF signal output at the DRU is dependent on the modulation protocol and the number of carriers.

2.1.5 Optical and Electrical Connections

The optical and electrical connections with the DRU's and DEU's are supported by six optical and six electrical ports. Each optical and electrical port consists of a status LED, an RJ-45 DC power jack, a port enabled/disable switch, and a small form factor LC-type optical transceiver (available separately). Each transceiver is color-coded to identify whether it supports single-mode (blue) or multi-mode (black/beige) fiber. An optical port may be connected to a DRU, a DEU, or not used. An electrical port may be connected to a DRU or not used. Unused ports are disabled via the corresponding port enable/disable switch. When disabled, the port LED is off, the alarm reporting function is disabled, the laser is off, and the DC power is off. Enabling the enable/disable switch activates all functions. The modular optical transceivers are accessory items and are field replaceable.

2.1.6 Powering

The DHU is powered by 120–240 VAC (50/60 Hz) power which is supplied through a standard three-conductor 120 VAC power cord. The power cord is provided with the DHU and is 98 inches (2.5 meters) long. A resetable circuit breaker/On-Off switch is provided at the unit front panel. The switch applies power to the DHU internal power supply.

2.1.7 Cooling

Continuous air-flow for cooling is provided by dual fans mounted on the right side of the housing. A minimum of 3 inches (76 mm) of clearance space must be provided on both the left and right sides of the DHU for air intake and exhaust. An alarm is provided that indicates if a high temperature condition (>50º C/122º F) occurs. The fans may be field-replaced if either fan fails.

2.1.8 User Interface

The DHU user interface consists of the various connectors, switches, terminals, and LEDs that are provided on the DHU front panel. The DHU user interface points are described in Table 1 and indicated in Figure 3.

Table 1. Digital Host Unit User Interface

REF No.	USER INTERFACE DESIGNATION	DEVICE	FUNCTIONAL DESCRIPTION
1	⏚	Ground stud	Used for connecting a grounding cable to the DHU chassis.
2	POWER	3-wire AC power cord connector	Used for connecting the AC power cord.
3	I/O	I/O rocker switch/ circuit breaker	Provides AC power On/Off control and AC power over current protection.
4	OK/NOK (Ports 1–6)	Multi-colored LED (Red/Green/Yellow)	Indicates if the DRU or remote DEU connected to the optical port is normal or faulty or if the reverse path optical input from the DRU or remote DEU is normal or lost. (see Note)
5	ON/OFF (Ports 1–6)	I/O rocker switch	Enables or disables corresponding electrical and optical ports.
6	DC PWR (Ports 1–6)	RJ-45 jack (female)	Used for connecting a DRU cat 3 or 5 power cable to the designated DC power jack.
7	FIBER (Ports 1–6)	LC-type optical transceiver	Used for connecting each DEU or DRU forward path and reverse path optical fibers to the designated optical port.
8	UNIT	Multi-colored LED (Red/Green/Yellow)	Indicates if the DHU is normal or faulty. (see Note)
9	OVERDRIVE	Multi-colored LED (Red/Green/Yellow)	Indicates when the forward path RF input power is overdriving the DHU digitizing circuitry. (see Note)
10	MAJOR MINOR	Screw-type terminal connector (14–26 AWG)	Used for connecting an external alarm system to the DHU. Includes normally open (NO), normally closed (NC), and common (COM) wiring connections.
11	RF IN	N-type female RF coaxial connector	Used for connecting the forward path RF coaxial cable to the DHU.
12	RF OUT	N-type female RF coaxial connector	Used for connecting the reverse path RF coaxial cable to the DHU.

Note: A more detailed description of LED operation is provided in Section 5.

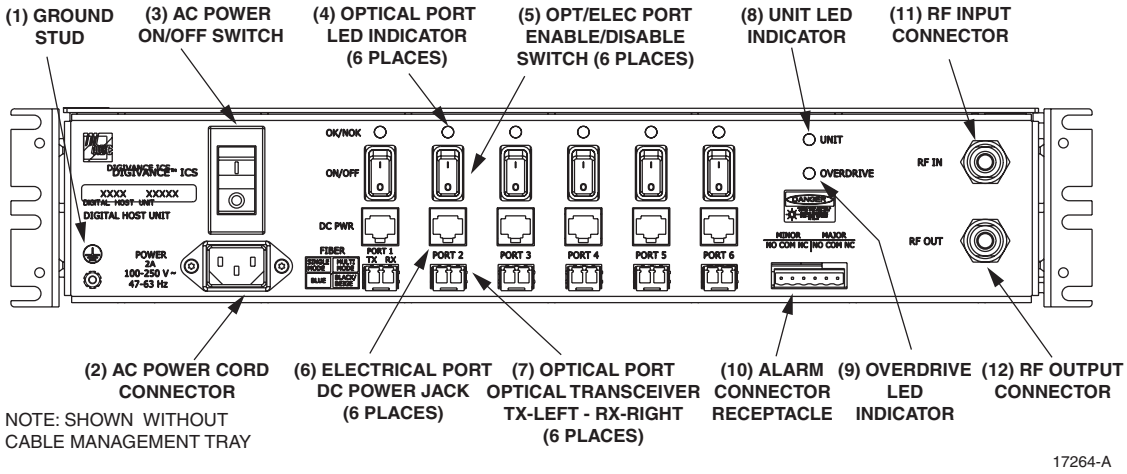

Figure 3. Digital Host Unit User Interface

2.2 Digital Remote Unit Description

The DRU, shown in Figure 4, serves as the remote interface unit for the Digivance ICS. The DRU provides the following basic functions:

- RF interface to the cellular users via an external antenna
- Optical interface to the DHU or DEU
- Conversion of the forward path digitized optical signal to a digitized RF signal
- Conversion of the digitized forward path RF signal to the original cellular RF signal
- Digitizing of the cellular reverse path RF signal
- Conversion of the digitized reverse path RF signal to a digital optical signal output
- Transports alarm status over the reverse path optical fiber

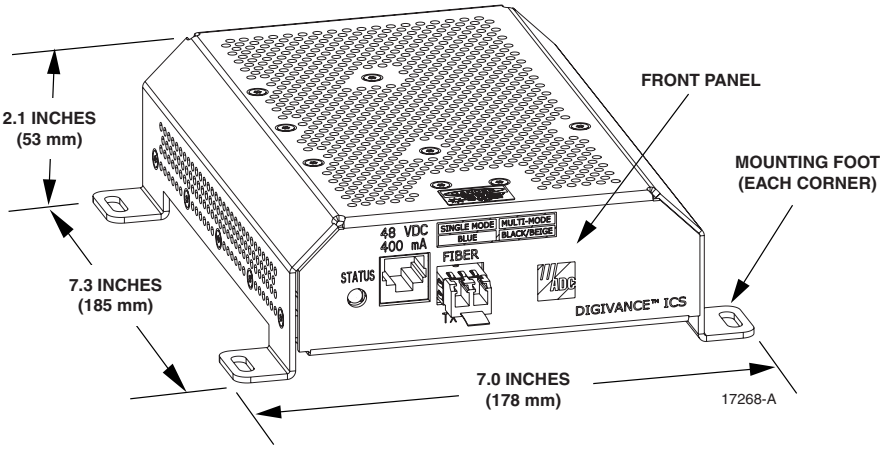

Figure 4. Digital Remote Unit

2.2.1 Primary Components

The DRU consists of an electronic circuit board assembly that is mounted within a powder-coated sheet metal enclosure. The metal enclosure provides a mounting point for the electronic assembly, serves as a heat sink, and controls RF emissions. Except for the optical transceiver, the DRU components are not field replaceable. The DRU is designed for use within a non-condensing indoor environment such as inside a building. All controls, connectors, and indicators (except the SMA antenna connector) are mounted on the DRU front panel for convenient access.

2.2.2 Mounting

The DRU is equipped with four integral mounting feet that allow it to be mounted on any flat horizontal or vertical surface. A typical location for mounting the DRU would be on a ceiling or a wall. Slots are provided in the mounting feet for securing the DRU to the mounting surface.

2.2.3 Fault Detection

The DRU detects internal circuitry faults or loss of system inputs. A front panel LED indicator turns from green to red when a fault condition is detected or when the optical input is lost. The DRU sends the fault information to the DHU or DEU over the reverse path optical fiber. A corresponding port LED at the DHU or DEU turns from green to red when the DRU reports a fault.

2.2.4 Antenna Connection

The RF signal interface between the DRU and the cellular users is provided through an external antenna. An SMA connector is provided for connecting the DRU to the antenna. The antenna must be ordered separately. Several types of antennas with various RF propagations are available. Non-ADC antennas may also be used with the DRU to meet various application requirements but must comply with equipment authorization for RF exposure compliance.

2.2.5 Optical Port

The DRU uses a small form factor LC-type optical transceiver for connecting the optical fibers. Each transceiver is color-coded to identify whether it supports single-mode (blue) or multi-mode (black/beige) fiber. Depending on the application requirements, the optical port may be connected to either a DHU or a DEU. The modular optical transceiver is an accessory item and is field replaceable.

2.2.6 Powering

The DRU is equipped with a female RJ-45 jack that provides a connection point for the DC power cable. The DRU is powered by 34–48 VDC power which is supplied through the RJ-45 connector. Power to the DRU may be supplied by the DHU, DEU, or by a 120 VAC to 48

VDC power converter (available separately as an accessory item) plugged into a properly grounded 120 VAC outlet. The AC/DC converter is a UL Listed stand-alone Limited Power Supply (LPS) unit with a rated output of 48 VDC at 1.2 Amps. When powered by the DHU or DEU, a category 3 or 5 twisted-pair cable terminated with RJ-45 connectors is required.

2.2.7 Cooling

The DRU is cooled by natural convection air-flow. The DRU mounting feet are designed to provide clearance under the unit so that air can enter the DRU enclosure from the bottom and exit through the top. A minimum clearance of 3 inches (76 mm) must be provided on all sides of the DRU (except the bottom) to ensure there is adequate air circulation for cooling. In addition, at least one surface of the DRU installation area must be open to the interior of the building.

2.2.8 User Interface

The DRU user interface consists of the connectors and the LED that are provided on the DRU front and rear panels. The DRU user interface points are described in Table 2 and indicated in Figure 5.

Table 2. Digital Remote Unit User Interface

REF No.	USER INTERFACE DESIGNATION	DEVICE	FUNCTIONAL DESCRIPTION
1	STATUS	Multi-colored LED (Red/Green/Yellow)	Indicates if the status of the DRU is normal or faulty or if the forward path optical input is normal or lost. (see Note)
2	48 VDC	RJ-45 jack (female)	Used for connecting a DC power cable.
3	FIBER TX RX	LC-type optical transceiver	Used for connecting the forward path and reverse path optical fibers.
4	–	SMA-type coaxial connector (female)	Used for connecting the antenna coaxial cable lead.

Note: A more detailed description of LED operation is provided in Section 5.

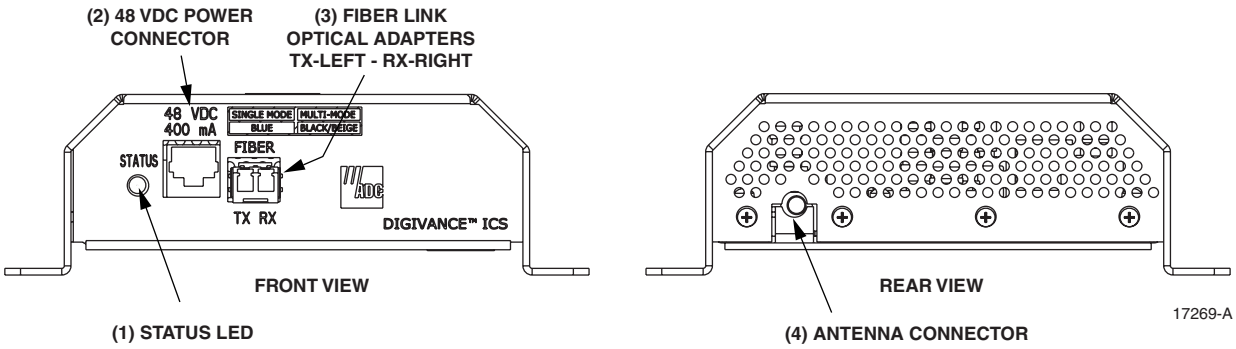

Figure 5. Digital Remote Unit User Interface

2.3 Digital Expansion Unit Description

The DEU, shown in Figure 6, serves as a service expansion unit and line extender for the Digivance ICS. The DEU provides the following basic functions:

- Optical interface to the DHU and up to six DRU's or DEU's
- Conversion of the forward path digitized optical signal to an electrical bit stream
- Splitting of the electrical bit stream into six separate bit streams
- Conversion of the six forward path electrical bit streams into six digital optical signals
- Conversion of up to six reverse path digital optical signals into six serial bit streams
- Combining of the six reverse path serial bit streams into a single digital composite signal
- Conversion of the single digital composite signal to a digital optical signal
- DC power for powering the DRU's
- Alarm transport via the optical fibers

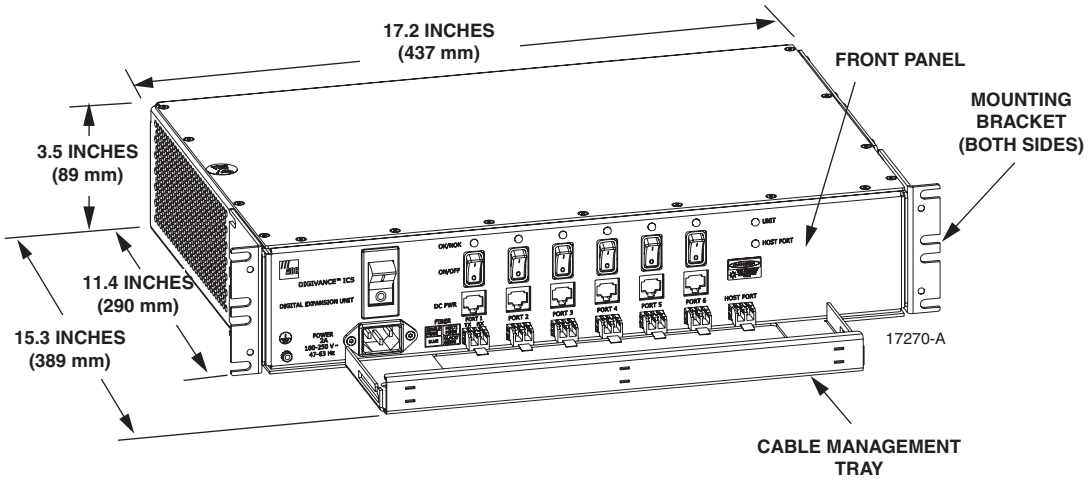

Figure 6. Digital Expansion Unit

2.3.1 Primary Components

The DEU consists of two electronic circuit board assemblies and a power supply that are mounted within a powder-coated sheet metal enclosure. The metal enclosure provides a mounting point for the electronic assemblies and serves as a heat sink. Except for the fan units and optical transceivers, the DEU components are not field replaceable. The DEU is designed for use within a non-condensing indoor environment such as inside a wiring closet or cabinet. All controls, connectors, and indicators are mounted on the DEU front panel for convenient access. Cable management functions for the power and fiber optic cables are provided by a cable management tray that extends outward from the DEU front panel.

2.3.2 Mounting

The DEU may be used in both rack-mount and wall-mount applications. For rack mount applications, a pair of reversible mounting brackets is provided that allow the DEU to be

mounted in either a 19-inch or 23-inch EIA or WECO equipment rack. When rack-mounted, the front panel of the DEU is flush with the front of the rack and the cable management tray extends 3.9 inches (99 mm) beyond the front panel. For wall-mount applications, a pair of holes is provided in the cable management tray which allow the DEU to be mounted on any flat vertical surface. The DEU should be oriented with the front panel facing upward when wall-mounted. Fasteners are provided for rack-mount applications.

2.3.3 Fault Detection

The DEU detects internal circuitry faults or loss of system inputs. Various front panel Light Emitting Diode (LED) indicators turn from green to red or yellow when a fault is detected or when an optical input is lost. The DEU transports the fault information to the DHU or supporting DEU over the reverse path optical fiber. A corresponding port LED at the DHU or DEU turns from green to red when the DEU reports a fault.

2.3.4 Optical and Electrical Connections

The optical and electrical connections with the DRU's and DEU's are supported by six optical and six electrical ports. Each optical and electrical port consists of a status LED, an RJ-45 DC power jack, a port enable/disable switch, and a small form factor LC type optical transceiver (available separately). Each transceiver is color-coded to identify whether it supports single-mode (blue) or multi-mode (black/beige) fiber. An optical port may be connected to a DRU, a DEU, or not used. An electrical port may be connected to a DRU or not used. Unused ports are disabled via the corresponding port enable/disable switch. When disabled, the port LED is off, the alarm reporting function is disabled, the laser is off, and the DC power is off. Enabling the enable/disable switch activates all functions. The DEU also provides one optical port (designated as the host port) for the optical interface with the DHU or a supporting DEU. The modular optical transceivers are available as accessory items and are field replaceable.

2.3.5 Powering

The DEU is powered by 120–240 VAC (50/60 Hz) power which is supplied though a standard three-conductor 120 VAC power cord. The power cord is provided with the DEU and is 98 inches (2.5 meters) long. A resetable circuit breaker/On-Off switch is provided at the unit front panel. The switch applies power to the DEU internal power supply.

2.3.6 Cooling

Continuous air flow for cooling is provided by dual fans mounted on the right side of the sheet metal housing. A minimum of 3 inches (76 mm) of clearance space must be provided on both the left and right sides of the DEU for air intake and exhaust. An alarm is provided that indicates if a high temperature condition (>50º C/122º F) occurs. The fans may be field-replaced if either unit fails.

2.3.7 User Interface

The DEU user interface consists of the various connectors, switches, and LEDs that are provided on the DEU front panel. The DEU user interface points are described in Table 3 and indicated in Figure 7.

Table 3. Digital Expansion Unit User Interface

REF No.	USER INTERFACE DESIGNATION	DEVICE	FUNCTIONAL DESCRIPTION
1	⏚	Grounding stud	Used for connecting a grounding cable to the DEU chassis.
2	POWER	3-wire AC power cord connector	Used for connecting the AC power cord.
3	I/O	I/O rocker switch/ circuit breaker	Provides AC power On/Off control and AC power over current protection.
4	OK/NOK (Ports 1–6)	Multi-colored LED (Red/Green/Yellow)	Indicates if the DRU or remote DEU connected to the optical port is normal or faulty or if the reverse path optical input from the DRU or remote DEU is normal or lost. (see Note)
5	ON/OFF (Ports 1–6)	I/O rocker switch	Enables or disables corresponding electrical and optical ports.
6	DC PWR (Ports 1–6)	RJ-45 jack (female)	Used for connecting a DRU cat 3 or 5 power cable to the designated DC power jack.
7	FIBER (Ports 1–6)	LC-type optical transceiver	Used for connecting each DRU or remote DEU forward path and reverse path optical fiber to the designated optical port.
8	HOST PORT	LC-type optical transceiver	Used for connecting the DHU or supporting DEU forward path and reverse path optical fiber.
9	UNIT	Multi-colored LED (Red/Green/Yellow)	Indicates if the DEU is normal or faulty. (see Note)
10	HOST PORT	Multi-colored LED (Red/Green/Yellow)	Indicates if the forward path optical input from the DHU or supporting DEU is normal or lost. (see Note)

Note: A more detailed description of LED operation is provided in Section 5.

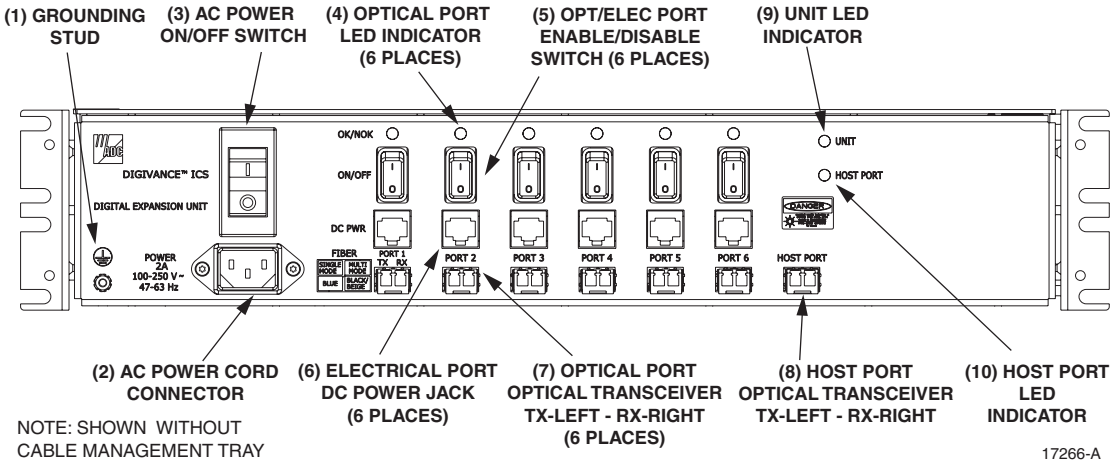

Figure 7. Digital Expansion Unit User Interface

2.4 Terms and Definitions

Refer to Table 4 for a listing of the terms used in this manual and their definition.

Table 4. Terms and Definitions

TERM	DEFINITION
Alarm Response	The response to an alarm input.
Base Transceiver Station	The radio equipment that transmits and receives the voice and control channels to and from the cellular handsets.
Composite Signal	A signal that is the sum of several signals.
Digital Expansion Unit	The unit that extends a single optical interface to multiple optical interfaces or that extends an optical run.
Digital Host Unit	The unit that converts and provides the digital source signal to all DEU's and DRU's and converts summed inputs from DEU's and DRU's.
Digital Remote Unit	The unit that interfaces the in-building user to the Digivance optical transport.
Digitized RF Signal	The RF signal in a digitized form.
Forward Path Signal	A signal that travels from the base station to the cell phone.
Major Alarm	An alarm condition that applies when any fault (except high temperature) occurs.
Minor Alarm	The alarm condition that applies when a high temperature condition occurs. (> 50º C/122º F)
Mute	To force a forward path RF signal to a "no signal" state.
Normal State	The operating state after power-up is completed and no faults are detected.
Port	An RF, optical, or electrical interface point.
Port Alarm	A fault that affects only the unit or units connected to that port. Indicates no optical input to port.
Power-Up State	The period between the application of power to a unit and the normal state. This period includes time for circuit stabilization and initialization operations.
Reverse Path Signal	A signal that travels from one or more cell phones to the base station.
Transport Alarm Signal	An alarm signal transported over the reverse path optical fiber.
Unit Alarm	A fault within a unit that usually affects all connected ports.

2.5 Specifications

Refer to Table 5 for the Digivance ICS system specifications. **All specifications apply after a five minute warm-up period**.

Table 5. System Specifications

PARAMETER	SPECIFICATION	REMARKS
Optical – All Units		
Fiber type	Multi-mode: 50 or 62.5 micron core Single-mode: 9 micron core	Two fibers per transport link
Maximum fiber length for guaranteed performance	500 m (1,641 ft) 750 m (2461 ft) 10 km (32,808 ft)	With 62.5 micron core MM fiber With 50 micron core MM fiber With 9 micron core SM fiber
Optical output power	–10 to –3 dBm	
Optical wavelength	850 nm for multi-mode use 1310 nm for single-mode use	
Environmental		
Operating temperature	0º to 50º C (32º to 122º F)	
Storage temperature	–30º to +70º C (–22 to 158º F)	
Humidity	No condensation	
Weather resistance	NEMA 1, IEC 529 IP30	Indoor installation only
Airborne contaminants (DRU only)	At or below levels established in Telecordia Standard, GR-63-CORE, Network Equipment-Building System (NEBS) Requirements: Physical Protection, Section 4.5 Airborne Contaminants, Table 4-11, Indoor Contaminant Levels.	
RF Forward Path System bandwidth	25 MHz	
1900 MHz freq. bands AD band DBE band BEF band EFC band	US PCS 1930 to 1950 MHz 1945 to 1970 MHz 1950 to 1975 MHz 1965 to 1990 MHz	
Output power	See Table 6	Maximum composite output signal requires maximum input signal
Gain	+36 dB nominal	At room temperature
Gain variation	≤ 6 dB < 1.5 dB variation per 1.25 MHz CDMA channel	Over frequency, temperature, and unit to unit. May have up to 2 dB variation at upper band edge.
OIP3	+35 dBm typical	At max. composite output power
CDMA ACPR1	≤ –45 dBc	
Spurious Output	≤ –30 dBm	
Maximum RF input signal level (composite)	Approximately –10 dBm	Will vary depending on access protocol and number of carriers

(continued)

Table 5. System Specifications, continued

PARAMETER	SPECIFICATION	REMARKS
RF Reverse Path System bandwidth	25 MHz	
1900 MHz freq. bands AD band DBE band BEF band EFC band	US PCS 1850 to 1870 MHz 1865 to 1890 MHz 1870 to 1895 MHz 1885 to 1910 MHz	
Gain	+14 dB nominal	
Gain Variation	≤ 6 dB < 1.5 dB variation per 1.25 MHz CDMA channel	Over frequency, temperature, and unit to unit.
Automatic Gain Limiting	Enabled for composite RF input ≥ –40 dBm	Prevents A/D saturation with large inputs.
Noise Figure	≤ 10 dB + 10 log N where N = # of remotes	≤ 10 dB typical. See Note at end of table.
DHU RF output signal level	–30 dBm maximum	With a –40 dBm composite maximum input signal at the DRU
Physical/Electrical – DHU Weight	18.5 lbs (8.4 kg)	
RF connection	Type N	Female
Alarm connection	Screw terminals (14–26 AWG)	NO, NC, and COM (form C relay contacts)
Optical connection	Duplex LC transceiver	
DC power output connection	RJ-45	Female
Power input	120–240 VAC, 50/60 Hz	
AC power connection	IEC 320	Male
Power consumption	250 W	Maximum
Current rating	2 Amps at 120 VAC	
Physical/Electrical – DEU Weight	18.5 lbs (8.4 kg)	
Optical connection	Duplex LC transceiver	
DC pwr output connection	RJ-45	Female
Power input	120–240 VAC, 50/60 Hz	
AC power connection	IEC 320	Male
Power consumption	250 W	Maximum
Current rating	2 Amps at 120 VAC	

(continued)

Table 5. System Specifications, continued

PARAMETER	SPECIFICATION	REMARKS
Physical/Electrical – DRU Weight	1.5 lbs (708 g)	
RF connection	SMA	Female
Antenna types	Ceiling mount omni directional 90º directional panel Ceiling mount hallway	2.5 dBi gain 7.5 dBi gain 4 dBi gain
Optical connection	Duplex LC transceiver	
DC pwr input connection	RJ-45	Female
Power input	34 to 48 VDC	
DC power cable length (Cat-3 or -5 cable)	500 meters (1,641 ft) maximum	Any distance beyond 500 meters requires alternate power sourcing
Power consumption	19 W	Typical
Current rating	400 mA at 48 VDC	

Note: The noise from all remotes is added at the host. Given N units with identical gain and noise, the formula applies exactly. Slight unit to unit noise figure and gain variations make this a very useful approximation.

Table 6.Maximum Forward Path RF Output Signal Levels at the Digital Remote Unit

MODULATION	GSM 1900		EDGE 1900		TDMA 1900		CDMA 1900		W-CDMA 1900	
NUMBER OF CARRIERS	Composite (dBm)	Per Carrier (dBm)	Composite (dBm)	Per Carrier (dBm)	Composite (dBm)	Per Carrier (dBm)	Composite (dBm)	Per Carrier (dBm)	Composite (dBm)	Per Carrier (dBm)
1	24	24	24	24	23	23	16.5	16.5	16.5	16.5
2	22	19	21	18	21	18	15	12.5	13	9.5
3	21	16	20	15	20	15	14.5	10	10.5	5.5
4	20	14	19	13	19	13	14	8	9	3
5	19.5	12.5	18	11	18	11	13.5	7	-	-
6	19	11	17	9	18	10	13	6	-	-
7	18.5	10	16.5	8	17	9	12.5	5	-	-
8	18	9	16	7	17	8	12	4	-	-

Note : Per Industry Canada Section 5.3 – The rated output power of this equipment is for single carrier operation. For situations where multiple carrier operation signals are present, the rating would have to be reduced by 3.5 dB, especially where the output signal is re-radiated and can cause interference to adjacent band users. This power reduction is to be by means of input power or gain reduction and not by an attenuator at the output of the device.

3 INSTALLATION PLANNING AND SYSTEM DESIGN

This section provides installation planning information and basic system design recommendations for RF engineers that will be designing and installing an in-building coverage solution using the Digivance ICS. System design and planning services are available from ADC if required. Refer to Section 7 of this manual for additional information.

3.1 Base Station Interface Requirements

The DHU may be interfaced either locally or remotely with the BTS. As referenced in this publication, the BTS could be either a microcell or a cell site base station. With a local interface, a hard-wire connection is provided between the DHU and the BTS (microcell) using coaxial cables. With a remote interface, an over-the-air connection is provided between the DHU and the BTS (cell site base station) using a donor antenna.

3.1.1 Local BTS (Microcell) Interface

A local interface between the DHU and the BTS (microcell) over coax requires specific RF input and output signal levels at both the DHU and BTS. The correct signal levels can generally be provided by inserting attenuation in the forward and reverse signal paths.

In the forward path, the correct input level can be provided at the DHU using the High Power Conditioning Panel (HPCP). The HPCP is an accessory item that is used to attenuate the forward path RF signal. The HPCP provides attenuation adjustments in 1 dB increments over a range of **40** to **70 dB**. A block diagram of a typical **local** BTS interface is shown in Figure 8.

The maximum RF input signal level the DHU will accept is determined by the DHU overdrive limiter. When the RF signal **input** to the DHU is set to 1 dB below the DHU overdrive level, the RF signal **output** at the DRU will be at the specified maximum level (see Table 6). The level of the RF signal output at the DRU is dependent on the modulation protocol and the number of carriers.

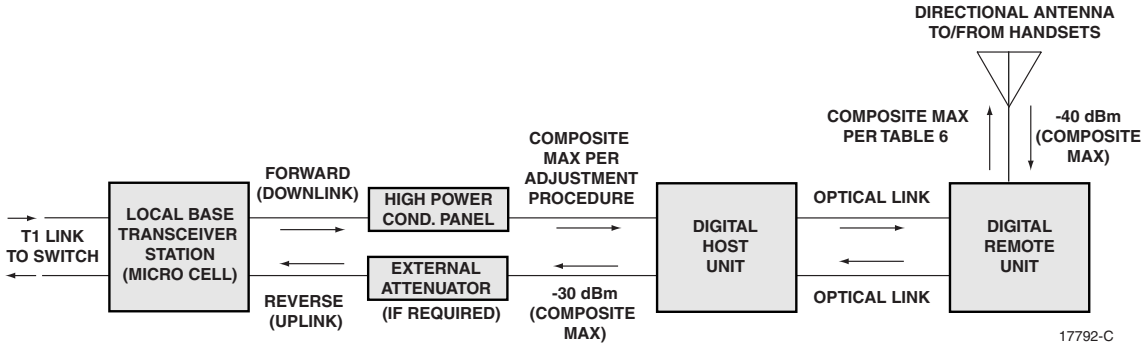

Figure 8. Local BTS Interface Block Diagram

In the reverse path, the input signal level required at the BTS can generally be provided using an external attenuator or by adjusting the BTS. When the level of the reverse path (uplink) signal at the DRU is at the recommended composite maximum of **–40 dBm**, the level of the RF output signal from the DHU will be **–30 dBm**.

The HPCP is rack or wall mountable. Refer to the Digivance ICS 800 and 1900 MHz High Power Conditioning Panel User Manual (ADCP-75-175) for additional information.

3.1.2 Remote BTS (Cell Site Base Station) Interface

A remote interface between the DHU and the BTS (cell site base station) via a donor antenna requires specific RF input and output signal levels at both the DHU and the antenna. The correct input and output signal levels can generally be provided using the Remote Interface Unit (RIU). The RIU is an accessory item that is used to adjust both the forward and reverse path RF signal levels. In the forward path, the RIU provides gain adjustments in 1 dB increments over a range of **+9 to +40 dB**. In the reverse path, the RIU provides gain adjustments in 1 dB increments over a range of **+28 to +59 dB**. A block diagram of a typical **remote** DHU to BTS interface is shown in Figure 9.

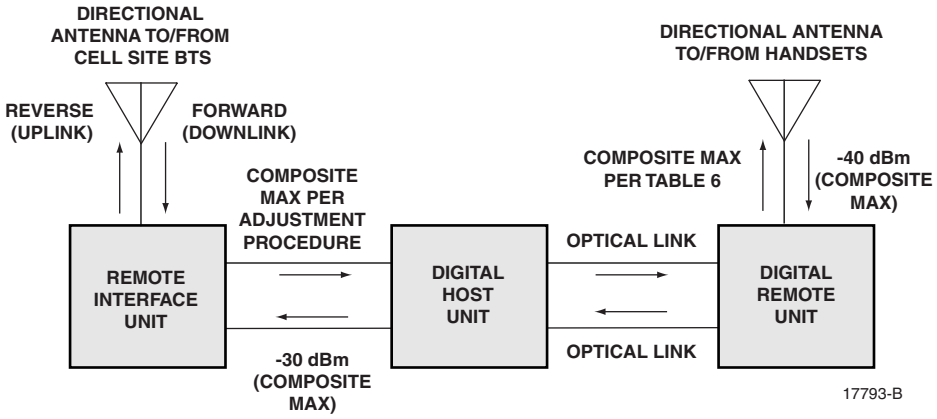

Figure 9. Remote BTS Interface Block Diagram

The RIU connects to a directional antenna through a duplexer (internal) that provides separate forward and reverse path connections for the DHU. In the forward path (downlink), the maximum RF input signal level the DHU will accept is determined by the DHU overdrive limiter. When the RF signal **input** to the DHU is set to 1 dB below the DHU overdrive level, the RF signal **output** at the DRU will be at the specified maximum level (see Table 6). The level of the RF signal output at the DRU is dependent on the modulation protocol and the number of carriers.

In the reverse path, the RF output signal level required at the donor antenna will vary depending on the distance from the BTS. When the level of the reverse path (uplink) signal at the DRU is at the recommended composite maximum level of **–40 dBm**, the level of the RF output signal from the DHU with be **–30 dBm**. Therefore, it will generally be necessary to add some gain to the reverse path signal in order to provide the output RF signal level required at the donor antenna.

The RIU is rack or wall mountable and is powered by 120–240 VAC (50/60 Hz) power. Refer to the Digivance Remote Interface Unit User Manual (ADCP-75-114) for additional information.

3.2 Location and Mounting Requirements

3.2.1 DHU and DEU Location and Mounting Requirements

The DHU and the DEU may be either rack mounted or wall mounted. Fasteners (both metric and US standard) are included with each unit for rack mount applications. A pair of reversible mounting brackets is provided that allows the unit to be mounted in either a 19-inch or 23-inch EIA or WECO equipment rack. When rack-mounted, the front panel of the unit is flush with the front of the rack. The cable management tray extends 3.9 inches (99 mm) beyond the front panel. Both the DHU and DEU occupy 3.5 inches (89 mm) of rack space. Make sure the mechanical loading of the rack will be even to avoid a hazardous condition such as a severely unbalanced rack. The rack should safely support the combined weight of all the equipment it holds and be properly anchored.

For wall-mount applications of the DHU or DEU, a pair of holes is provided in the cable management tray that allows the unit to be mounted on any flat vertical surface. The mounting holes are spaced 11-21/32 inches (296 mm) apart. The DHU/DEU should be oriented so the front panel faces up when mounted. Appropriate fasteners for wall mounting must be provided by the installer. It is recommended that a backer board such as 3/4-inch plywood be installed over the mounting surface to provide a secure base for attaching the DHU or DEU.

The DHU and DEU should be mounted in a non-condensing indoor environment such as inside a wiring closet or within an environmentally controlled cabinet. All controls, connectors, and indicators are mounted on the front panel. All cables should be routed to the front panel for connection. Cable retainers provided on the cable management tray for securing the fiber optic, DC power, and external alarm system cables.

The maximum recommended ambient temperature for the DHU and DEU is 50º C (122º F). Sufficient space for air circulation should be provided between each unit when installed in a multi-unit rack assembly because the operating ambient temperature of the rack environment might be greater than room ambient. A minimum clearance of 3 inches (76 mm) should be provided on both the left and right sides of the unit for air intake and exhaust. Refer to Figure 2 for the DHU dimensions and Figure 6 for the DEU dimensions.

3.2.2 DRU Location and Mounting Requirements

The DRU must be installed in a non-condensing indoor environment and may be wall-mounted or ceiling-mounted. The DRU may also be installed in spaces used for environmental air such as the space over a suspended ceiling or beneath a raised floor. However, the DRU is not intended for installation in marine, industrial, or Intrinsic Safety (IS) environments without an engineering review of the air quality as well as other constituent gasses and dusts. Indoor air environments are to have air borne contaminants at or below levels established in Telcordia Standard, GR-63-CORE, Network Equipment-Building System (NEBS) Requirements: Physical Protection, Section 4.5 Airborne Contaminants, Table 4-11, Indoor Contaminant Levels. Contact ADC for application assistance if necessary.

The DRU is equipped with four integral mounting feet that allow it to be fastened to any flat vertical or horizontal surface. Holes are provided in the mounting feet for inserting fasteners. Appropriate fasteners for securing the DRU to the selected mounting surface must be provided by the installer.

The DC power cable and optical fibers should be routed to the DRU front panel for connection. The antenna coaxial cable should be routed to the DRU rear panel for connection. A minimum of 3 inches (76 mm) of clearance space should be provided on all sides of the DRU (except the bottom) to ensure there is adequate air circulation for cooling. In addition, at least one surface of the DRU installation area must be open to the interior of the building. If a portable/flexible antenna will be installed, a minimum of 9 inches (229 mm) clearance should be allowed on the surface that is perpendicular to the antenna. Refer to Figure 4 for the DRU dimensions.

3.3 Powering Requirements

3.3.1 DHU and DEU Powering

The DHU and DEU are powered by 120–240 VAC (50/60 Hz) which is supplied through a standard three-conductor 120 VAC power cord. The power cord is provided with the unit and is 98 inches (2.5 m) long. Both the DHU and the DEU have a current rating of **2.0 Amps at 120 VAC** input. Each unit should be located so that an AC outlet is within the reach of the power cord.

If back-up powering is required, it is recommended that the building Uninterruptible Power Supply (UPS) system be used to provide back-up power to the DHU and DEU in the event of an AC power outage. This will also power all the DRU's that are powered by the DHU or DEU.

3.3.2 DRU Powering

The DRU is powered by 48 VDC power which is input to the DRU through the front panel RJ-45 connector. Power to the DRU may be provided by the DHU, DEU, or by a 120 VAC to 48 VDC power converter (available separately as an accessory item) plugged into a properly grounded 120 VAC outlet. The DRU has a current rating of **400 mA at 48 VDC** input.

If the DRU will be powered by the DHU or DEU, the power cable must be fabricated on-site by the installer. Category 3 or 5 twisted pair cable should be used for the power supply cable. The maximum recommended length of the power cable is **500 meters**. The power cable must be routed between the DHU or DEU and the DRU. Both ends of the power cable must be terminated with a **male** RJ-45 connector. If the DRU will be located more than 500 meters from the DHU or DRU, it must be locally powered by a 48 VDC power converter.

The DRU may be powered locally by the AC/DC converter, shown in Figure 10, which is available as an accessory item. The converter is a UL Listed stand alone Limited Power Supply (LPS) unit with a rated output of **48 VDC at 1.2 Amps**. The converter is equipped with a 6-foot (1.8 m) DC power cable which is terminated with an RJ-45 male connector. The converter is powered by 120–240 VAC (50/60 Hz) power which is supplied though a standard three-conductor 120 VAC power cord. The power cord is 6 feet (1.8 m) long and is provided with the converter.

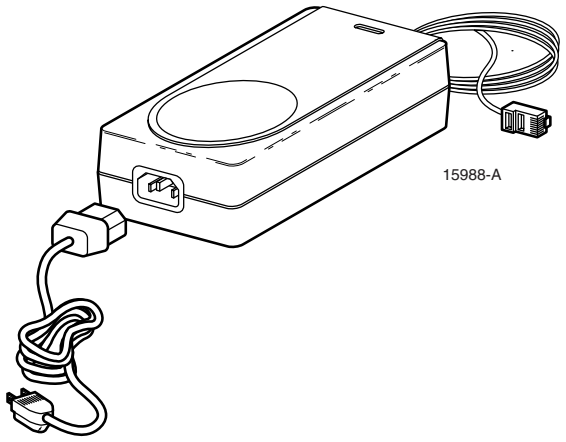

Figure 10. AC/DC Power Converter

3.4 Optical Options and Requirements

Each DHU and its associated DEU's and DRU's are connected over a pair of optical fibers. One fiber transports the forward path optical signal and the other fiber transports the reverse path optical signal. Either 62.5 or 50 micron core multi-mode optical fiber; or 9 micron core single-mode optical fiber may be used for the optical transport connection. With 62.5 micron core fiber, the optical path may be up to 500 meters in length. With 50 micron core fiber, the optical path may be up to 750 meters in length. With 9 micron core cable, the optical path may be up to 10 kilometers in length. Single- and multi-mode fibers may be used in the same system. A diagram of the optical connections is shown in Figure 11.

Whenever possible, use conduit or a guideway such as the FiberGuide system to route the optical fibers between the DHU, the DEU's, and the DRU's. Avoid routing optical fibers through ladder type cable racks or troughs that do not provide sufficient support to limit bending or prevent accidental damage. Tie-wrapping is not recommended as a means of securing fiber optic cables. Provide sufficient slack at each unit for connecting each fiber to the required port. Fibers may be pre-terminated or terminated on-site using field-installable LC type connectors.

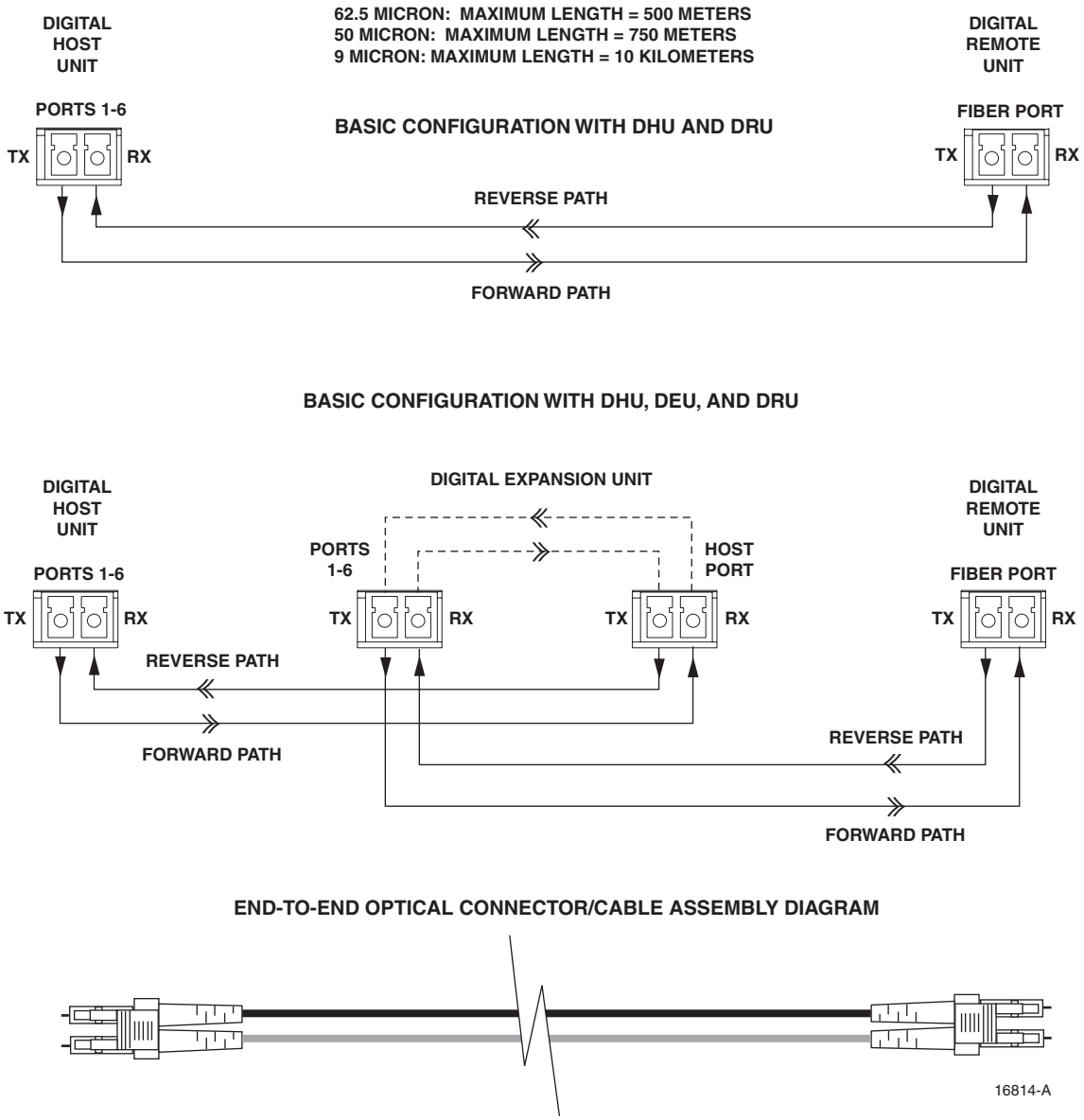

Figure 11. Digivance ICS Optical Connections

3.5 Coaxial Cable Requirements

The DHU interfaces either locally (see Figure 8) or remotely (see Figure 9) with the BTS through coaxial cable connections. In a local interface, coaxial cables are required to link the DHU, HPCP, and the BTS. In a remote interface, coaxial cables are required to link the DHU, RIU, and the donor antenna. The DHU, HPCP, and RIU are equipped with N-type female connectors for connecting the forward and reverse path coaxial cables. High performance, flexible, low loss 50-ohm coaxial communications cable (RG 400 or equivalent) should be used for all coaxial connections.