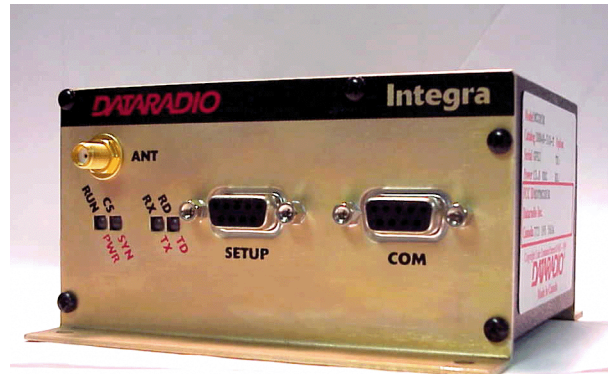


INTEGRA
H Version
Technical Manual

DATARADIO®

INTEGRA-H



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Part Number: 001-4090-101/102
Revision 0
September 2000

DATARADIO COR Ltd. designs and manufactures radios and radio modems to serve a wide variety of data communication needs. DATARADIO produces equipment for the fixed data market including SCADA systems for utilities, petrochemical, waste and fresh water management markets and RF boards for OEM applications in the Radio Frequency Data Capture market.

PRODUCT WARRANTY

The manufacturer's warranty statement for this product is available from DATARADIO COR, Ltd. 299 Johnson Avenue, Box 1733, Waseca, MN 56093-0833. Phone (507) 835-8819.

The information in this document is subject to change without notice.

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PRODUCT OVERVIEW

1.1 SCOPE OF MANUAL

This document provides information required for the operation and preventive maintenance of the DATARADIO COR Ltd. Integra-H Spread Spectrum Radiomodem. This manual is intended for system designers, professional installers and maintenance technicians

1.2 GENERAL DESCRIPTION

Integra-H is a high-speed protocol transparent radiomodem. It is designed specifically to fit the needs of Supervisory Control and Data Acquisition (SCADA), telemetry and control applications. Integra-H provides the communication links to data equipment for installations where wired communication is impractical.

Integra-H will work with most makes and models of remote terminal units (RTU) and programmable logic controllers (PLC) and their protocols. Configuration settings allow tailoring for a variety of application requirements.

Integra-H supports:

1. Point to point configuration in switched simplex mode
2. Point to multipoint configuration

Settings and connections for these configurations are given later in this manual

1.2.1 CHARACTERISTICS

Integra-H has the following characteristics:

- Selectable network speeds of 9600, 19200, 21400, and 25600 b/s
- One COM port for connection to DTE. Speed of 300 - 19200 baud
- One Setup port, for configuration and diagnostics output (speed fixed to 9600 baud, 8 bit, (unlicensed frequency hopping band) no parity, 1 stop bit
- Built-in 0.1 - 1-watt transceiver, operating in the 902-928 MHz communications bands
- Fully transparent operation with error-free data delivery (no “dribble bits”)
- Allows transmission of “break” characters
- DOX (Data Operated Transmit) or RTS mode
- Two 8-bit analog inputs (0 - 10V)
- Low power consumption modes: “sleep” and “suspend” modes (< 20 mA)
- “13.3 VDC, negative ground” device

1.2.2 ACCESSORIES AND OPTIONS

Table 1-1 Integra-H Accessories and Options

Accessory	DRL Part Number
Local RSS & RDS software kit (diskette and setup/data cable)	023-4090-005
SMA Male - BNC Female adapter cable	023-3410-098
Power cable	732-03273-001 (DRI p/n)

For information on accessories and options, contact your sales representative. In the United States phone 1-800-992-774. For international sales, phone 1-612-882-5529 or 1-305-829-4030.

1.2.3 CONFIGURATION

Operating characteristics of the Integra-H are configured by means of Integra-H Radio Service Software (INTRSS). The RSS/RDS software kit also includes the Radio Diagnostic Software (INTDIAG), which permits both local and remote diagnostics. These programs are Win/95 or later based (16 Megabytes of memory required).

Integra-H requires the use of INTRSS for both configuration and adjustment.

1.3 FACTORY TECHNICAL SERVICE

The Technical Service Department provides customer assistance on technical problems and serves as an interface with factory repair facilities. They can be reached in the following ways:

Dataradio COR Ltd.
299 Johnson Avenue, P.O. Box 1733
Waseca, MN 56093-0833

Technical Service hours are: Monday to Friday 7:30 AM to 4:30 PM, Central Time

Phone: 1-800-992-7774

1-507-835-6408 or 1-507-835-8819

Fax:1-507-835-6648

Email address: support@dataradio-cor.com

1.4 PRODUCT WARRANTY

The warranty statement for the Integra-H is available by contacting your sales representative. DRL warranties are included in .pdf format on CD versions of DATARADIO technical manuals.

1.5 REPLACEMENT PARTS

This product is normally not field-serviceable, except by the replacement of complete units. Specialized equipment and training is required to repair logic boards and radio modules.

Contact Technical Service for information before returning equipment. A Technical Service representative may suggest a solution eliminating the need to return equipment.

1.6 FACTORY REPAIR

Dataradio products are designed for long life and failure-free operation. If a problem arises, factory service is available. Contact the Technical Service Department before returning equipment. A service representative may suggest a solution eliminating the need to return equipment.

A Return Material Authorization (RMA) is required when returning equipment to Dataradio for repair. Contact the Technical Service Department at 800-992-7774, extension 6290 to request an RMA number. Be prepared to give the equipment model and serial number, your account number (if known), and billing and shipping addresses.

Include the RMA number, a complete description of the problem, and the name and phone number of a contact person with the returned units. This information is important. The technician may have questions that need to be answered to identify the problem and repair the equipment. The RMA number helps locate your equipment in the repair lab if there is a need to contact Dataradio concerning the equipment. Units sent in for repair will be returned to the customer re-tuned to the current Dataradio Test and Tune Procedure and will conform to all specifications noted in this section

Customers are responsible for shipping charges (to Dataradio) for returned units in warranty. Units in warranty are repaired free of charge unless there is evidence of abuse or damage beyond the terms of the warranty. Dataradio covers return shipping costs for equipment repaired while under warranty.

Units out of warranty are subject to repair service charges. Customers are responsible for shipping charges (to and from Dataradio) on units out of warranty. Return shipping instructions are the responsibility of the customer.

1.7 PHYSICAL DESCRIPTION

Integra-H consists of a logic PCB (which includes modem circuitry) and a radio module. Each logic PCB and radio module are matched together and characterized in the factory to optimize performance as an intelligent unit. The two boards then slide into the rails of an extruded aluminum case.

The Integra-H transceiver “hops” from channel to channel several times per second using a “hop” pattern applied to the master and remotes in a network. A distinct hopping pattern is provided for each of the available network addresses. This distinct pattern minimizes the chance of interference with other spread spectrum networks. In the United States (and certain other countries), no license is necessary to install and operate this type of spread spectrum system.

DTE connection is made via a front panel connector. Power is applied through a rear panel 4-pin connector which includes two programmable analog connections usable as inputs or specialized outputs.

The unit is not hermetically sealed and should be mounted in a suitable enclosure when dust and/or a corrosive atmosphere are anticipated. Physically, there are no external switches or adjustments. All operating parameters are set using the INTRSS software program.

1.8 DIAGNOSTICS

Integra-H has sophisticated built-in diagnostics that may be transmitted automatically without interfering with normal network operation. In addition, commands to generate test transmissions, etc., may be issued either locally or remotely.

Diagnostic information takes one of two forms:

Online diagnostics Information is automatically sent by each unit at the beginning of every data transmission. Online diagnostics are available via the setup port or INTDIAG software.

Offline diagnostics Information is sent by a specific unit in response to an inquiry made locally or from another station. Off

1.9 FIRMWARE UPGRADES

The Integra-H firmware resides in flash EPROM and is designed to allow field upgrades.

Upgrades are done using a PC connected to the Integra-H but do not require opening the unit. Upgrades require interaction with DRL's Technical Service.

1.10 INSTALLATION

1.10.1 PROFESSIONAL INSTALLATION REQUIRED

The Integra-H complies with Part 15 of the FCC rules and must be professionally installed. Operation must conform to the following conditions

- *This device may not cause interference*
- *This device must accept any interference including interference that may cause undesired operation of the device*

The installer of this equipment must ensure the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population; consult Safety Code 6 (available from Health Canada).

1.10.2 ANTENNA CONNECTION

This equipment has been tested and approved with antennae having a maximum gain of 10 dB. Antennae with a higher gain are strictly prohibited (regulations of Industry Canada). The required antenna impedance is 50 ohms. To reduce potential radio interference, the antenna type and its gain should be chosen to ensure the equivalent isotropically radiated power (EIRP) is not more than required for successful communication.

PRODUCT OVERVIEW

FCC/IC Rule: The output power is not to exceed 1.0 watt and the EIRP not to exceed 6 dBW if the hopset uses 50 or more frequencies. A sample calculation is provided below.

Sample Calculation: Yagi Antenna: 10 dB Exceeds 6 dBi gain by 4 dB
Cable Loss: 1 dB

Integra-H output must be reduced by 4 dB (plus 1 dB to account for cable loss)

30 dBm - 4 dB + 1 dB (cable loss) = 27 dBm at antenna port of Integra-H
after 1 dB loss through cable: 27 dBm - 1 dB = 26 dBm input to antenna
Result: reduction of 4 dB

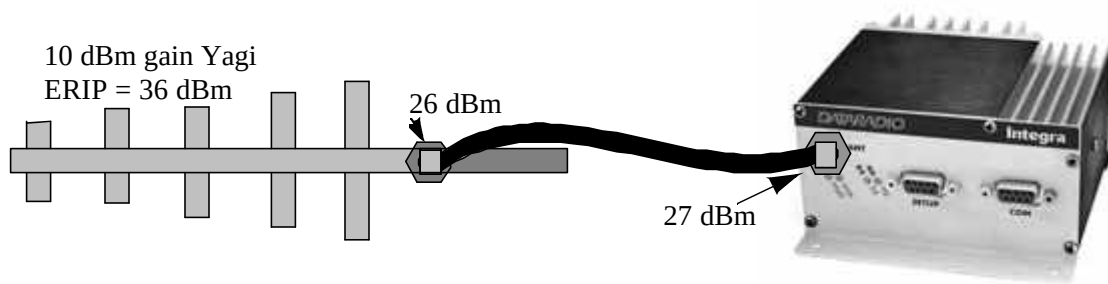


Figure 1-1 Sample Equation Graphic

1.10.3 ACCEPTABLE ANTENNAE

The antennae listed in Table 1-2 were tested and typed for maximum gain. These antennae are FCC approved for use with the Integra-H.

Table 1-2 Acceptable Antennae

Type	Manufacturer	Part Number	Gain (dBi)
Yagi	Maxrad	MYG9159	10
Omni Directional	Maxrad	MFB9157	7
Unity Gain	Maxrad	MFB9150	0
Whip	Maxrad	EXE-902-SM or EXR-902-BN	0

1.10.4 SAFETY NOTICE

RF Exposure



The Integra-H uses low power radio frequency transmitters. The concentrated energy from an antenna may pose a health hazard. People should not be in front of the antenna when the transmitter is operating.

1.11 NETWORK APPLICATION

Integra-H is suited to a variety of network applications. Its primary design goal satisfies the needs of SCADA systems using RTUs, PLCs, or other similar equipment in either point-to-point or point-to-multipoint service.

This section gives an overview of some common configurations. Selection of “master” or “remote” as well as data delivery conditions is done using INTRSS.

1.11.1 RF PATH AND COMMUNICATIONS RANGE

Integra-H is designed for use over distances dependent on terrain and antenna system. To assure reliable communications, the RF (radio frequency) path between stations should be studied by a competent professional who can determine what antennae are required and whether or not a repeater is needed.

1.11.2 BASIC CONNECTIONS

The connections required are shown in Figure 1-2.

While an RTU or PLC is shown in the diagram, master stations often use a PC running an application designed to communicate with remote RTUs or PLCs.

The Setup PC is used for both configuration and local and remote diagnostics. It may be left connected at all times but is not required for normal operation once the unit has been configured.

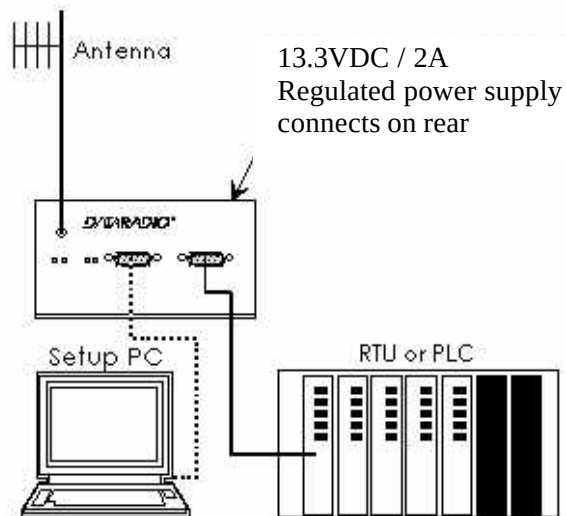


Figure 1-2 Basic Required Connections

1.11.3 COMMON CHARACTERISTICS

The networks described in this section share common characteristics:

- 1.The network speed (9600, 19200, 21400, and 25600 b/s) must be the same for all stations in a network.
- 2.Transmission of online diagnostics may be enabled or disabled at any station or stations without affecting their ability to communicate with other stations.

1.11.4 POINT-TO-POINT SYSTEM

A simple point-to-point connection is shown in Figure 1-3.

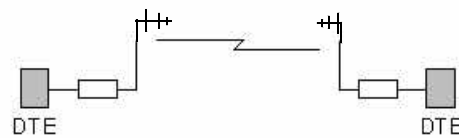


Figure 1-3 Point-to-Point System

In this system, the user's equipment (DTE) is set up in a master-remote configuration.

1.11.5 POINT-MULTIPOINT SYSTEM

Basic point-multipoint systems are shown in Figure 1-4:

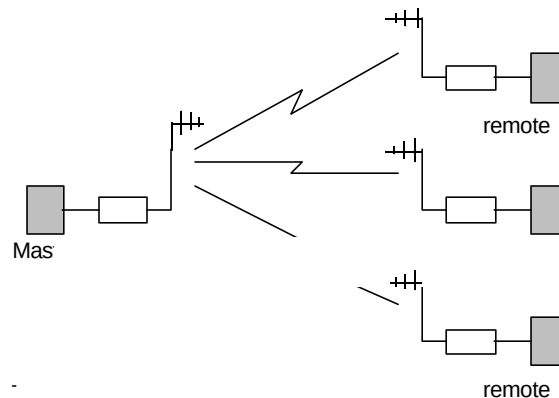


Figure 1-4 Point-Multipoint System

Using the Integra-H programming software, one Integra-H must be set to “master”. The remaining units in the network must be set to “remote”. All units are set to “selective” data delivery to prevent remote stations from hearing each other's responses.

1.11.6 EXTENDING A LANDLINE (TAIL CIRCUIT)

Integra-H may be used to extend a landline circuit (giving access to difficult locations, etc.). This type of connection is called a “tail circuit” and is shown in Figure 1-5. The tail circuit assembly may be used in any of the network types described in the preceding sections.

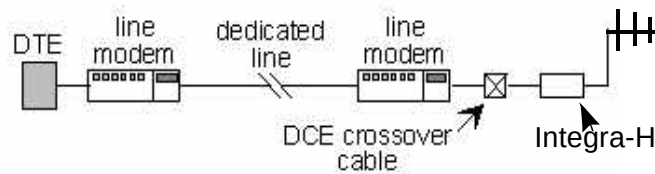


Figure 1-5 Landline (Tail Circuit)

Note: The phone-line modems should be full duplex units.

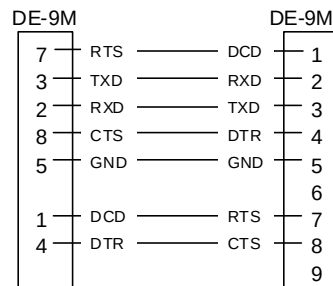


Figure 1-6 DCE Crossover Cable for RTS-CTS mode

Some point-to-point FDX landline modems or line drivers may require the use of DOX mode and an alternate pinout for DTR, DCD, CTS and RTS as shown in Figure 1-8.

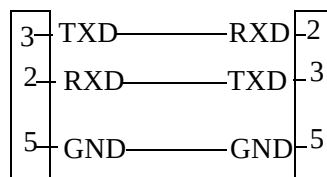


Figure 1-7 DCE Crossover Cable for DOX mode

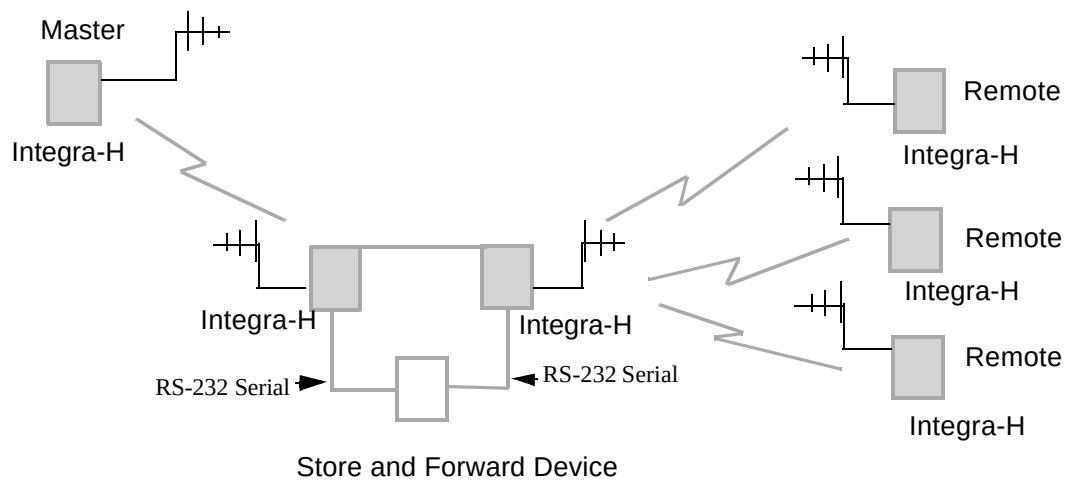


Figure 1-8 Point-Multipoint Using a Store and Forward Device

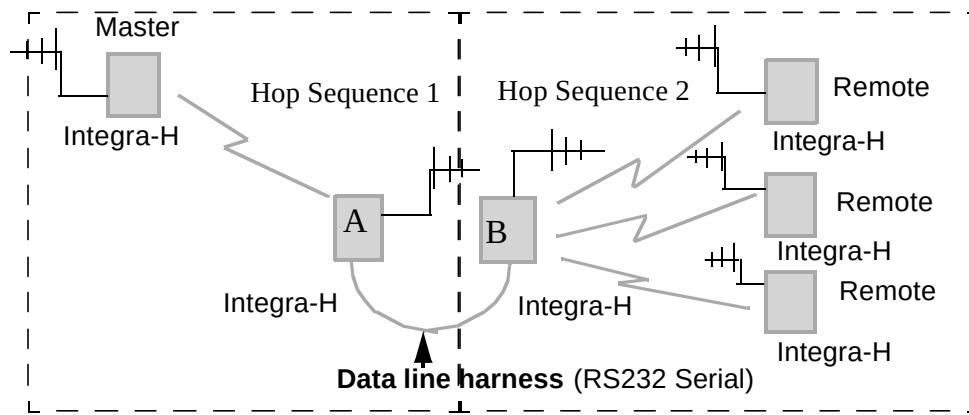


Figure 1-9 Point-Multipoint (Repeater)

GENERAL SPECIFICATIONS

These specifications are subject to change without notice.

GENERAL	
Frequency	902-928 MHz
Controlled Channel Access	Interference avoidance system Carrier Sense or Active Channel monitoring for dynamic channel usage
IF Channel Steps:	50 kHz for systems
IF Channel Bandwidth	30 kHz (Minimum 512 channels @ 900 MHz)
Operating Temperature	-30° to + 60° C
Supply voltage	10 - 16 VDC maximum
Receive Current	200 ma
Transmit Current	650 ma
Standby Current	20 ma
Data Format	Asynchronous 7 and 8 bit words
User Data Rates	19200, 21400, 25600 baud
Data Protocol	Transparent to user data
Nominal Dimensions	4.5" W x 2.2" H x 4.75" D (11.4 x 5.6 x 12.1 cm)

RECEIVER	
Sensitivity	10-6 BER @ -105 dBm @ 9600 bps
Intermodulation	75 dB
Spurious Rejection	80
Conducted Spurious	70
Secondary Image	65 dB

*psophometrically weighted

TRANSMITTER	
RF Power Output	.100 -1 Watt, software adjustable
Spurious and Harmonics	
Frequency Stability	1.5 ppm
Output Impedance	50 ohms
Maximum SWR	Stable over 10 to 1
Tx Duty Cycle	100% unlimited Tx time

Modem / Logic	
Operation	Switched Simplex
Data Bit Rates	25 kHz channel: 19200, 21400, 25600 baud
Modulation Type	DRCMSK (Differential Raise-Cosine Minimum Shift Keying)
RTS/CTS Delay (RTS mode)	4 ms
Addressing	8 bit station address, 1 bit station type (master / remote)
Bit Error Rate (BER)	
9600 b/s, 12.5 kHz	1 x 10 ⁻⁶ at 1.4 µV minimum /-104 dBm
9600 and 4800 b/s, 25 kHz	1 x 10 ⁻⁶ at 1.0 µV minimum / -107 dBm
19200 b/s, 25 kHz	1 x 10 ⁻⁶ at 2.3 µV minimum / -100 dBm

COM Port	
Interface	EIA RS-232C
Data Rate	300 - 19200 b/s
Protocol	Transparent, 7 or 8 data bits, 1 or 2 stop bits, even, odd or no parity
Transmit Control	RTS or DOX (data operated transmit)

PRODUCT OVERVIEW

Setup/Diag Port	
Data Format	Proprietary binary for setup, ASCII for diagnostics
Data Rate	9600 b/s, 8 bit, no parity, 1 stop bit

Analog Inputs	
Interface	Two inputs, 0-10 VDC, 8 bits. May be read only via offline diagnostics. Absolute maximum input voltage < 20 Vdc. Inputs are reverse-voltage protected.

Display	
4 Bi-color status LEDs	RUN/PWR/ CS/SYN, RX/TX, RD/TD

Connectors	
RF	SMA Female
COM	DE-9F
SETUP/DIAG	DE-9F
Power/Analog	Snap & Lock 4-Pin DC Power Jack

Diagnostics	
Online	Short ID, temperature, B+ voltage, local RSSI, remote RSSI, fwd and rev power, Rx Quality
Offline	As for Online plus: Demodulated Signal Voltage, Analog Input Levels

FEATURES AND OPERATION

2.1 OVERVIEW

This chapter describes the connections, indicators, and operating characteristics of the Integra-H. This chapter is intended for system application and installation personnel.

2.2 FRONT PANEL

The various front panel elements are described in the following sections.



Figure 2-1 Integra-H Front Panel

2.2.1 ANTENNA CONNECTOR

Antenna connector is a female 50-ohm SMA- type. The Integra-H is designed to operate with an antenna having a maximum gain of 10 dB. Antennae with a higher gain are strictly prohibited (FCC & Industry Canada). Required antenna impedance is 50 ohms. The installer of this equipment must ensure the antenna does not emit an RF field in excess of Health Canada limits for the general population (Safety Code 6 available from Health Canada).

2.2.2 RF EXPOSURE COMPLIANCE REQUIREMENTS

The Integra-H is intended for use in the SCADA market. It must be mounted within a fixed RTU. The Integra-H must be professionally installed to ensure a minimum separation distance of more than 20 cm is maintained between the radiating structure and any person. Typical installation is the antenna mounted on a tower. (In rare instances, a 1/2 wave whip antenna is used.) In these installations, the antenna is mounted greater than the minimum distance of 20 cm.

2.2.3 SAFETY NOTICE

RF Exposure



The Integra-H uses low power radio frequency transmitters. The concentrated energy from an antenna may pose a health hazard. People should not be in front of the antenna when the transmitter is operating.

2.2.4 LED INDICATORS

Integra-H has four two-color LED indicators. Their functions are shown in Table 2-1.

Table 2-1 LED Color Functions

RUN/PWR	Green	Normal operation
	Flash green	Sleep mode (flashes during wakeup)
	Flash red & green	Setup mode or loading new application or new bootloader
	Flash red	Firmware error*
	Red	CPU or PROM failure*
CS/SYN	Off	No RF RX carrier
	Green	Receive carrier present
	Red	(Reserved)
RX/TX	Off	No RF RX carrier
	Green	Receiving network data
	Yellow	Synthesizer unlocked
	Red	Transmitter is on
RD/TD	Off	Idle
	Green	RX data outgoing from RS-232 port
	Red	TX data incoming at RS-232 port

* Contact technical support.

2.2.5 CONNECTION TO DTE

Integra-H is configured as DCE. Most DTE should be connected using a nine-conductor pin-to-pin “straight” cable. Some RTUs or PLCs may require a special cable to route the signals correctly. See the documentation for your data equipment for further information.

2.2.6 COM PORT

Baud rates from 300 to 19200 are supported. Integra's are factory set (default) for 9600 b/s, 8 bits, no parity, and 1 stop bit. Unless required by your operating protocol, ***we advise restricting port speed to be equal to or less than the RF network speed.***

Table 2-2 COM Port Signals

Pin	Name	Function
1	DCD	Output: Always asserted or asserted when receive RF carrier present (selectable via RSS)
2	RXD	Output: Data from Integra-H to DTE
3	TXD	Input: Data from DTE to Integra-H
4	DTR	Input: Ignored
5	GND	Signal and chassis ground
6	DSR	Output: always positive
7	RTS	Input: Used as a “begin transmission” signal in RTS mode Will “wake up” unit in sleep mode
8	CTS	Output: Used for handshaking in RTS mode and used for flow control in DOX mode RTS mode: RTS to CTS delay in 4 ms DOX mode: CTS always asserted except when data overflow is detected
9	RI	Not internally connected, reserved

2.2.4.1 Connector Pin out

The DE-9F pin out is shown in Figure 2.2 for reference.

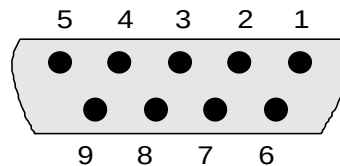


Figure 2-2 COM and Setup Port Connectors Pin Locations

2.2.4.2 Wire Connection (DOX)

For DTE that lack RTS control, Integra-H can operate in DOX mode (Data Operated Transmit) with only Transmit Data, Receive Data and Ground (“3-wire interface”).

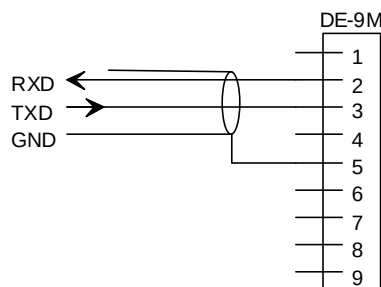


Figure 2-3 3-Wire Interface

2.2.7 SETUP PORT

The Setup port uses a DE-9 female connector configured as DCE. Signals are described Table 2-4.

Table 2-3 Setup Port Signals

Pin	Name	Function
1	DCD	Tied directly to DTR
2	RXD	Data from Integra-H to setup PC
3	TXD	Data from setup PC to Integra-H
4	DTR	Tied directly to DCD
5	GND	Signal and chassis ground
6	DSR	Output: always positive (asserted)
7	RTS	Tied to CTS. Also monitored to “wake up” unit from sleep mode
8	CTS	Tied to RTS
9	RI	Not internally connected, reserved

The Setup port uses a proprietary communications protocol designed to work with the Integra-H RSS and RDS programs. It is also designed to provide numeric diagnostics information when connected to a PC terminal emulator. (See section 2.5.1.2 for diagnostics format.)

2.3 REAR PANEL

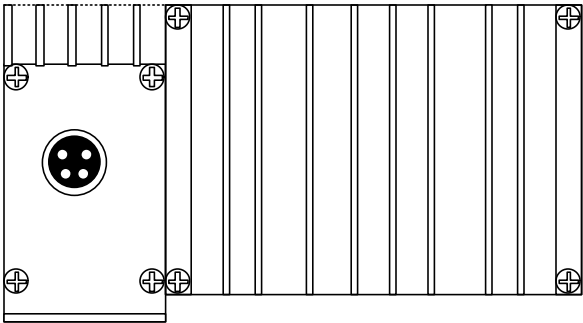


Figure 2-4 Integra-H rear panel

2.3.1 HEAT SINK

The rear panel heat sink is essential for proper operation of the Integra-H transmitter. The unit must be mounted in a location that permits free air circulation past the heat sink. Cooling will be best if the fins are vertical.

2.3.2 POWER

The Integra-H power requires a regulated power source of 13.3 VDC nominal (10 - 16 VDC max.) negative ground with a minimum 2.0 A rating. An internal surface-mount 3A modem fuse (not field-replaceable) and a crowbar diode protect the main RF power components from reverse polarity. Application of more than 16 VDC will damage the unit and is not covered by the warranty.

WARNING: Do not exceed 16Vdc.

2.3.3 POWER / ANALOG CONNECTOR

The 4-pin power / analog connector pin out is shown in Figure 2-5.

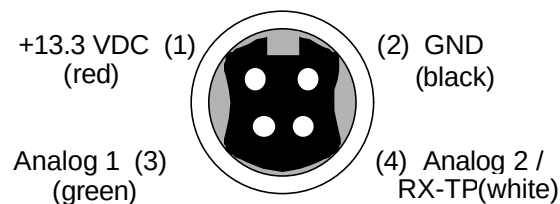


Figure 2-5 Power / Analog Connector

Note: The color of the power cable wires are shown in parenthesis. If the analog connections are not used the green and white wires should be cut back and/or taped to prevent contact. (See Table 1-1 for power cable part number)

2.3.4 ANALOG CONNECTIONS

The two analog connections can be programmed as inputs (monitoring) or as outputs.

2.3.4.1 Analog Inputs

Voltage inputs are scaled between 0 and 10 VDC and have a resolution of eight bits (1 part in 256). Monitoring inputs, measured in tenths of a volt, are referenced to chassis ground. The absolute maximum input voltage should not exceed 20 VDC. These inputs are reverse-voltage protected. Integra-H allows reading the analog values, locally or remotely, using the Offline Diagnostics function of the Radio Diagnostics Software (RDS) program. To use an analog connection as input, ensure that the required input box is checked in the RSS program under Settings / Analog Connector.

2.3.4.2 Analog outputs

To use an analog connection as output, be sure to check the appropriate box (in the RSS program under *Settings/Analog Connector*):

1. Analog 1 (green)

a. Input (or)

b. Fan Control

With the Fan Control selected, the output signal regulates fan operation. It is factory set for all units equipped with the cooling option. The temperature-controlled open-collector transistor is rated 100 mA maximum. The unit's internal thresholds are set for ON $\approx 48^{\circ}\text{C}$ and OFF at $\approx 38^{\circ}\text{C}$.

2. Analog 2 (white)

a. Input

The following two selections depend on hardware configuration and should not be changed in the field.

b. Rx-Tp

With the Rx-Tp selected, the output signal performs as the receiver demodulated audio signal test point (Rx-Tp). The Rx-Tp should measure 1 V p-p.

c. Antenna SW

Tx = Low

Rx = Open

With the Antenna Switch Control selected, the output is an open collector transistor rated at 100 mA max. The output signal supports the use of a redundant (HSB) base.

2.4 OPERATION

Integra-H is designed for fully transparent operation. This means that all binary values are transmitted as data with minimum time delays and without regard to their binary value. "Break" signals can also be transmitted. Unlike most transparent radiomodems, Integra-H eliminates "bit dribble" and allows DOX operation. A CRC-16 error check is used so that faulty data will not be delivered.

2.4.1 OPERATING MODES

Integra-H has two operating modes for its COM port: (selectable via the RSS program)

DOX mode: The RS-232 port is monitored for incoming data. Upon receipt of the first data byte, the transmitter is turned on. The RTS signal is ignored (Note: RTS may still be used as a wakeup signal for a unit that is asleep).

RTS mode: The RTS signal is monitored for a low-to-high transition. This transition causes Integra-H to turn on its transmitter. CTS is raised 4 ms later to accommodate DTE that requires a CTS transition before it can send data. The transmission will continue until RTS is dropped or until the Tx Time out (see section 2.8) expires.

CTS is used as a handshaking/flow control signal in both modes. If the Integra-H's buffers fill, CTS will be dropped as a signal to the DTE to stop sending data. This condition is most likely when the Data port speed exceeds the radio network speed. In such cases, reduce the DTE baud rate so that Integra-H buffers will not fill.

2.4.2 DATA FORWARDING TIMER

The data forwarding timer can modify the timing between data blocks in a transmission to accommodate some RTU's special timing requirements. Set to "normal" (15 ms) unless advised otherwise by technical support. Do not use "fast" (5 ms) timer below 2400 baud.

2.4.3 SENDING BREAK SIGNALS

Integra-H may be configured to send "break" signals, as required by some SCADA user protocols. A break signal is generated by holding TXD in the zero state for longer than one character time. Indication of a break signal is carried in a special data transmission to the remote station, which in turn generates its own output break signal.

At a port speed of 19200 b/s, the output break signal has a duration of 5 to 10 ms, regardless of the duration of the input break signal. These times are scaled proportionally for other baud rates. Integra-H may also be set to ignore "break" signals in order to prevent spurious transmissions when terminal equipment is powered on and off.

2.4.4 COM PORT BAUD RATES

The COM port operates at standard baud rates from 300 to 19200 b/s. Baud rate is set using the Integra RSS and is independent of the network speed setting.

We recommend that the COM port baud rate be set to a speed less than the network speed. Setting a COM port baud rate higher than the network rate may result in data buffers filling, which in turn may cause Integra-H to drop CTS. This could have detrimental effects on some protocols, particularly those that ignore CTS.

The COM port will support 7 or 8 data bits, one or two stop bits, and even, odd or no parity. Selection is made via the Radio Service Software (RSS). These parameters may be set differently on various Integra-H units without affecting their ability to communicate with each other.

2.4.5 ADDRESSING

Each Integra-H is associated with three identification numbers (addresses):

ESN: The Electronic Serial Number is uniquely assigned to each Integra-H at time of manufacture and cannot be changed. It is identical to the serial number printed on the label of the unit. Integra-H uses this number for identification only; it does not form part of the on-air protocol. The ESN of a remote unit may be viewed with the RDS by doing a *Remote GET*.

Short ID: The short ID (maximum value of 254) is used to identify Integra-H for purposes of diagnostics (both online and offline), remote configuration and commands. The default value of the short ID (set at factory) is calculated from the ESN. This value may be changed via the Integra RSS. It is important that all stations within a communicating group have unique short IDs.

Station Type: This is a 1-bit value used to identify the station as a master or remote. See 2.4.6.

2.4.6 STATION TYPE

On simplex or repeater networks, all remote stations can hear the master and many remote stations can hear each other. Certain SCADA user protocols are designed with the assumption that remote stations cannot hear the responses to polls made by other remote stations.

To allow operation with such protocols in simplex networks, Integra-H has a simple addressing scheme. Stations may be designated as master or remote. This sets a flag in the header identifying the type of the originating station.

On the receive side, Integra-H stations can be set to accept all data, or accept data only if it originates from a station **of the opposite type** (selective). This choice is made by setting Data Delivery to selective or all using the RSS.

2.5 ONLINE DIAGNOSTICS

Online diagnostics may be enabled or disabled on a per-unit basis without affecting inter-communication. Enabling this option adds about 2.5 ms delay at 19.200 b/s, 5 ms at 9600 b/s or 10 ms at 4800 b/s to each transmission, but has no other effect on network operation. At the beginning of each data transmission from a unit, diagnostics are delivered locally to its own setup port regardless of the Online Diagnostics setting. If user-enabled, diagnostics are also sent on the network.

Where user applications require continuous data transmission from a master unit, diagnostics are delivered locally to its own setup port regardless of the *Online Diagnostics* setting at the start of each data transmission and also at intervals of 20 seconds. If user-enabled, diagnostics are also sent on the network but only at the start of the first data transmission.

Reception of online diagnostics is always enabled and is delivered out at the Setup Port in an ASCII form.

Online diagnostics do not interfere with normal network operation. The following information is gathered:

- Unit's "short ID"
- Inside case temperature: in degrees C
- Supply voltage (B+): in volts
- Local received signal strength: in dBm
- Remote received signal strength: in dBm
- Forward power: in watts
- Reverse power: good / poor
- Receive quality: based on last 15 data blocks received.

2.5.1 USING AN EXTERNAL PROGRAM FOR ONLINE DIAGNOSTICS

The Setup port communicates with the RDS using a proprietary protocol. However, if a terminal, or PC running terminal software is connected to the Setup port, online diagnostic information will be delivered in plain ASCII form. We will refer to the proprietary data format as RSS/RDS mode.

2.5.1.1 Initialization

When powered on, it will attempt to establish a link with the RSS/RDS and select its output mode as follows:

1. If RTS is not exerted on the setup port, Integra-H will immediately switch to ASCII mode.
2. If RTS is exerted on the setup port, Integra-H will send an initialization message in RSS/RDS mode and wait for the proper response from the RSS or RDS.
3. If there is no response, Integra-H will switch to ASCII mode.

A user-program should initialize the PC serial port with RTS false. This disables RSS/RDS mode and only ASCII data will be output from the port.

2.5.1.2 Online Diagnostic String Format

In ASCII output mode, the setup port will output a one line diagnostic string each time the unit receives a transmission from another unit. No other data will be output. The string consists of a number of comma-delimited fields terminated by a carriage return. Each field

within itself is a constant length, but the fields are not all uniform in length. Field definitions are shown in Table 2-4.

Table 2-4 Online Window Field Definition

Name	Length (in bytes)	Description
Short ID	4	1 - 254
Temperature	3	Signed value
B+	4	From 6.0 to 18.8 V
Remote RSSI	4	Signal strength received by remote station in dBm
Local RSSI	4	Signal strength for this remote as received by local station in dBm
FWD Power	4	From 0.1 to 1 watt
Rev Power	1	0 = good 1 = poor
Rx Quality	3	Number of good data blocks received in the last 15
	3	Number of total data blocks detected, maximum 15

A typical diagnostic string (0003,+28,13.1,-093,-088,.9,1,015,015) would be interpreted as:

- Remote station # 3 reports that:
- Its internal case temperature is +28°C
- Supply voltage is 13.1 VDC
- It is receiving a signal of -93 dBm from the master
- The master is receiving a signal of -88 dBm from station 003
- The forward power is .9 watt
- The reflected power is OK
- 15 of the last 15 data blocks were received correctly

2.5.2 INTERPRETING DIAGNOSTIC RESULTS

Interpretation of the diagnostic results is similar for both online and offline diagnostics. Differences will be noted where they exist in the text. For simplicity, we continue to assume that diagnostics are being collected at the master station.

2.5.2.1 Short ID

Online diagnostic data is identified by the Short ID of the unit. Users should make sure that all units in a communicating group have unique Short IDs.

2.5.2.2 Temperature

Internal case temperature of sending unit. This is a 3-digit signed value in degrees C. This value should remain within the limits of -30°C to +60°C ±2°C.

2.5.2.3 B+ Voltage

Current value of supply voltage. SWB+ is a 4-digit value in volts, e.g. a value of 13.3 indicates 13.3 VDC. This value should remain within the limits of 10-16 VDC $\pm 2\%$.

2.5.2.4 Remote RSSI

Displays the strength of the last valid data signal received by a reporting remote unit. In a polling type network, the last signal usually originates from the polling master unit. For the master itself, the last signal received is that of the remote that answered the previous poll. This is a 4-digit value, including the leading minus sign, expressed in dBm with a typical accuracy of ± 2 dB. For example, a value of -090 indicates a signal strength of -90 dBm.

2.5.2.5 Local RSSI

Displays the strength of the last valid data signal received by the connected Integra-H unit. The format described in the Remote RSSI section above applies.

2.5.2.6 Interpreting RSSI Readings

Typical values of RSSI will be in the range of -110 to -60 dBm (depending on network speed), with higher values (i.e. less negative values) indicating a stronger signal.

Reliability of data reception depends largely on signal strength. Good design practice calls for a minimum 30 dB “fade margin”, based on a threshold reception level of -107 dBm (1 μ V) at speed of 9600 b/s. Experience indicates that this will give about 99.5% reliability.

Some representative performance values for 9600 b/s operation are given below. These values assume that the units are correctly aligned and installed in a quiet location. Environments with high electrical or RF noise levels will require an increase in the numbers shown to achieve a given level of reliability.

-100 dBm Approximately 50% reliability. Fading may cause frequent data loss.

-90 dBm Approximately 90% reliability. Fading will cause occasional data loss.

-80 dBm Approximately 99% reliability. Reasonable tolerance to most fading.

-70 dBm Approximately 99.9% reliability with high tolerance to fading.

If RSSI values drops seasonally the most likely cause is tree foliage which can interfere with radio transmissions during the spring and summer.

2.5.2.7 Forward Power

Approximate measure of transmit power. This is a 4-digit value in watts rounded to the nearest tenth. ***Note that this is an approximate value that should be used for trend monitoring only.*** It does not compare in accuracy with values obtained by a standard wattmeter.

2.5.2.8 Interpreting Power Readings

The values returned are approximate and should not be regarded as an absolute indicator of performance. For example, a unit that shows a forward power of .9 watt may actually measure at .9 watt on a lab quality wattmeter. For this reason, these values should not be used to indicate that a unit is out of spec or to compare one unit to another.

However, the values returned should be consistent for any given unit. If statistics are kept on a unit per unit basis, changes in forward or reflected power can be monitored. The following conditions are worthy of investigation.

1. Forward power output (in watts) drops or rises by more than 10% from its established value. Reflected power remains low. This indicates that the transmitter may need alignment or that a component may be in need of replacement.
2. Forward power output drops by more than 10% from its established value or reflected power shows an increase. This indicates a possible antenna or feedline problem that affects SWR (Standing Wave Ratio).

2.5.2.9 Reverse Power

Approximate measure of reverse (reflected) power. The value is returned differently for on-line and offline diagnostics:

Online: The value returned is 0 if reverse power is within acceptable limits, 1 if reverse power is too high. The threshold is set to approximately 1/3 of the forward power value.

Offline: Value is in watts to the nearest tenth. This value is intended as an indication of antenna problems and will normally be used for trend monitoring. Ideally it should be close to zero, but values up to about 15% of Forward Power may be encountered in properly operating systems.

We recommend recording values following original installation for use as future reference.

2.5.2.10 Reverse Power and SWR

A reverse power reading above zero is an indication that the antenna, feedline or connectors are damaged, corroded or improperly tuned. This creates standing waves that are reported as a Standing Wave Ratio (SWR).

Table 2-5 is based on a forward power of 1 watt (it may be scaled for lower power settings) and gives guidelines to interpreting these figures:

Table 2-5 SWR / Rev Pwr Interpretation

SWR	Rev Pwr	Significance
1:1	0	Ideal situation
1.5:1	0.05	Normal operation
2:1	0.2	Should be investigated
3:1 or greater	0.3 or greater	Defective antenna, feedline, or connectors

Should values returned by the built-in diagnostics seem to indicate a problem, verify using proper radio shop equipment.

2.5.2.11 RX Quality Indicator

This is the number of good received data transmissions out of the last 15. The receive quality indicator value returned by any remote unit to the master station is an indication of the reception quality on the outbound path.

If the master station is monitored, either from a remote station or by using a local GET STATS, users should note that the receive quality indicator thus returned is a composite value which represents the average reception from the last 15 remotes. Any significant drop in the receive quality indicator returned by the master station is likely to indicate a problem with the master station receiver itself rather than any one remote station.

2.6 OFFLINE DIAGNOSTICS

Offline diagnostics are returned in response to a specific request to a particular station. Requests are issued using the Integra RDS, either locally or remotely from another station. This may cause slight temporary network disruption. We recommend the user application be offline.

The diagnostic information available is similar to that available from online diagnostics with the following additions:

- Demodulated signal voltage: peak-to-peak
- Analog 1 input voltage: 0 - 10.0 VDC
- Analog 2 input voltage: 0 - 10.0 VDC
- Reverse power: in watts rather than a good / poor flag.

2.7 LOW POWER OPERATION

To accommodate users, who operate sites with limited available power, Integra-H offers the following power saving features:

- Reduced transmit power
- Suspend mode
- Sleep mode

2.7.1 REDUCED TRANSMIT POWER

The Integra-H transmitter is type-approved for power levels varying from .1 to 1 Watt. Select the desired power setting using the Integra RSS.

2.7.2 SUSPEND MODE

Note: As long as the RTS is asserted (on any port), the unit will be kept awake.

2.7.2.1 Remote Station

Remote stations remain in “low power consumption mode” (< 20 mA) waking up periodically for about 100 ms to check the presence of a carrier. If a carrier is present, the unit will remain awake for a period set by the *Activity timeout*. At the end of that time, if a carrier is present or if data has been decoded, the *Activity timeout* is restarted. If there is no carrier or no data was decoded, the unit goes into “low power consumption mode” for the duration of the *Suspend period*. The *Suspend period* can be set via the RSS to any value between 50 to 12000 ms in 50 ms steps. Setting a value of 0 disables the Suspend mode. The *Activity timeout* can be set via the RSS to any value between 1 and 255 seconds. **The same *Activity timeout* and *Suspend period* values must be set for both master and remote stations.**

2.7.2.2 Master Station

Master stations always remain awake. To make sure those suspended remotes have time to wake up for outbound master data transmission, the master unit will automatically extend its start-of-transmission synchronization time to slightly exceed that of the remote stations' *Suspend period*. This is done only for the first transmission. If the subsequent master transmissions begin within the *Activity timeout* setting, it will then begin with a normal start-of-transmission synchronization time.

If the delay between master transmissions is more than the *Activity timeout*, the next transmission will be extended.

2.7.3 SLEEP MODE

In this mode, the unit is always in low power consumption (< 20 mA). Only asserting RTS on the COM or the SETUP ports can wake-up the unit. When the unit is sleeping, it cannot detect the presence of a carrier. This mode can be selected from the RSS. The unit will be ready to receive a carrier and decode data within 45 to 65 ms (depending on radio model and temperature) after wake-up.

2.7.4 REMOTE UNIT WAKE-UP BY DTE

A Remote Terminal Unit (RTU) connected at an Integra-H (configured as remote) can be awakened by raising either RTS inputs.

DOX mode: either COM or SETUP ports RTS can be used for wake-up. Data from DTE cannot wake-up the unit.

RTS mode: the SETUP port RTS can be used for wake-up without causing transmission.

2.8 EXTENDED PREAMBLE

This selection is used to extend the transmitted synchronization time when the Integra-H is used as remote or master in networks with repeaters. This time is in addition to the standard transmitter turn-on time. Depending on user's protocol, add 5 to 10 ms for each repeater the Integra-H communicates through in the network.

2.9 OPTIMIZING YOUR SYSTEM

Detailed system engineering is beyond the scope of this manual. However, there are some simple tips that can be used to optimize performance of a radio based SCADA or telemetry system.

Choose the best protocol Some SCADA devices allow a choice of more than one operating protocol. In some cases, performance can be improved by selecting a different protocol. Contact Technical Service for assistance.

Check timer settings Polling protocols issue a poll and wait a certain time for a response. Integra-H adds a short amount of delay to each poll and response (typically in the order of 60 to 70 ms). Timer settings that are too short may cause erroneous indication of missed polls, in which case the application may retry or continue to cycle, ignoring the missed station. In this case, the response may collide with the next poll, further increasing errors. Setting an adequate timer margin will avoid problems and maximize performance.

Avoid flow control Set the Com port baud rate to a value less than or equal to the radio network speed (4800, 9600 or 19200 b/s). In a polling system, this will prevent buffer overflow with possible missed transmissions. If the port baud rate must be set higher than the radio network speed, you may have to limit message length to prevent possible buffer overflow. Integra-H will exert a flow control signal (CTS dropped) if buffers are almost full, but not all DTE honor such signals.

FEATURES AND OPERATION

Use the highest suitable port baud rate (without exceeding the radio network speed) Operating an RTU at 1200 b/s on a 9600 b/s network will increase data transmission delays and reduce system performance.

Evaluate the need for online diagnostics Enabling online diagnostics increases delays by 2.5 to 10 ms (depending on speed). In critical applications, this extra delay can be eliminated by disabling online diagnostics. Offline diagnostics (diagnostics on request) remain available.

MAINTENANCE AND ADJUSTMENTS

3.1 OVERVIEW AND MAINTENANCE INTERVALS

This chapter outlines the basic tests and adjustments required upon initial installation and thereafter at annual maintenance intervals or whenever deterioration in performance indicates that adjustment may be required. Units are delivered from the factory properly aligned and tested on the frequency range specified at time of order. Adjustment beyond that described in this chapter is not required unless radio modules have been tampered with or repaired. In such cases, we recommend complete factory re-alignment as special test equipment is required. This chapter is intended for use by installation and maintenance personnel.

3.2 EQUIPMENT REQUIRED

The adjustments described below require the following equipment:

1. 13.3 VDC / 2A regulated power supply.
2. Radio service monitor (IFR1200 or equiv.).
3. Cable with SMA male connector to connect Integra-H to the service monitor.
4. Integra Radio Service Software (RSS) kit.
5. A Win/95 PC or better to run the RSS.
6. Normal radio shop tools.

3.3 TEST POINT

For trouble shooting aid, there is one test point available at pin 4 of the power/analog connector (white wire). This demodulated signal measurement is half the voltage read at the RSSI bar graph (found in INTRSS and INTDIAG programs).

Note: the RX-TP mode must be selected (*Analog Connector* window) using the Integra RSS.

3.4 BASIC TESTS/ADJUSTMENTS

Basic tests and adjustments to be performed are:

1. Transmitter power output
2. Transmitter frequency
3. Transmitter deviation
4. Demodulated signal level
5. 12 dB Sinad
6. Distortion

3.5 PRELIMINARY STEPS

Important Note: Before proceeding make sure that the service monitor has been calibrated recently and has warmed up for at least the time specified by its manufacturer. Some reported frequency and deviation problems have actually been erroneous indications from service monitors that have not adequately warmed up. This is particularly likely when field service is done during winter months.

1. Connect the Integra-H antenna connector to the radio service monitor RF input using a 023-3410-118 or equivalent 50-ohm cable. That input should be able to support at least 1 watt.
2. Connect Integra-H to the power supply and adjust the supply voltage to 13.3 volts.

WARNING: Do not exceed 16 VDC during setting-up for tests and adjustments.

3. Using a 9-conductor straight RS-232 cable, connect the unit's Setup port to the RS-232 port of a PC and run the Integra RSS program (INTRSS.exe) on the PC.
4. Press GET for the unit configuration.
5. From the Settings menu command, click on Radio Settings, set the frequency to be used for testing. Leave this window open and on top.
6. Follow the steps in Table 7.

3.5.1 AFTER ADJUSTMENTS ARE COMPLETED

Adjustments made using the RSS are temporary and must be made permanent as follows:

1. After all adjustments are completed satisfactorily, press "PUT" to save the changes permanently to the unit.
2. Press Station Reset to activate all configuration changes.

MAINTENANCE AND ADJUSTMENTS

Table 3-7 Tests and Adjustments

Step	Action	Expected Results	Measure With	If Not?
1	Output Power	$1W^1 + 5\%, -20\%$	Service monitor set to read power	Adjust using the RSS <i>Power Out</i> setting (255 is the maximum) or refer to Factory Tech support
2	Frequency Error Press TX <i>Unmod</i>	Within ± 300 Hz	Service monitor set to read frequency	Adjust using the RSS <i>Freq Warp</i> setting. (Typical adjustment range is 1.5kHz) If found outside limits, call factory technical support.
3	Deviation Press TX tone For any bit rate speeds selected	Tol. +5%, -10% For Full channel: ± 8.0 kHz	Service monitor set to read deviation with mid(15-30 kHz) IF filter	Adjust using the RSS <i>Deviation</i> setting (if required)
4	Carrier Sense Inject a non-modulated carrier at -120 dBm to the Integra-H RF input; Raise the service monitor RF output until the CS LED comes on	The CS LED should be off The CS LED should come on within 2 dB from the value set by the INTRSS: Default: approx. -105 dBm (-110 in non-refarmed mode)		The threshold may be raised to prevent false CS operation in the presence of noise, intermodulation, or other sources of radio interference (e.g., for ambient noise at -100 dBm (measured with a spectrum analyzer), set the CS threshold for -95 dBm)
5	Set the service monitor to generate a -80 dBm signal on the selected receive frequency. The signal should be modulated with a 1.0 kHz tone at deviation specified below. Set service monitor IF filter to mid (15-30 kHz), no audio filter. <i>Note: Use test audio (pin 4) of the power/analog connector (white lead) for SINAD and distortion²</i>			
6	Demodulated Audio Press <i>CHK</i> For any bit rate speeds selected, set deviation to ± 8 kHz	$2 V_{pp} \pm 0.2$ If read on Bar graph in <i>Radio Settings</i> window or $1 V_{pp} \pm 0.1$ If read at Test audio pin 4 of PWR analog connector		Adjust using <i>RXA adjust setting</i> (if required)
7	12 dB SINAD Set service monitor IF filter to mid (15-30 kHz) set deviation to ± 8 kHz	$\leq 0.5 \mu V^3$	Service monitor set for SINAD	Refer to Factory Technical Support
8	Distortion Set service monitor IF filter to mid (15-30 kHz) <i>Deviation level as per SINAD above</i>	$< 3\%$	Service monitor set for DISTORTION	Refer to Factory Technical Support

¹ (Unless you set a lower value). Note that readings less than 1 watt may be due to losses in the cables used for testing. Check also your wattmeter frequency calibration curve.

² In the RSS' Analog connector window, check the RX-TP box. (Accessed by clicking Settings and then Analog Connector).

³ If a psophometrically weighted filter is available on the service monitor, use $0.35 \mu V$.

NETWORK TROUBLESHOOTING

4.1 TROUBLESHOOTING OVERVIEW

A Radio Diagnostic Software program is provided to help the user find problems on individual units within a network. This program is launched via the executable file INDIAG.EXE. This program runs (only) from the Integra Setup port.

Here is a list of tests that a user (having network communication problems) can try while using this software utility:

With user network application's running:

- Monitor the current network activity by using online diagnostics monitoring feature.
- Gather diagnostics (i.e. local GET Status) from the unit connected to and check that they are within tolerances.

With user network application offline:

- Check communication link between two units (i.e. Link test)
- Gather remote diagnostics (i.e. Remote GET Status) from a “suspect” remote unit and check that they are within tolerances.
- Check RF signal strength of a particular remote unit transmitting a continuous unmodulated test carrier (i.e. Remote Carrier button).
- Check RF power output from the connected unit by using the Carrier test button. The RSSI bar graph will turn to a divided wattmeter (Forward and Reflected power).
- Check carrier frequency from the unit connected by using the Carrier button and a RF communication test set.
- Check transmit deviation from the unit connected by using TX Tone button and a RF communication test set.

4.2 INTDIAG

The INTDIAG.EXE program is divided into two distinct parts: the *Online* and *Offline* diagnostics. Refer to the Readme.txt file included on the RSS/RDS installation diskette for the software installation instructions.

4.2.1 ONLINE DIAGNOSTICS

Online diagnostics may be used for monitoring an operating network with the user's applications running. The diagnostics are piggy-backed (carried along with user data transmissions) and do not interfere with day-to-day operations. Refer to Table 4-1 for diagnostics, descriptions, and tolerances.

Maintaining a registry listing typical diagnostic readings for a network is an effective tool for comparing test readings and trend monitoring (system history). Variances in the data displayed can alert technicians to changes in network status. Earlier detection leads to earlier intervention.

4.2.2 OFFLINE DIAGNOSTICS

Offline diagnostics are used for trouble-shooting and test transmissions to remote units or to a local connected unit. Offline diagnostics are intrusive as they take control of radio channels. User applications may have to be offline.

4.3 GET STATUS

The Get Status function allows the user suspecting network communications problems to gather diagnostics and check tolerances as follows:

- Local GET Status: gathers diagnostics from the unit connected to the network
- Remote GET Status: gathers diagnostics from a suspect remote unit connected to the network

Values displayed are taken at the moment the GET Status button is pressed. The GET Status does not continuously update. Press the Clear button and press GET Status again to update the information.

Table 4-1 Diagnostic Information

Field Name	Description	Tolerance
Unit ID	Identifies the unit whose diagnostics are displayed	Between 1 & 254
FPWR	Approximate measure of transmit RF power If power read from Bar graph or from reported diagnostics <i>Note: If power read from an external wattmeter</i>	
RPWR	Approximate measure of reflected power. Online Diagnostics: Offline Diagnostics:	0 if reflected power is within limits, 1 if reflected power is too high. The threshold is set to approximately 1/3 of FPWR Value is in watts, ideally close to zero, but values up to about 15% of FPWR may be encountered in properly operating systems. If a dummy load is used to test a unit, expect reflected power to be less than 0.2W
RSSI and Remote RSSI	If “Radio Source” is in “Remote” mode: <ul style="list-style-type: none"> • the RSSI reading indicates local station signal strength in dBm as heard by the remote • the Remote RSSI indicates how well the local unit receives the remote signal measured in dBm If “Radio Source” is in “Local” mode: <ul style="list-style-type: none"> • the RSSI reading indicates how well the local unit receives the remote signal measured in dBm. • the Remote RSSI reading indicates local station signal strength in dBm as heard by the remote <p style="text-align: right;">table continued on page 4-3</p>	Normally +/- 3dB accuracy A good received signal level should be higher than -90dBm

Field Name	Description	Tolerance
Temp	Internal case temperature	Operating limits: -30 degrees C to +75 degrees C
SWB+	Selected unit main DC power measured in tenths of a volt from 6.0 to 18.8 volts, WARNING: Do not exceed 16Vdc. Application of more than 16 VDC will damage the unit and is not covered by the warranty.	Should nominally be close to 13.3VDC Operating limits: 10.0 to 16.0 V
Peak	Demodulated signal voltage: peak-to-peak (Available only for Offline Get Stats)	See transmit deviation tables
Ext1	User-specified "Analog 1" input as a voltage between 0 and 10 volts DC in tenths, at 8 bits of resolution. (Available only for Offline Get Stats) If the "Fan Control" (Analog 1) box is checked in the RSS program, the value displayed will be 00.0 Volt	0 to 10.0 VDC
Ext2	User-specified "Analog 2" input as a voltage between 0 and 10 volts DC in tenths, at 8 bits of resolution. (Available only for Offline Get Stats) If the "Rx/Tp (Analog 2) box is checked in the RSS program, the value displayed will be 00.0 Volt	0 to 10.0 VDC
Good	Number of correctly decoded transmissions in the last 15 received In multiple frequency networks (duplex), this ratio will be an aggregate of all stations heard. In single frequency networks (simplex), this ratio usually represents receptions from the master station.	15/15 equals 100% Lower values (8/15), coupled with strong received signals (Remote RSSI), usually mean local interference at the remote site.
Total	Used with the number in the field "Good" to establish a percentage indicative of reception quality.	

4.4 LINK TEST

Tests the network data link status by sending a number of transmissions to a remote unit, back from the remote, computing a ratio of good to bad signals received and displaying the result as a link quality for both individual links as well as the overall link.

Caution: Shut down your application before pressing "Link Test".

Before starting a Link Test:

- 1.Ensure that the Radio Source selected is "Remote".
- 2.Click in the active Short ID field and enter the address of the desired remote unit.
3. Press the "Link Test" button to start transmitting blocks of data.

The selected remote decodes and returns data blocks. Transmission will continue until the link test button is pressed again or after 100 data blocks are transmitted. The sent and received data are compared and the ratio of good to bad blocks are calculated. The error rate is calculated separately for each direction and for the link as a whole. The results are displayed on the message screen in the format detailed in Table 4-2.

Table 4-2 Link Test Display Format

Action	Format	Results	Relation
Blocks Sent	0-100	Records the total number of blocks transmitted to the remote	A
Blocks Received by remote	0-100	Indicates recorded total number of blocks received by the remote	B
Link Quality to re-mote	0.0% to 100.0%	Ratio (percentage) of blocks received by the remote compared to blocks transmitted. Value is indicative of link quality to remote	B over A
Responses from re-mote	0-100	Indicates recorded total of response-blocks received from the remote	C
Link Quality from remote	0.0% to 100.0%	Ratio (percentage) of blocks received from the remote compared to the recorded total of blocks received by the remote. Value is indicative of link quality from remote	C over B
Overall Link Quality	0.0% to 100.0%	Ratio (percentage) of blocks received from the remote compared to the recorded total of blocks first transmitted to the remote. Value is indicative of overall link quality to and from remote	C over A

4.5 BAR GRAPH

A Received Signal Strength Indicator (RSSI) bar graph is available during continuous test transmissions (i.e., remote “Tx Tone” and “Carrier”). The appearance of the “Local RSSI” indicator is a single vertical graph bar with indicated values in “dBm”. The accuracy of the reading is normally better than +/- 3db.

The bar graph changes during user maintenance local test transmissions of “Tx Tone” and “Carrier”. A split screen of two parallel vertical bars is seen. The “Local TX Pwr” measurements of “Forward power” and “Reflected power” are in “Watts”.

4.6 CARRIER

To send an unmodulated carrier, press the “Carrier” button. Used mainly to check carrier frequency, RF power level (local unit) and received signal strength from a remote unit (See Figure 4-1).

Warning: Care must be taken while reading transmit deviation remotely. Over-the-air service monitor readings may give higher results than expected because of RF noise and interference that superimpose on the received signal.

- If Source is “Local”, pressing Carrier transmits until the button is pressed again.
- If Source is “Remote”, the selected unit will send for 30 seconds. Remote transmissions cannot be interrupted.

All buttons are inactive during test transmissions.

4.7 TX TONE

The TX Tone is used mainly to check transmit deviation. To send a modulated carrier, press the “TX Tone” button.

- If Source is Local, sends a 1200 Hz sine wave for 30 seconds or until the button is pressed again.
- If Source is Remote, causes the selected ID remote to send a tone for 30 seconds. Remote transmissions cannot be interrupted. All buttons are inactive during test transmissions. Typical transmit deviation are network speed dependant and are shown in Table 4-3.

Table 4-3 Typical Transmit Deviation

Connected to an Integra-H, Part Number 242-4090-XY0, Native Compatibility Mode		
Network Speed (in b/s)	Typical Deviation (kHz)	Voltage at Pin 4 when receiving that deviation from other units (white wire of analog/power connector) (Vpp)
19200	± 8.0	1
9600	± 8.0	1
4800	± 8.0	1

CONFIGURABLE PARAMETERS

5.1 PARAMETER OVERVIEW

The parameters used to configure the Integra-H units are described in the Radio Service Software (INTRSS) help file. Section 5 summarizes the Integra-H parameter settings and their variations when used within a network.

Table 5-1 Normal Factory Settings (Units)

Fields	Integra-H with Integra-H
Network Settings	
Compatibility Mode	Integra-TR
Tx/Rx Mode	Both Tx and Rx
Extended Preamble (ms)	0
Network Speed	9600, 19200, 21400, 25600
Tx Time Out	30 sec ON
Tx Online Diagnostics	Yes
Unit Type	Master
Data Delivery	All
Suspend Period (ms)	0
Activity Time-out (sec)	5
Sleep Mode	Disable (N/A)
COM Port	
Device Baud	19200
Data fwd timer	Normal
Parity	8 bit, no parity, 1 stop bit
Break	Ignore break
Xmit Control	DOX
DCD Control	Active
Analog Connector	
Analog 1	Input or Fan Control (Units with cooling option)
Analog 2	Input
Frequency	
Transmit	User choice
Receive	User choice
Adjustments	
Carrier Sense (-dBm)	105
Power Out	255 (indicates 1 Watts nominal)
Frequency Warp	Grayed out (radio dependent)
Deviation	Values set at factory can be changed, if required; hit related test button to enable field
RXA Adjust	

Refer to help files for descriptions of the above fields.

CIRCUIT DESCRIPTION**6.1 OVERVIEW**

Section 6 describes the circuit operation of the logic board. This section is intended for use by engineering and service personnel.

6.2 CIRCUIT DESCRIPTION

Refer to Figure 6-1 for the block diagram of the Integra-H Logic Board.

6.2.1 MICROPROCESSOR CIRCUIT

The microprocessor contains two Z84015 CMOS low power Intelligent Peripheral Controllers (IPC). Each IPC is an 8-bit microprocessor integrated with CTC, SIO, PIO Clock Generator Controller and Watch Dog Timer.

One of the Z84015s (U17) is used in the normal mode. The other Z84015 (U21) is used in the evaluation mode and only the CTC, SIO and PIO sections are used. The CPU section is disabled.

The first Z84015 Clock Generator uses a 19.6608 MHz crystal that provides a CPU clock rate of 9.8304 MHz for both Z84015s. The 9.8304 MHz clock is further divided by 2 to feed all 8 CTC (4 in each Z84015).

The 64K-memory space of the Z84015 is divided into two blocks of 32k each. The lower 32K are used for the firmware program and the upper 32K by the CMOS RAM (U18). The memory IC used for the program is a CMOS FLASH (U22) with 1024 sectors of 128 bytes each.

The dual Z84015 circuit provides up to 8 Counter Timer Channels (CTC), 4 Serial Input/Output (SIO) and 32 Parallel In-put/Output (PIO) lines.

The CPU also provides the clock for the CPLD modem.

6.2.2 RS232

The RS232 IC (U15) is used to interface the application DE-9 connector to the SIO_B section of U17, and the set-up DE-9 connector to the SIO_A section of U21. Two receivers remain enabled in sleep mode to ensure fast wakeup.

6.2.3 MODEM

The modem section is used to interface the serial digital data to the transceiver.

The CPLD modem IC (U16) with a programmable Raise-Cosine filter (U10) operates in DRCMSK mode at 4800, 9600, and 19200 bits/sec. It incorporates a 7-bit hardware scrambler and uses Differential (NRZI) encoding in DRCMSK mode to minimize data pattern-sensitivity. An electronic potentiometer U5B (E-Pot), controlled by CPU U17, is used to set the transmitter deviation by amplitude adjustment of the baseband signal. Electronic potentiometer U5C is also provided to fine adjust the RF carrier frequency.

6.2.4 TRANSMIT & RECEIVE DATA

Transmit Data from the RS-232 port is level-shifted to TTL by U15 and passed through the CPU for further processing and conversion from asynchronous to synchronous format. The CPLD modem, U16, takes the digital data stream from SIO-A of the CPU and synthesizes to the constant-amplitude analog baseband signal. The synthesized data stream is filtered by U10, buffered by U9B, and applied to radio module TXA at P1-6.

Received signals are applied to the RXA pin on P1-13 and amplified by U3A. U3A gain is set by the electronic potentiometer, U5D, and filtered by U10. The same filter circuit is used for transmission and reception. Two analog multiplexer/demultiplexer gates (U8A and B) controlled by TX_EN line are used for sharing. The filter U10 cut-off frequency is programmable by the CPLD, based on the data rate. The analog signal is buffered by U1D and fed to Peak Detectors U3C, U3D, and U3B, and to slicer circuit U1C via U1B. The raw data is passed to the CPLD modem (U16) for de-scrambling and receive clock recovery. The resulting synchronous bit stream is fed to CPU SIO-A for further processing and conversion to asynchronous format before delivery to the RS-232 driver and to the user port.

6.2.5 INTEGRA-H A/D AND DIGIPOT

An 8 channel, 8-bit successive approximation A/D converter, type ADC0838 (U4), is interfaced to CPU (U17) and Peripheral (U21).

CH0 and CH1 are connected to the positive and negative peak detector of the modem section. The software can read the positive or negative value of an RX signal, or using the differential mode, the actual peak-to-peak RX signal value.

CH3 is used to measure the radio RSSI signal which was amplified by U7A.

CH4 is connected to the radio diagnostic signal (P3-14). This pin is used to output an analog signal corresponding to the power output and the reflected signal.

CH5 is connected to U6 (LM50), a temperature sensor with a -40 to +125°C range.

CH6 is used to read the SWB+ voltage after proper scaling into the 0-5 V range.

CH7 and CH8 are connected to EXT SIGNAL 1 and 2. A 2:1 divider and protection circuit is inserted between both external signals and the A/D.

The External Signal (pins 1 and 2) is also connected to U21 at PB6 and PB7 through transistors Q3 and Q4 and can be used for Analog Input or Digital Output.

EXT_SIGNAL 2 is also connected to the Rx test point RX-TP through U8A (74HC4066). Under software control, the RX-TP (scaled down by 2) is available on the power connector for trouble-shooting purposes.

A 4-channel digital potentiometer type (U5) is used to adjust the RX Signal, TX Modulation, Carrier Frequency and Carrier Detect Threshold.

CIRCUIT DESCRIPTION

An 8 channel, 8-bit successive approximation A/D converter, type AD0838 (U9), is interfaced to CPU (U18) and Peripheral (U20).

U19 generates a power-on reset for the CPU and U6 is a temperature sensor used by the firmware to compensate for variations in RSSI.

The RSSI signal from the transceiver is amplified and filtered by U7A. The signal is compared to a threshold value set by digital potentiometer (U5A). The output of the comparator (U7B) is used to change the hold time of both peak detectors at the beginning of the receive packet.

6.2.6 WAKE-UP CIRCUIT

The wake-up circuit for the Integra-H consists of a 50 ms monostable circuit that is triggered by the rising edge of a Sleep signal from CPU (U17). The falling edge of this 50 ms pulse (end of pulse) is connected to the \NMI of the CPU and will wake up the CPU from Sleep mode after 50 ms.

When exiting SLEEP mode on a \NMI, the CPU firmware will increment a counter, then return to Sleep until it reaches a limit set by a software parameter. When the programmed count is reached the CPU will wake up the radio and the RS232 driver, program the synthesizer, and watch for channel activity.

While in sleep mode (during the 50 ms pulse), an active RTS from either communication port will reset (terminate) the 50 ms pulse so that its falling edge will restart the CPU immediately.

The CPU will check to see if either RTS signal is valid each time it is restarted by the \NMI. The firmware will only start the sleep timer after checking that all “wake-up” inputs are inactive.

6.2.7 POWER SUPPLY

The 13.3-volt DC power input is protected by a 3-amp fuse and reverse-protected by a diode.

A 5 volt, low voltage regulator (U12) is used to power all digital functions and another 5 volt, low voltage regulator is used to control the analog +5V_SW voltage in the sleep mode.

CIRCUIT DESCRIPTION

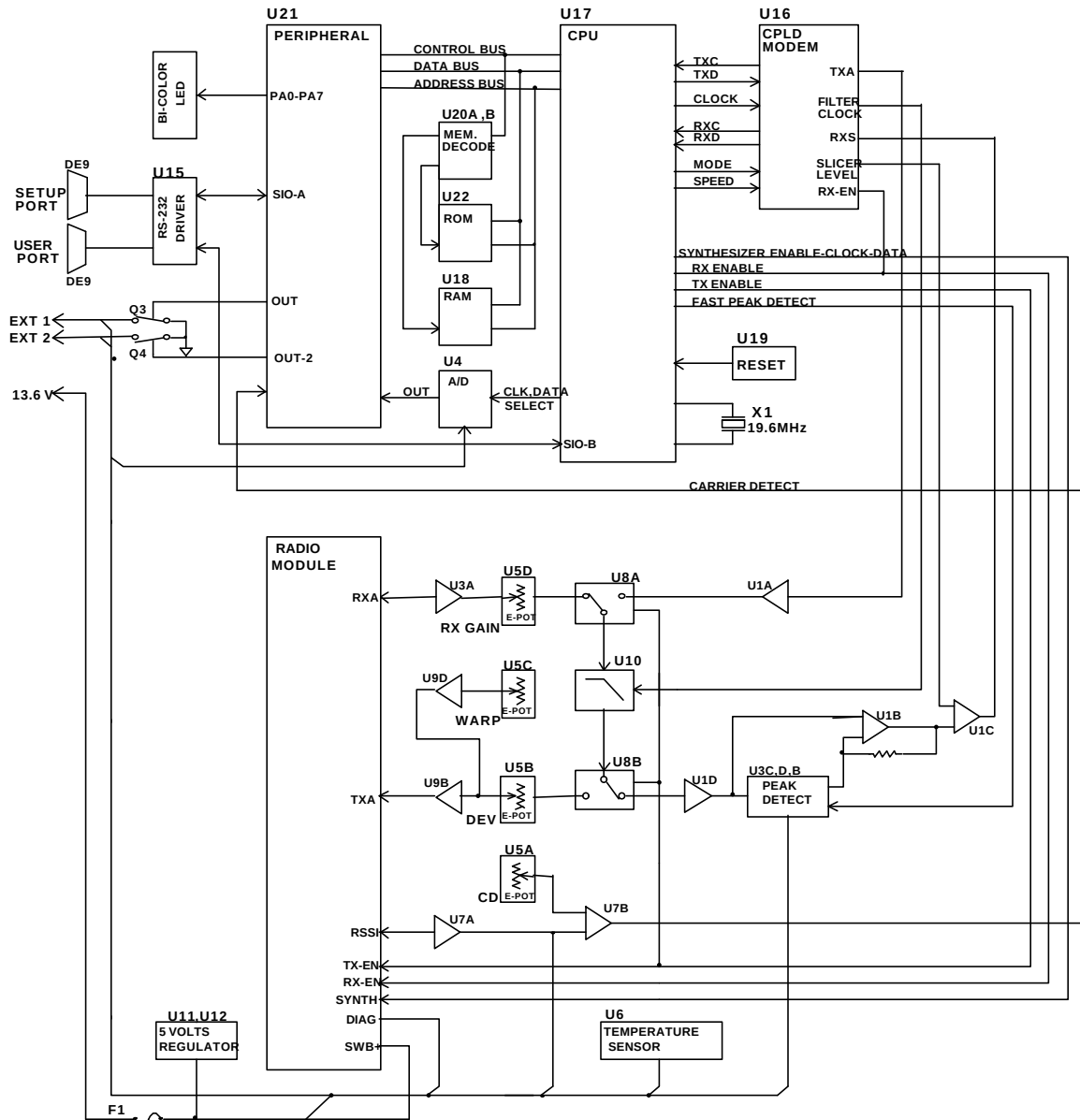


Figure 6-1 Logic Board Block Diagram

DEFINITIONS

Bit dribble	Extraneous bits delivered at the end of a data transmission. Equivalent to a “squelch tail” in voice systems. Integra-H does not have bit dribble.
COM Port	The Communications Port of Integra-H. This port is configured as DCE and is designed to connect directly to DTE.
CTS	Clear to Send. An RS-232 output signal from Integra-H indicating that it is ready to accept data (used in RTS mode).
DCE	Data Communications Equipment. This designation is applied to equipment such as modems. DCE is designed to connect to DTE.
DOX	Data Operated Transmit. A mode of operation in which Integra-H begins a transmission as soon as data is presented to the RS-232 port.
DTE	Data Terminal Equipment. This designation is applied to equipment such as terminals, PCs, RTUs, PLCs, etc. DTE is designed to connect to DCE.
EIRP	Effective Isotropic Radiated Power
Full Channel	Radio channel bandwidth equal to 25kHz.
Half Channel	Radio channel bandwidth equal to 12.5kHz.
Network speed	This is the bit rate on the RF link between units. Could be different from COM port baud rate.
PLC	Programmable Logic Controller. An intelligent device that can make decisions, gather and report information, and control other devices.
RDS	Radio Diagnostic Software. This software allows local and remote diagnostics of Integra-H. Also called INTDIAG.
Refarming	Strategy for using the radio spectrum more efficiently to meet future communications requirements and the FCC's minimum bit rate requirements with speeds up to 19200 in Full Channel and 9600 in Half Channel.
RSS	Radio Service Software. This software allows configuration and testing of Integra-H. Also called INTRSS.
RTS	Request to Send. RS-232 input signal to Integra-H indicating that the DTE has data to send. RTS may optionally be used as a transmit switch for Integra-H.
RTS mode	A mode of operation in which Integra-H begins a transmission when RTS is raised and continues transmitting until RTS is dropped.
RTU	Remote Terminal Unit. A SCADA device used to gather information or control other devices.
SCADA	Supervisory Control And Data Acquisition. A general term referring to systems that gather data and/or perform control operations.
SETUP Port	The configuration / diagnostic port of Integra-H. This port is designed to be connected to a PC running the Integra RSS program.
Transparent	A transparent unit transmits all data without regard to special characters, etc.