
CHAPTER 1—GENERAL

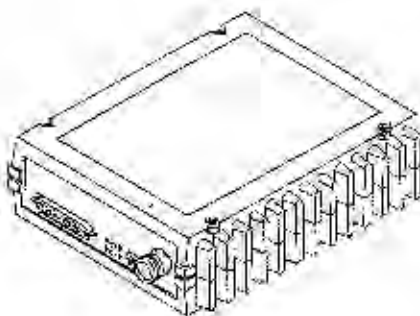
INTRODUCTION

The MDS 4310 Transceiver offers continuous duty, high-performance data communications in the 390–470 MHz frequency band. The transceiver is fully synthesized and can be programmed to operate on 12.5 kHz and 25 kHz channels within this range.

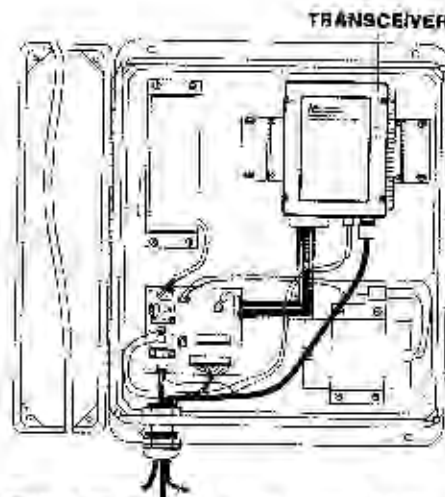
The MDS 4310 Transceiver can be supplied with a MDS 2314Axx main PC board *or* a MDS 2013Axx main PC board. Although the two PC boards are similar, this manual covers transceivers with the 2314Axx main PC board. Refer to the MDS 05-2141A01 manual for specific information regarding transceivers equipped with the 2013Axx main PC board.

The Transceiver's design is highlighted by a compact and rugged die-cast aluminum case which houses the basic RF unit, and all diagnostic and modem options. The MDS 4350 and MDS 4355 are alternate weatherproof models which include the MDS 4310 radio *plus* a power supply, back-up battery and interface/utility board, all mounted in a NEMA 4X enclosure. Appendix F of this manual covers the main features of the MDS 4350 and Appendix G covers the MDS 4355 Package.

The contents of this manual center on the MDS 4310 Data Transceiver. All discussions relating only to the MDS 4350 and MDS 4355 Packaged models are clearly marked.



The MDS 4310 Data Transceiver



The MDS 4350 Packaged Radio
(MDS 4355 Similar in appearance)

APPLICATIONS

The MDS 4310 Data Transceiver is a single channel, half-duplex, radio designed for use in multiple address systems (MAS) such as those licensed under Part 90 of the Federal Communications Commission rules, with an emission designation of F1D, F2D, or F3D, depending on application and configuration.

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As a component of point-to-multipoint data telemetry systems, the MDS 4310 Transceiver is well suited for such applications as:

- Supervisory Control and Data Acquisition (SCADA)
- Telemetry Systems
- Energy Distribution Automation
- Information Systems
- Oil Fields and Pipelines
- Alarm Monitoring
- Security

MDS 4000 Series radio systems offer the advantage of a frequency band which in many areas is specially coordinated to provide protection from co-channel interference. Because these are primarily data-only channels, voice users are not likely to interfere with data transmission and reception.

TERMS "ANALOG" AND "DIGITAL"

In all MDS literature, the terms "analog" and "digital" are commonly used to describe the modulation modes and other signal characteristics of various products. The following are examples of how these terms are commonly used in this manual.

Analog Modem, Analog Radio, Analog Mode—

These terms relate to equipment or operating modes using linear frequency modulation and detection techniques. The circuitry handles analog communication signals, such as audio frequency shift keying (AFSK) or analog voice frequency signals through the system. Generally, these products or modes operate in the 50 to 1200 bits per second (bps) data range in non-voice applications. Modulation sources include an internal MDS brand 1200 bps modem or external 4-wire audio sources such as AFSK modems.

Digital Modem, Digital Radio, Digital Mode—

These terms relate to equipment or operating modes using non-linear frequency shift keying modulation and detection techniques. The signal may alternate between two or three discrete frequencies (FSK) depending on equipment configuration. Generally, these products or modes operate in the 4800 and 9600 bps range.

MDS 4310 MODULATION TECHNIQUES

The MDS 4310 Transceiver can be modulated by either audio frequency shift keying (AFSK) or frequency shift keying (FSK) controlled directly by the digital output of the MDS internal modems. Alternatively, an external modem can be used for controlling AFSK transmission.

The MDS 4310 is capable of interfacing with data equipment at standard rates between 50 and 4800 bits per second (bps) with an asynchronous interface to the local terminal unit. The MDS 4310 provides a synchronous or asynchronous interface at data speeds of 1200, 4800 and 9600 bps with one of the optional FSK modems installed internally.

MICROCONTROLLER FEATURES

The MDS 4310 Transceiver features an internal microcontroller that allows user programming and control of operating parameters and interrogation of diagnostic data. Programming of radio settings and monitoring of operating parameters can be done with a terminal unit connected through the transceiver's DB-25 INTERFACE connector, eliminating the need to remove the radio from its mounting position or open its top cover. The terminal can be either an MDS-supplied Hand-Held Terminal (HHT), or an IBM PC (or compatible) personal computer running MDS-supplied software, or other PC-based communications.

software (such as PCPLUS™, PROCOMM™, PCTALK™, etc.). As a third alternative, any terminal with an RS-232 serial port can also be used.

With one of these devices connected, the user can program the transmit and receive frequencies, RTS/CTS delay time, PTT delay, soft carrier dekey, time-out-timer, loopback code and the MDS-patented Squelch Tail Eliminator circuit. In addition, an internal message field (up to 27 characters) can be entered to label each transceiver with its own identity. Password security and several other functions are also programmable.

Diagnostic functions that can be measured through the diagnostic module include received signal strength indication (RSSI), various critical voltage levels, internal temperature, forward power, and antenna/feedline VSWR. When equipped with the remote maintenance module and used in a system with an MDS 4100 Series Master Station, several of these diagnostic measurements can be sent over-the-air back to the master station for display by the associated PC diagnostic software.

The internal micro-controller also provides basic indication of operating parameters and values. While not a substitute for calibrated test equipment, this is useful for quick field evaluations.

SOFT CARRIER DEKEY

This feature can be used to keep the transmitter keyed for a short period of time (typically up to 5 ms) after the last data bit has been transmitted. This period of silence provides a clear indication that the message has ended and helps ensure no errors are introduced into the data stream as a result of the transmitter unkeying too soon. The soft carrier dekey feature can be selected or modified by using the HHT.

CONTROL INPUTS AND OUTPUTS

Four control inputs and outputs are provided on the MDS 4310 Data Transceiver's 25-pin "D" INTERFACE connector. They are:

1. **Receiver Squelch.** This output goes low when the receiver is squelched, and is pulled high when the receiver squelch is open. When the squelch is open, this pin supplies +8 Vdc through a 1 k Ω resistor.
2. **Out-of-Lock Alarm.** When this output is low (less than 0.5 Vdc), it indicates normal operation. A logic high (greater than 4 Vdc) indicates a failure in the phase lock loop signal source, or a transmitter time-out condition.
3. **Received Signal Strength Indicator.** This analog signal output supplies a received signal strength indicator (RSSI) voltage on Pin 21 of the DB-25 connector. The RSSI voltage is proportional to the strength of the signal present at the antenna connector, and provides a useful indication of signal levels between -120 dBm and -60 dBm. This can be especially helpful during installation to aid in aiming the station antenna for maximum received signal strength.
4. **Radio Disable.** When this input on Pin 12 of the INTERFACE connector senses a ground, it disables or "turns off" most circuits in the radio, including transmit, receive, modem and diagnostic functions. This reduces power consumption, yet preserves the radio's ability to be brought quickly online. Total current drain in the disabled state is less than 14 mA.

The annunciator or LED indicator panel on the transceiver's face shows the radio's basic performance without removing the housing cover. For transceivers without a built-in modem, front-panel indicators are provided for primary power on, receive carrier detect, out-of-lock

alarm, transmit keyline activity and transmit status. When used with the modem option, an annunciator panel indicates the status of the RS-232 interface lines (TXD, RXD, DCD, RTS, CTS). If desired, the LED display can be turned off by moving a jumper inside the radio. This may be desirable in applications where power consumption must be kept to an absolute minimum.

MODEL NUMBER CODES

The model number as found on the serial number label may be used to determine the general hardware configuration of the radio as it was shipped from the factory. Figure 1-1 illustrates the significance of the various characters in the radio's serial number. The serial number label is located on the end of the radio enclosure.

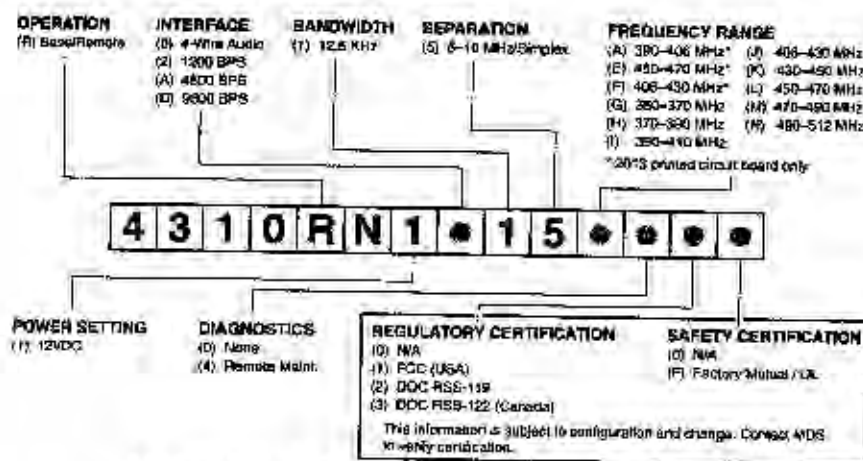


Figure 1-1. MDS 4310 Model Number Codes

MAIN PRINTED CIRCUIT BOARD PCB VARIATIONS

The MDS 4310 Transceiver may be equipped with a 2314Axx main PC board or a 2013Axx main PC board. The significant difference is the frequency range. Although the two PC boards are similar, this manual covers transceivers with the 2314Axx main PC board which has a frequency range of 350 to 512 MHz. Refer to manual part number MDS 05-2141A01 for specific information regarding transceivers equipped with the 2013Axx main PC board which has a frequency range of 390 to 470 MHz. See Figure 1-2 for the location of the main PCB part number label.

The main PC board part number can be identified without removing the housing cover. Refer to Figure 1-1 to determine the transceiver frequency range. The frequency ranges identified with a G, H, I, J, K, L, M or N are equipped with the 2314Axx main PC board. The main PC board part number can also be determined by using the **HREV** command via the HHT or terminal. The **HREV** command displays the main PC board part number and the revision level.

The nominal frequency operating range of the transceiver PCB can also be determined by using the **MOD** command via the HHT or terminal. The **MOD** command displays the main PC board model number and the revision level.

See Chapter 3 - Programming and Diagnostics for detailed information on the use of the Hand-Held Terminal.

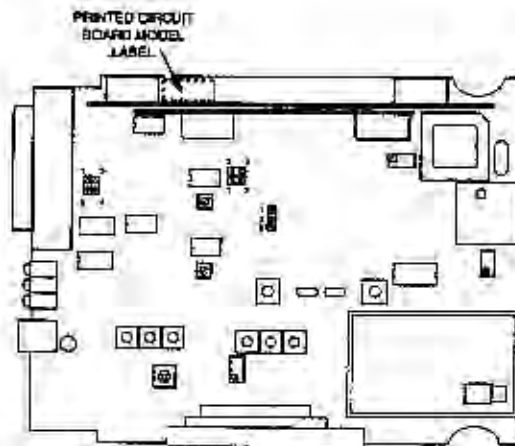


Figure 1-2. Printed Circuit Model Number Location

SPECIFICATIONS: MDS 4310 DATA TRANSCEIVER (2314 MAIN PC BOARD)

General

Frequency Range:	350-512 MHz (Nominal)
Operating Bands— any one of eight:	350-370 MHz, 370-390 MHz, 390-410 MHz, 406-430 MHz, 430-450 MHz, 450-470 MHz, 470-490 MHz, and 490-512 MHz
Frequency Programming:	Programmable in 6.25 kHz increments to any channel pair in radio operating sub-band.
TX/RX Spacing:	0 (Simplex), 5 MHz, 10 MHz standard; others are possible, consult with factory.
Primary Power— <i>Model 4310 Transceiver</i>	
Voltage:	13.8 Vdc Nominal (10.5-16.5 Vdc Operating Range)
TX Supply Current:	2.0 A typical, 2.5 A Maximum, at 13.8 Vdc Varies with power output adjustment
RX Supply Current:	65 mA typical, without options installed or LED indicators turned OFF
Standby Current (Radio Inhibited) :	14 mA maximum
Connector:	Integral part of power cable assembly (Six foot/1.8 meter cable assembly included)
Fuse:	3.0 A, 3AG, FB (Fast Blow); Holder part of cable assembly
Reverse Polarity Protection:	Diode across primary power input with internal 4 A plug-in fail-safe fuse.

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General *Continued*

Model 4350 and 4355 Packaged Radios

Voltage:	120/220 Vac with 5 ampere-hour Battery Back-up (Standard) 12, 24, 48, & 125 Vdc (Optional)
DC Supply:	Positive, Negative; Floating Ground with 24, 48, & 125 Vdc
TX Power Consumption:	50 watts maximum at rated output
RX Power Consumption:	5 watts maximum
Transient Protection:	2500 Volt Isolation on Voice Frequency (VF) Inputs and Outputs, Power Supply & Keying

Dimensions:

Model 4310 Transceiver

2.0" x 5.62" x 7.25"
50 x 143 x 184 mm
(Not including mounting hardware or connector housings)

Model 4350 Packaged Radio

9.5" x 17.5" x 19.5"
241 x 445 x 495 mm
(Not including mounting hardware or connector housings)

Model 4355 Packaged Radio

6.5" x 11.85" x 13.75"
165 x 301 x 350 mm
(Not including mounting hardware or connector housings)

Weight:

Model 4310 Transceiver

Maximum 3.5 Lbs./1.6 kg
w/all options installed

Model 4350 Packaged Radio

Maximum 33 Lbs/15.0 kg
w/all options installed

Model 4355 Packaged Radio

Maximum 21 Lbs/9.53 kg
w/all options installed

Transmitter

Frequency Range:	350-512 MHz (Nominal)
Operating Bands— any one of eight:	350-370 MHz, 370-390 MHz, 390-410 MHz, 406-430 MHz, 430-450 MHz, 450-470 MHz, 470-490 MHz, and 490-512 MHz
Frequency Programming:	Programmable in 6.25 kHz increments to any channel pair in radio operating sub-band.
TX/RX Spacing:	0 (Simplex), 5 MHz, 10 MHz standard; others are possible, consult with factory.

Power Output:	5 Watts/+37 dBm (standard) at the ANTENNA Connector Adjustable down to 0.5 watt/+27 dBm
Duty Cycle:	100%/Continuous
Output Impedance:	50 Ohms
Forward & Reflected Power Detector:	Built-in
Frequency Stability:	$\pm 0.00015\%$ (1.5 PPM), -30°C to $+60^{\circ}\text{C}$, For All Models
RF Channel Bandwidth:	12.5 kHz (25 kHz Compatible)
Spurious & Harmonic Emissions:	-65 dBc
TX Response Time:	≤ 4 ms
Modulation Type:	FSK—With 4800 and 9600 bps modems FM—With 1200 bps AFSK modem
Deviation:	± 2.5 kHz Maximum
Time-Out Timer:	Internal; Programmable from 1–255 Seconds, or Off
Analog Model Audio Input Characteristics—	
Level:	Adjustable, -20 to +10 dBm for 2.5 kHz Deviation Model 4310: 600 Ohms, Unbalanced Model 4350: 600 Ohms, Balanced, 4-Wire Audio
Frequency Response:	Model 4310: +1 dB, -3 dB, 50–3000 Hz Model 4350: +1 dB, -3 dB, 300–3000 Hz
Soft Carrier Dekey:	Programmable from 0 to 255 ms in 1 ms steps Soft Carrier Dekey factory set to... 0 ms with no internal modem 0 ms with MDS 1200 baud modem 2 ms with 4800 FSK internal modem 4 ms with 9600 FSK internal modem
Transmitter Keying:	Positive-going and negative-going, TTL-compatible keying inputs are provided. Inputs will operate with signal voltages between 5 and 40 volts. Dry contact closures are also suitable. Keyline input pins have an input impedance of 10 kilohms and have built- in over-voltage protection up to ± 40 volts.
PTT Delay:	Programmable from 0-31 ms in 1 ms steps

Receiver

Frequency Range:	350–512 MHz (Nominal)
Operating Bands— any one of eight:	350–370 MHz, 370–390 MHz, 390–410 MHz, 406–430 MHz, 430–450 MHz, 450–470 MHz, 470–490 MHz, and 490–512 MHz
Frequency Programming:	Programmable in 6.25 kHz increments to any channel pair in radio operating sub-band.
Type:	Double Conversion Superheterodyne
Frequency Stability:	$\pm 0.00015\%$ (1.5 PPM) -30° to $+60^{\circ}$ C, For All Models
Sensitivity for Analog Models: (at ANTENNA connector)	12 dB SINAD at -117 dBm ($0.3 \mu\text{V}$) w/de-emphasis OFF 12 dB SINAD at -119 dBm ($0.25 \mu\text{V}$) w/de-emphasis ON
Bit Error Rates:	Analog/AFSK at 1200 bps: BER 1×10^{-6} at -110 dBm Digital/FSK at 4800 bps: BER 1×10^{-6} at -110 dBm Digital/FSK at 9600 bps: BER 1×10^{-6} at -108 dBm
Intermodulation:	75 dB Minimum (ELA)
IF Selectivity:	100 dB minimum at Adjacent Channel (± 25 kHz, one generator method, 20 dB quieting)
Desensitization:	70 dB minimum (EIA) on 25 kHz channels 65 dB minimum (ELA) on 12.5 kHz channels
Spurious and Image Rejection:	85 dB Minimum
Analog Audio Output Characteristics— Frequency Response (Refer. to 1 kHz):	Model 4310—Basic Transceiver: Filtered, +1, -3 dB, 50 - 3000 Hz Model 4310—with VOX Board: Filtered, +1, -3 dB, 50 - 3000 Hz Unfiltered, +1, -3 dB, 50 - 4500 Hz Model 4350: Filtered, +1, -3 dB, 300 - 3000 Hz
Level:	Adjustable, -20 to +5 dBm Model 4310: 600 Ohms, Unbalanced Model 4350/55: 600 Ohms, Balanced
Harmonic Distortion:	< 3%, All Models, Measured w/de-emphasis
RF Channel Bandwidth:	12.5 kHz (25 kHz compatible)
Received Signal Strength Indicator (RSSI):	Built-in, Range: -120 dBm to -60 dBm
Squelch Opening Time:	2 ms

Diagnostics & Programming Interface (through INTERFACE connector)

Signaling Standard:	RS-232C Interface
Connector:	DB-25
I/O Devices:	<ul style="list-style-type: none">• MDS Hand-Held Terminal• IBM PC or compatible computer with CGA, EGA, VGA or Hercules Graphics™, DOS 2.0 or later and 640K of memory.

System Data Characteristics (through INTERFACE connector)

Signals:	<i>without modem</i> Transmit Audio Input Filtered Receiver Audio Output Receiver Unsquelled Sensor (RUS) Received Signal Strength Indicator (RSSI) Out-of-Lock Alarm PTT/ $\overline{\text{PTT}}$ <i>added with internal modem</i> RS-232 Compatible Data Lines RXD TXD RTS CTS DCD DSR ETC* TC* RC* * w/synchronous FSK only
Data Rates—	
AFSK:	50 to 9600 bps—Asynchronous audio interface using external modems 30 to 1200 bps—Asynchronous w/internal Bell 202T compatible modem
FSK:	50 to 4800 bps—Asynchronous, w/internal direct FSK interface 4800 bps—Async/Synchronous, w/internal direct FSK interface 9600 bps—Async/Synchronous, w/internal direct FSK interface
Data Turn-Around Time:	10 ms, including RTS/CTS time delay with internal modem installed
CTS Delay:	5 to 255 ms, Programmable in 1 ms increments