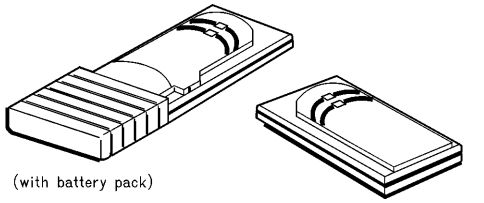
National Semiconductor

June 1994

AirShare™ Radio Module

General Description

The AirShare Radio Module provides an easy-to-use, point-to-point serial RF wireless data link, creating a new standard for cordless local area systems (CLAS). Pocket-sized AirShare modules connect to any standard RS232 serial port, and are ideal for an array of mobile personal data communications applications. Using FM radio technology, AirShare can communicate through most walls and floors, offering a clear advantage over IR (infrared) line-of-sight solutions. AirShare offers a convenient wireless alternative to free mobile workers from the restrictions of cabled connections. The AirShare modules offer cost-effective short-range wireless communications, especially useful for remote PC file, printer, and peripheral access, as well as other consumer, diagnostic, and monitoring applications. Many software packages that access a serial port or use a modem can *instantly* take advantage of the AirShare wireless link for connectivity.



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Serial cable not shown

Features

- Wireless RF technology, works through most walls and floors
- Portable and lightweight (3 oz. alone, 5 oz. with battery)
- Cost-effective PC-to-PC data connectivity
- Provides RS232-to-RS232 connectivity
- Easy installation and operation
- Less than 0.5W typical power consumption
- Serial port option, wide PC platform support
- Serial port communications speed operation (0.3 kbps to 115 kbps)
- Typical range of 30-feet in semi-open office environment
- Three user-selectable, full-duplex radio channels
- Multiple power options: battery pack, mouse port cable, AC adapter
- Self-contained with integral antenna
- LED status indicators
- Non-licensed operation under FCC Part 15.249
- Scalable to various form factors
- Protocol independent
- Can augment existing wired infrastructure

System Diagram (Typical Configuration)

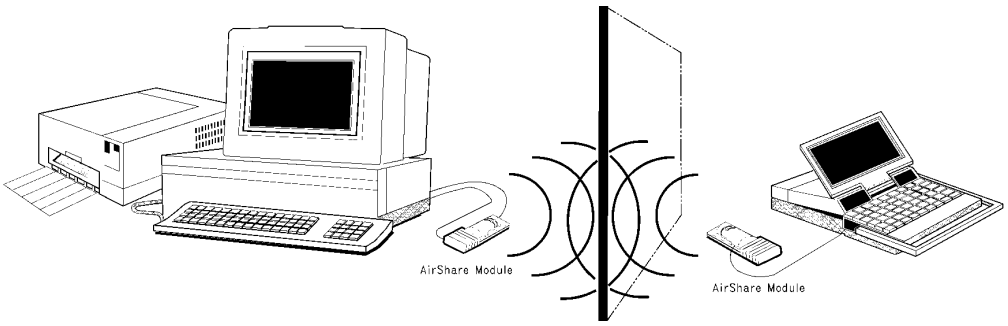

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Table of Contents

1.0 Interface Diagrams

This section includes overview diagrams of all interfaces for the AirShare module and power options. For complete interface descriptions, see Section 2.0, ''Interface Descriptions.''

1.1 AIRSHARE RADIO MODULE

Figure 1-1 shows the external interfaces of the AirShare radio module. Three side views as well as a front view are given to show the module's DB9 serial interface, mini-DC power interface, frequency selection switch, and LED indicators.

The AirShare module has red and green LED indicators. The Port Status red LED indicates that the serial port is enabled. Some information about AirShare external power supply may also be indicated by the red LED. The Connection Status green LED indicates that the module is receiving an RF signal.

The external frequency selection switch allows the user to manually select one of three possible frequencies for communication. Channels A, B, and C correspond to high, mid, and low frequencies within the band of operation.

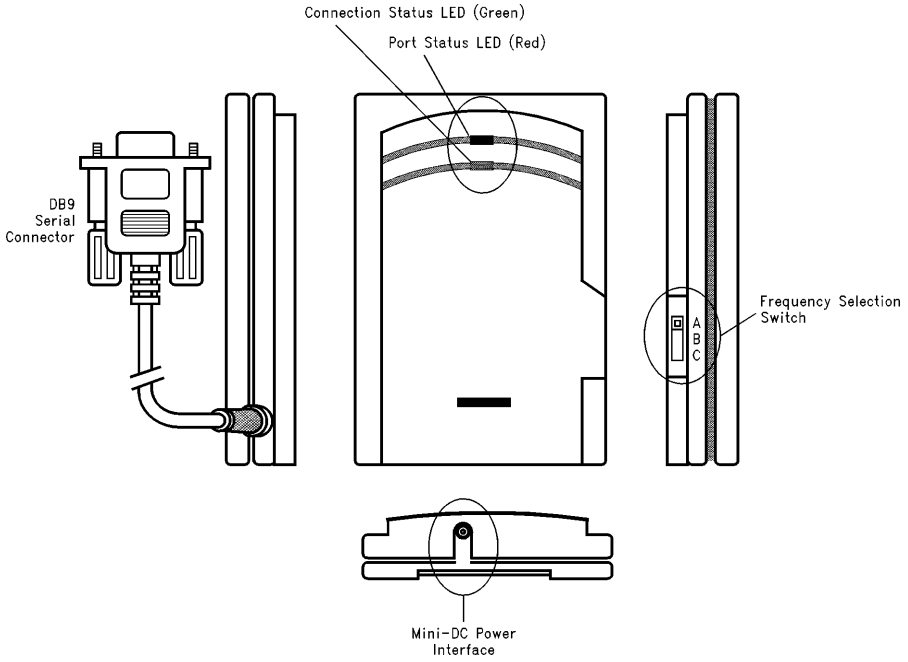

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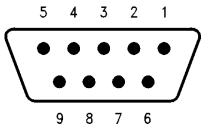
FIGURE 1-1. AirShare Radio Module Interface Overview

Figure 1-2 shows the pin-out of the AirShare female DB9 serial connector. The AirShare DB9 serial connector plugs into any PC's RS232 serial port.



1-CD	6-DSR
2-RXD	7-RTS
3-TXD	8-CTS
4-DTR	9-RI
5-GND	

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FIGURE 1-2. AirShare DB9 Serial Interface (Female)

A diagram of the AirShare module's male mini-DC power interface is shown in *Figure 1-3*.

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FIGURE 1-3. AirShare Mini-DC Power Interface (Male)

1.2 AC ADAPTER

The 120V AC input, 6V 150 mA DC nominal output AirShare power adapter is shown in *Figure 1-4*. This power option plugs directly into the AirShare module mini-DC power jack.

1.0 Interface Diagrams (Continued)

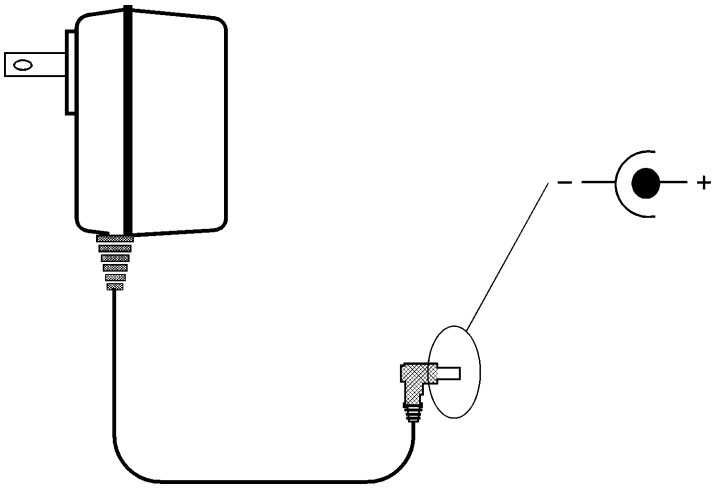

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FIGURE 1-4. AirShare AC Adapter Power Interface (Female)

1.3 BATTERY PACK

Figure 1-5 shows the external battery pack for AirShare. The battery pack slides and snaps onto the bottom end of the AirShare module, plugging into its mini-DC power jack. The dashed lines indicate the location of the 9V battery inside the pack.

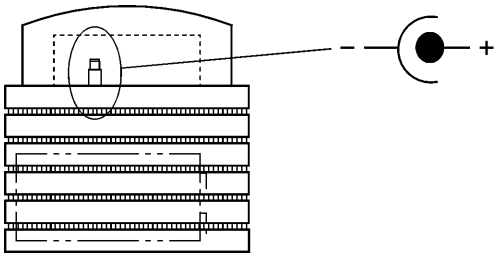

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FIGURE 1-5. AirShare Battery Pack Power Interface (Female)

1.0 Interface Diagrams (Continued)

1.4 MOUSE PORT POWER CABLE

Figure 1-6 shows the AirShare mouse port power cable. The female mini-DC power connector directly to the AirShare module's mini-DC power jack. The male mini-DIN connector plugs into the 6-pin mini-DIN mouse port on the host computer. An external mouse device can be plugged into the female mini-DIN connector to take advantage of the cable's pass-through capability (i.e., both a mouse device and an AirShare mouse port power cable can share a single port).

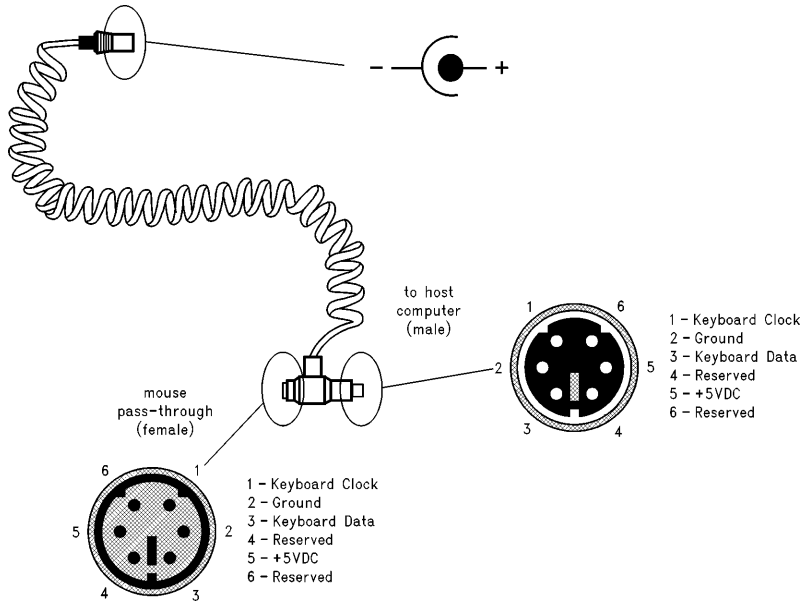

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FIGURE 1-6. AirShare Mouse Port Power Cable Power Interface (Female) and 6-Pin Mini-DIN Interfaces

2.0 Interface Descriptions

2.1 AIRSHARE RADIO MODULE INTERFACES

Symbol	Connection No	Direction	Description
AirShare DB9 Serial Interface (Female) (Note 1)			
CD	1		**CARRIER DETECT:** This signal is not connected to any internal circuitry.
RXD	2	O	**RECEIVE DATA:** Data received by AirShare module connected to host computer.
TXD	3	I	**TRANSMIT DATA:** Data transmitted by AirShare module connected to host computer.
DTR	4	I	**DATA TERMINAL READY:** Asserted by software through the host computer's serial port to turn the AirShare module power supply on.
GND	5		**GROUND:** Ground for the AirShare module; connected to common ground.
DSR	6	O	**DATA SET READY:** When asserted, indicates to the host computer an adequate received signal level. Asserted state of DSR is also indicated by a lit green LED.
RTS	7	I	**REQUEST TO SEND:** This connection is looped back to CTS (connection 8) on the AirShare serial connector. This signal is not connected to any internal circuitry.
CTS	8	O	**CLEAR TO SEND:** This connection is looped back to RTS (connection 7) on the AirShare serial connector. This signal is not connected to any internal circuitry.
RI	9		**RING INDICATOR:** This signal is not connected to any internal circuitry.

Note 1: Signal levels conform to EIA RS232C Specification.

Symbol	Connection	Description
AirShare Mini-DC Power Interface (Male)		
+	Center	**+:** Input supply voltage to the AirShare module.
−	Barrel	**−:** Ground for the supply voltage to the AirShare module.

Symbol	Position	Description
AirShare Frequency Selection Interface (Note 2)		
A	Top	**CHANNEL A:** User-selectable low frequency channel—Air Tx, Share Rx at 923.144 MHz; Air Rx, Share Tx at 919.552 MHz.
B	Middle	**CHANNEL B:** User-selectable mid frequency channel—Air Tx, Share Rx at 912.35 MHz; Air Rx, Share Tx at 908.8 MHz.
C	Bottom	**CHANNEL C:** User-selectable high frequency channel—Air Tx, Share Rx at 910.294 MHz; Air Rx, Share Tx at 906.552 MHz.

Note 2: There are two types of AirShare modules: Air modules and Share modules. See Section 5.4 for an explanation of the differences.

Symbol	Color	Description
AirShare LED Indicator Interface		
Port Status	Red	**PORT STATUS:** This LED is on when DTR is asserted on the host computer, enabling power to the AirShare module. It varies in brightness, depending on the amount of external power being supplied to the radio module (bright = sufficient, dim = insufficient, off = none).
Connection Status	Green	**CONNECTION STATUS:** This LED indicates adequate received signal strength and is a visual indication of the state of DSR (i.e., green LED on when DSR asserted).

2.0 Interface Descriptions (Continued)

2.2 AC ADAPTER POWER INTERFACE

Symbol	Connection	Description
AC Adapter Power Interface (Female)		
+	Center	**+:** 6V 150 mA DC nominal output voltage to the AirShare module.
−	Barrel	**−:** Ground for the 6V 150 mA DC nominal output AirShare power adapter voltage to the AirShare module.

2.3 BATTERY PACK POWER INTERFACE

Symbol	Connection	Description
Battery Pack Power Interface (Female)		
+	Center	**+:** 9V output battery voltage to the AirShare module.
−	Barrel	**−:** Ground for the battery voltage to the AirShare module.

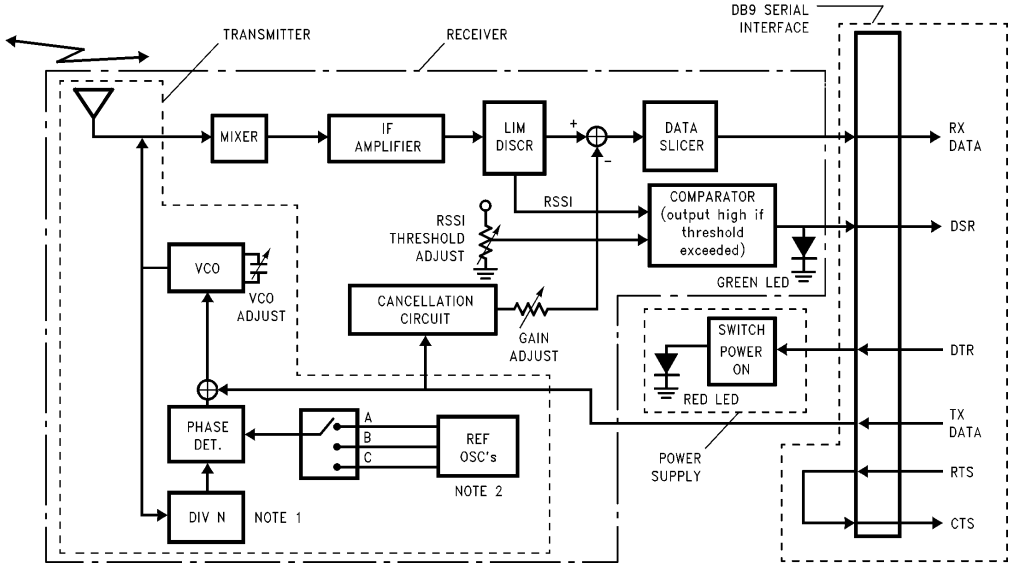
2.4 MOUSE PORT POWER CABLE INTERFACES

Symbol	Connection	Description
Mouse Port Power Cable Mini-DC Power Interface (Female)		
+	Center	**+:** Output host computer mouse port voltage to the AirShare module.
−	Barrel	**−:** Ground for the host computer mouse port voltage to the AirShare module.

Symbol	Connection No	Direction	Description
Mouse Port Power Cable (6-Pin) Mini-DIN Interface (Male)			
Keyboard Clock	1	O	**KEYBOARD CLOCK:** Provided for optional pass-through mouse device.
Ground	2		**GROUND:** This connection is connected to the ground of the mouse port power cable mini-dc power interface (barrel).
Keyboard Data	3	I	**KEYBOARD DATA:** Provided for optional pass-through mouse device.
Reserved	4		**RESERVED:** Not used.
+5VDC	5		**+5VDC:** This connection is connected to the center of the mouse port power cable mini-dc power interface.
Reserved	6		**RESERVED:** Not used.

Symbol	Connection No	Direction	Description
Mouse Port Power Cable (6-Pin) Mini-DIN Interface (Female)			
Keyboard Clock	1	O	**KEYBOARD CLOCK:** Provided for optional pass-through mouse device.
Ground	2		**GROUND:** This connection is connected to the ground of the mouse port power cable mini-dc power interface (barrel).
Keyboard Data	3	I	**KEYBOARD DATA:** Provided for optional pass-through mouse device.
Reserved	4		**RESERVED:** Not used.
+5VDC	5		**+5VDC:** This connection is connected to the center of the mouse port power cable mini-dc power interface.
Reserved	6		**RESERVED:** Not used.

3.0 Internal Block Diagram



Note 1: Division ratio N = 256 for air module; N = 257 for share module.

Note 2: Manual switch selects one of three crystals.

FIGURE 3-1. AirShare Block Diagram

4.0 Functional Description

4.1 OVERVIEW OF RADIO

The AirShare radio uses narrowband frequency modulation (FM) in the 900 MHz band. FM is chosen as the modulation scheme because of good noise immunity. The output power of the AirShare radio is less than −2.0 dBm, permitting unlicensed operation in accordance with FCC Part 15.249 rules. A data rate of up to 115 kbps can be achieved. At data rates above 115 kbps, the performance of the AirShare module will be significantly degraded. The data rate range was selected to achieve a low-cost design.

A pair of AirShare modules, consisting of an ''Air module'' and a ''Share module,'' is required for proper operation (see Section 5.4, ''Using Multiple Modules (Air vs Share),'' for a description of the two module types). The AirShare module is capable of full duplex operation. Full duplex operation is achieved by using distinct transmit and receive frequencies for each channel. For a given channel, the transmit frequency for the Air module is the receive frequency for the Share module and vice versa. (See the Center Frequency specifications in Section 8.0, ''AC/DC Specifications'').

The following discussion regarding the AirShare radio operation refers to the AirShare Block Diagram shown in *Figure 3-1* in Section 3.0.

4.1.1 Transmitter

Three channel frequencies, designated A, B, and C (corresponding to high, middle, and low frequencies within the band), can be selected by a manual switch. The VCO (voltage controlled oscillator) is phase locked to one of three crystal references selected by the manual switch. Different VCO divide ratios are used for the Air module and the Share module so that each module has its own pair of transmit and receive frequencies. The transmitter is always active when the AirShare module is powered on. See Section 2.1, ''AirShare Radio Module Interfaces'' for the actual channel frequencies.

The VCO is frequency modulated by the digital data on the TXD (Transmit Data) line. *Figure 4-1* shows the digital data on the TXD line and the resulting signal that frequency modulates (FM's) the VCO. Filtering results in a three-level waveform at the VCO input. The waveform consists of a positive pulse for positive going data edges, a negative pulse for negative going data edges and a nominal level between data transitions.

The VCO output is fed to the antenna for transmission and also to the receiver mixer. The VCO output can serve the dual purpose of receiver local oscillator (LO) and transmitter output. The combined transmitter and antenna gain result in a maximum equivalent isotropic radiated power (EIRP) of less than −2.0 dBm to meet the FCC Part 15.249 rules on maximum output power for unlicensed operation.

4.1.2 Receiver

The antenna operates for both transmit and receive signals. The mixer input port contains both the receive signal from the antenna as well as the LO from the VCO output. The receive signal is down-converted to the IF frequency. Filters provide selectivity for adjacent channel rejection and limit the noise to the limiter-discriminator. The adjacent channel

4.0 Functional Description (Continued)

rejection is typically 8 dBc. The limiter-discriminator performs hard limiting and frequency demodulation of the IF signal. Note that the receiver is always active when the AirShare module is powered on.

A cancellation circuit removes the transmit signal from the receive data. This compensated signal is input to the data slicer. The data slicer dynamically adjusts the threshold level. *Figure 4-1* shows the threshold and corresponding recovered data.

A received signal strength indicator (RSSI) is also provided from the limiter-discriminator. The comparator output is used to drive the DSR signal line and the green LED. The DSR line will be asserted and the green LED will be lit when the RSSI is above the signal detect threshold. The RSSI threshold is factory set for an input signal level of −70 dBm.

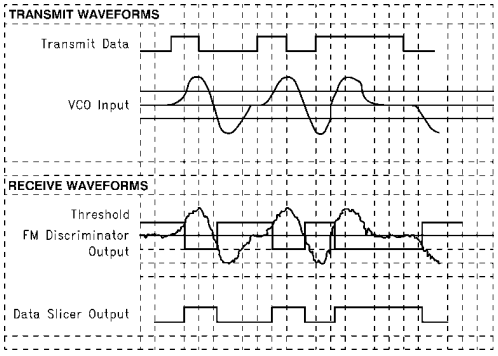


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FIGURE 4-1. Transmit and Receive Modulation Signal Waveforms

4.1.3 Serial Interface

The data interface to the host computer is through a DB9 serial interface. Transmit Data from the host is input to the AirShare through the TXD line. Receive Data is output to the host through the RXD line. The asynchronous serial interface precludes the need for the AirShare radio to perform bit timing recovery.

Four control and status lines are used. The CTS output is hardwired to the RTS input so the radio will always indicate it is ready to accept data whenever RTS is asserted. The DTR input must be asserted by the host computer to turn on the AirShare power supply. The DSR output indicates to the host computer an adequate receive signal strength for reliable data recovery.

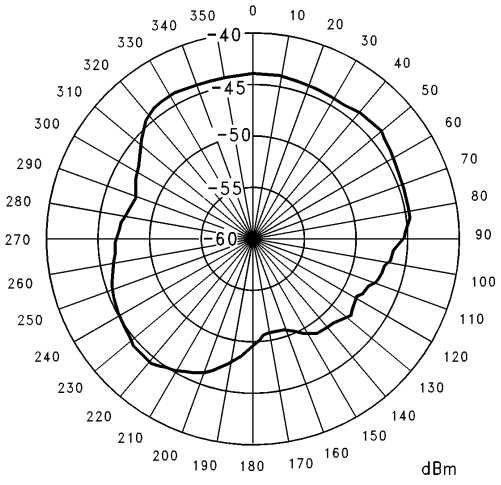
4.1.4 Power Supply

When DTR is asserted by the host computer, power to the radio is switched on. A red LED will light, verifying power to the radio. The power source is either from 1) a 120V AC input, 6V 150 mA nominal output power adapter 2) a 9V battery pack or 3) the mouse port power cable. The power from the external power source is regulated to 4.5V in the AirShare module.

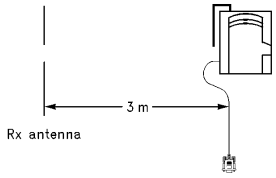
4.0 Functional Description (Continued)

4.2 ANTENNA

A printed microstrip antenna integral to the AirShare module is used. Plots of the antenna patterns for two orientations are shown in *Figures 4-2a* and *4-2b*.



AirShare module oriented as shown, with serial cable hanging down vertically:



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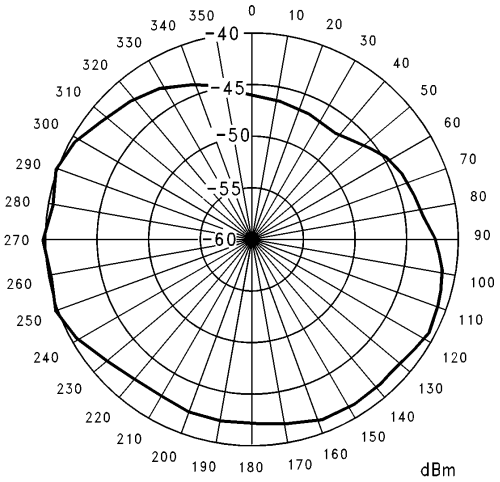
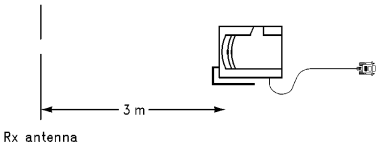
Maximum field strength approx. 28 mV/meter.

FIGURE 4-2a. Antenna Radiation Pattern 1



AirShare module oriented as shown, with serial cable hanging down vertically:



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Maximum field strength approx. 39 mV/meter.

FIGURE 4-2b. Antenna Radiation Pattern 2

4.0 Functional Description (Continued)

The antenna ground plane separation is selected to provide minimal distortion to the antenna pattern when the AirShare module is placed on a metal surface. However, placing the module on a metal surface will still cause shadowing of the antenna pattern below the plane of the metal surface. The antenna pattern is essentially omnidirectional, although due to multipath effects, slight movement of the modules can improve the radio link performance.

The antenna is designed to include the effect of the enclosure material on the impedance match between the antenna and radio. The antenna has a 5 dB bandwidth of 80 MHz and provides RF selectivity.

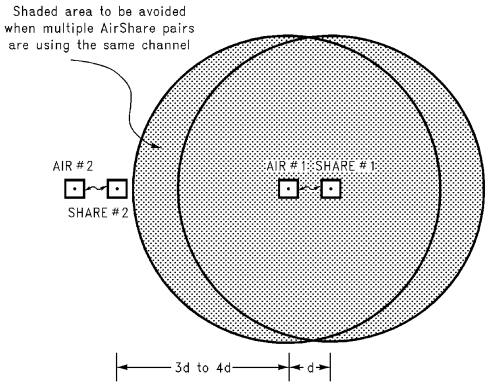
Obstructions between the units may cause decreased performance or range of operation. The degree of degradation is a function of the size, placement and material of the obstructions. For example, solid metal obstructions such as file cabinets or metal posts may be problematic, while operation with office partitions as barriers will generally give good performance depending on their construction. Refer to Application Note *"RF Propagation Characteristics"* for information about multipath effects.

4.3 INTERFERENCE

There are two main sources of EMI interference that can be encountered: mutual interference from other AirShare units and interference from other devices in the 900 MHz band. The amount of interference is dependent on the transmitted frequency and relative power of the desired signal and interference.

IF filtering in the AirShare should provide enough adjacent channel rejection to prevent multiple pairs of AirShare modules which are operating at different frequencies from interfering with one another. Mutual interference among other AirShare modules can only occur if more than one pair of AirShare modules is operating on the same channel. The amount of interference is a function of the relative distance between the modules. The impact of the interfering signal can be essentially eliminated if the distance between the interfering unit and either of the AirShare modules is at least 3 to 4 times the distance between the AirShare pair trying to communicate. This is illustrated in *Figure 4-3* which shows the desired separation between multiple AirShare units sharing the same frequency channel.

Interference from other devices in the 900 MHz band is more difficult to quantify. The amount of interference is a function of the output frequency, power and relative proximity of the interfering device. The interference can be reduced or eliminated by maintaining sufficient separation between the interfering device and the AirShare units.



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All modules are on Channel A.

FIGURE 4-3. Recommended Separation between Multiple AirShare Pairs Using the Same Channel

4.4 RADIO ADJUSTMENTS

Warning: The AirShare has three adjustments which are factory set. *Do not attempt to align these adjustments.* Misalignment of the VCO operating point or the FM cancellation circuit may result in degraded operation or non-interoperability of AirShare units. Misalignment of the RSSI threshold may result in either reduced operating range or false indication of signal presence.

5.0 Operational Description

5.1 INSTALLATION

The AirShare modules are ready to install on any PC-compatible portable or desktop computer with a serial port. Each module requires external power which can be provided by any of the available power options.

To connect the AirShare hardware:

- Plug the AirShare module directly into the DB9 (9-pin) serial port on each of the two computers to communicate over the wireless link.
- For each module, choose one power option (AC adapter, mouse port power cable, or battery pack) and connect. See Section 5.7, ''Power Options'' for more information.

Both modules trying to communicate should be set to the same channel.

The AirShare modules can also be used on 25-pin serial ports, with the aid of a 9-to-25 pin serial adapter. See Section 5.10.1 for the DB9 to DB25 conversion diagram.

AirShare modules can also be used with straight-through serial extension cables, taking cable capacitance specifications into account.

Appropriate applications software must also be installed on one or both PCs to take advantage of the wireless connection provided by the AirShare hardware. See Section 5.9 for ''Guidelines for Compatible Software Use.''

5.2 PLACEMENT, ORIENTATION AND RANGE

Proper placement and orientation may be important to optimize the performance of the AirShare modules. The AirShare modules can communicate through most barriers and do not require line-of-sight placement. The distance over which the AirShare modules can communicate (the effective range) is affected by the operating environment. Typically, the effective range will be greater if the modules are used outdoors instead of indoors. Barriers, such as partitions and walls can also decrease the effective range. See Application Note ''*RF Propagation Characteristics*'' for more information.

A good, reliable wireless connection is indicated by a solidly lit green LED on the AirShare module. The green LED should not appear intermittent or blinking regardless of obstructions and movement in the surrounding environment.

In general, a reliable wireless connection can be achieved by placing the modules up high and away from obstructions (e.g., out from behind a desktop PC). Using serial extension cables with AirShare can enhance the performance by offering more flexibility in placement.

The modules should also be placed away from potential sources of interference. There are two main sources of interference that may affect the performance of the unit:

- *Coherent EMI (Electro-Magnetic Interference)*, from other RF devices operating in the same frequency range as AirShare (e.g., some cordless phones, cordless stereo speakers, mobile cranes, vehicle locator services, etc.)
- *Non-coherent EMI*, from any device generating non-coherent EMI (e.g., computer monitors, LCD or plasma laptop screens, any device with an electric motor). The likelihood of interference with AirShare depends on the strength of the EM field generated by the device and its proximity.

Although the AirShare antenna is generally omnidirectional, there is an element of directionality which may be more pronounced when communicating over a longer range. In this case, experimenting with the orientation of the units can help achieve a more reliable connection. For example, positioning both modules in the same orientation (e.g., both flat, both upright, etc.). may improve performance.

5.3 USING MULTIPLE PAIRS

The AirShare modules have three channels to allow up to three pairs of modules to operate in the same vicinity without interfering with one another. For proper operation, both modules within a pair must be set to the same channel. The channel can be set by moving the slide switch on the right edge of the module.

For more information on the interference behavior of multiple AirShare pairs (if two pairs in the same vicinity are both attempting to use the same channel, for example), see Section 4.3, ''Interference.''

5.4 USING MULTIPLE MODULES (AIR vs SHARE)

Each pair of AirShare modules consists of two types of modules: an Air module and a Share module.

Air Module: identified by its shorter serial cable and product label, and is recommended for use on a laptop computer.

Share Module: identified by its longer serial cable and product label, and is recommended for use on a desktop computer.

There are internal as well as external differences between the two module types. The Air Module transmits and receives at different, complementary frequencies from the Share Module, making full-duplex operation possible. This is true for each of the three user-selectable channels (A, B, and C), as shown in *Figure 5-1:*

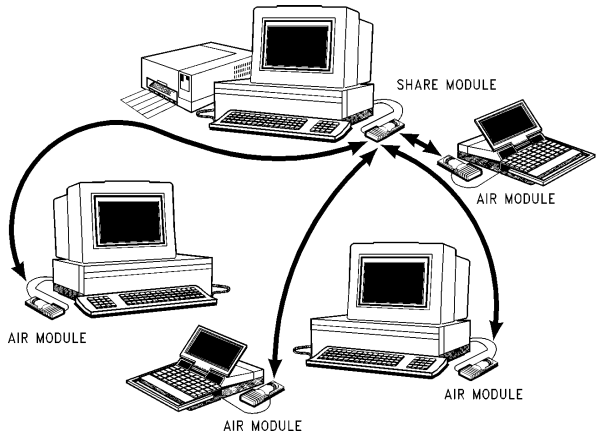
	Air Tx		Share Rx
Channel A	f_1	→	f_1
Channel B	f_2	→	f_2
Channel C	f_3	→	f_3
	Air Rx		**Share Tx**
Channel A	f_4	←	f_4
Channel B	f_5	←	f_5
Channel C	f_6	←	f_6

FIGURE 5-1. Air and Share Module Tx and Rx

Only Air and Share modules can communicate with each other. See Section 4.1 ''Overview of Radio'' for more information.

AirShare modules will work between any pair of PCs so they can be moved around to different PCs, keeping in mind the Air vs Share difference and making use of the three channels. For the example shown in *Figure 5-2,* if three user PCs want to communicate with one main PC, placing a Share module on the main PC and an Air module on each of the user PCs may make the most sense. This way, the main PC could communicate with each of the user PCs, one at a time. All three user PCs can be set to different channels (A, B, C), so by changing the main PC's module to the appropriate channel, the main PC can talk to each user PC. The user PCs would not be able to talk to one another, because they are all using Share modules.

5.0 Operational Description (Continued)



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Note: Share module communicates with each Air module ONE AT A TIME.

FIGURE 5-2. Multiple Module Example

5.5 POINT-TO-POINT COMMUNICATION

The AirShare modules provide a point-to-point wireless communications link between two devices. Each AirShare module can only communicate with one other module at a time.

AirShare uses RF FM technology, and has three dedicated channels. Because the AirShare module's transmitter is always on during operation, each channel can only be used by a single pair of AirShare units at a time. Also, the module's continuously active transmit carrier precludes the possibility of point-to-multipoint or multipoint-to-multipoint operation.

5.6 LED INDICATORS

Port Status (Red LED): The red LED indicates that the AirShare module is connected to an enabled serial port on the host computer. The port is enabled when the DTR signal is asserted turning on the AirShare module power supply.

The voltage level of the external power supply for AirShare may impact the brightness of the red LED, providing valuable information for troubleshooting power problems.

Connection Status (Green LED): The green LED indicates that the AirShare module is receiving an RF signal. Under normal conditions, the module will be receiving a signal from the intended remote module. However, the module may also be receiving unwanted signals from other nearby modules or the environment (i.e., other electronic devices in the 900 MHz region), causing false assertion of the green LED.

The red and green LED indicators can be useful for troubleshooting power and communications problems (see Section 5.11, ''Troubleshooting'').

5.7 POWER OPTIONS

The AirShare modules require external power because the RS232 serial port does not provide sufficient power to operate the AirShare module. Three power options, an AC adapter, a battery pack, and a mouse port power cable, have been designed for use with AirShare. No power is supplied to the AirShare module through the serial port.

AC Adapter (120V AC input, 6V 150 mA DC nominal output): Use the power adapter when the computer is stationary (e.g., on a desktop computer) and an outlet is easily accessible.

Battery Pack: Use the battery pack when mobility is important. The battery pack will snap into place when properly connected to the AirShare module. A fresh 9V alkaline battery provides up to 5–7 hours of continuous operation. Rechargeable 9V NiCd batteries will not provide acceptable battery life to the end user and are not recommended.

Mouse Port Cable: Use this option when the computer has a PS/2-style (6-pin mini-DIN) mouse port available. For portable computers, the computer's battery will supply power to the AirShare module, typically using 3%–5% of its power (depending on the battery life and usage pattern of the portable computer). Not all portable computers provide sufficient power to the mouse port for proper operation of the AirShare unit. Insufficient power may be indicated by a dim red LED indicator. See Section 5.6, ''LED Indicators,'' for more information.

Any power supplies other than those described above that are to be used with AirShare should meet the applicable power specifications in Section 8.0, ''AC/DC Specifications.'' Dimensions for the mini-DC power jack are shown in *Figure 10-7* in Section 10.1, ''Physical Dimensions.''

5.8 MAINTENANCE AND CARE

In general, the AirShare module should be used in the same manner and with the same amount of care as a portable computer.

The user should not attempt to open or service the AirShare module or any of the power options. Contact NSC if the product has been damaged, has come in contact with liquids, or exhibits abnormal operation or a marked change in performance.

AirShare Module and Battery Pack: The module and pack should be kept dry. Do not use either unit near or in water. Avoid exposure to temperature extremes, high humidity, direct sunlight, and excessive dust. Keep free from excessive vibration and mechanical shock. The exterior of the module and battery pack may be cleaned with a soft, dry cloth.

5.0 Operational Description (Continued)

Mouse Port Power Cable: Turn the host computer off before connecting and disconnecting the mouse port power cable. Do not leave the mouse cable connected to the computer if the AirShare module has been disconnected.

5.9 GUIDELINES FOR COMPATIBLE SOFTWARE USE

When using a pair of AirShare modules as a serial cable replacement, the properties of the RF wireless link must be taken into account by the applications software for optimum performance.

Although the AirShare wireless link is equivalent to a serial cable connection from a signal perspective, the wireless link cannot be assumed to be virtually error-free. It will be more susceptible to errors, data dropouts, and interference, which is normal when operating in this high frequency band.

Because of the nature of RF signals, transmitted data may arrive corrupted or not at all. The software protocol must be able to handle data loss and corruption to a satisfactory level (i.e., error recovery, retransmission, etc.) for the application. The AirShare hardware does not provide these functions.

High frequency RF signals in indoor environments may be affected by interference, attenuation, and multipath which are described below:

Interference: If other RF devices are transmitting at the same frequencies as the AirShare modules, this may cause transmitted data to be replaced by data from the interfering devices. Interference will cause the receiver to see the transmitted data broken up by different random and repeating patterns (which may be strikingly similar to the expected data).

Attenuation: Objects in the signal path will attenuate the signal, resulting in a weaker and noisier signal at the receiver. Attenuation will appear as randomly distributed errors (with respect to time) in the data. Applications software that can handle these random errors will be able to extend the effective range of the AirShare modules. The error rate may vary considerably based on the attenuation level (i.e., few errors if there is little attenuation, no signal at the receiver if too much attenuation). To minimize attenuation, avoid transmitting through materials like metal and cement.

Multipath: Multipath occurs when the transmitted signal reflects off of objects in the environment, causing it to take multiple routes to the receiver. Most objects in an office environment (including people) can cause some reflection of the radio signal, contributing to multipath. Multipath will appear as dropouts in the data or momentary breaks in the connection. The applications software should be prepared to handle the effect of multipath.

For more information, see Applications Note *"RF Propagation Characteristics."*

Some guidelines for writing and testing applications software for use with the AirShare modules are described below:

1. *Use time-outs for all loops.* Loops in the software must never depend on a particular signal or data pattern as an exit condition. The expected signal or data pattern may never arrive, causing the software to hang.
2. *Use sophisticated error checking.* Simple error checking can be misled by random noise or interfering devices.
3. *Consider using multiple CRC's or checksums.* Using multiple CRC's or checksums in different places in transmitted data packets will allow the receiver to recognize a bad message before the message is completely transmitted. The receiver can respond earlier with a negative acknowledgment and reduce wasted bandwidth.
4. *Use shorter data packets.* For bursty errors (as with multipath), shorter data packets will have a lower probability of being corrupted.
5. *Operate at a lower baud rate.* Consider using a lower baud rate if the error rate appears too high. Using a cumulative error count is not recommended; errors may be bursty and the channel performance will vary over time. Reset your error count periodically to avoid unnecessarily or prematurely reducing baud rate.
6. *Duplicate bytes or bits to improve the connection.* Reduce the data rate by sending repeated bytes or bits. For example, if you send each byte three times, the receiver can take the best two out of three.
7. *Simulate the wireless link using a PC and a routine.* Connect two PC's with a serial cable. Write a routine to corrupt the data as it passes from one serial port to the other to test the applications software. The routine should corrupt the data by creating random noise and dropouts, and randomly substitute repeating patterns in place of the data. If possible, the routine should also toggle the DSR signal.
8. *Simulate the wireless link using only a cable.* Connect the two devices with a serial cable. Test the robustness of the applications software by disconnecting and reconnecting the cable. Try dislodging the serial connector or only plugging it in partially. The software should be able to handle these situations in order to perform acceptably with the wireless link.

5.10 ADAPTER CABLE CONVERSION EXAMPLES

To use AirShare on devices without a DB9 connection, the following conversion examples may be helpful.

5.10.1 DB9 to DB25 Conversion

DB9 Pin	Function	DB25 Pin
2	Receive Data (RXD)	3
3	Transmit Data (TXD)	2
4	Data Terminal Ready (DTR)	20
5	Signal Ground (GND)	7
6	Data Set Ready (DSR)	6
7	Request to Send (RTS)	4
8	Clear to Send (CTS)	5

5.0 Operational Description (Continued)

5.10.2 DB9 to Apple Macintosh DIN-8 Conversion

DB9 Pin	DB9 Function		Mac DIN-8 Function	Mac DIN-8 Pin
2	RXD	⟷	Rx−	5
3	TXD	⟷	Tx−	3
4	DTR	⟷	HSKo	1
5	GND	⟷	GND	4
5	GND	⟷	Rx+	8
6	DSR	⟷	HSKi	2

5.11 TROUBLESHOOTING

The red and green LED indicators on the AirShare module may give the user helpful troubleshooting information. The normal operation of these indicators is described in Section 5.6, ''LED Indicators.'' Both red and green LEDs should be on during normal operation. The modules may work when this is not the case (e.g., red LED off); however, normal operation is not guaranteed. This section discusses what the user should try for each of the following cases if the modules do not appear to be communicating.

Red LED off, Green LED off: The AirShare module must have sufficient external power and be connected to an enabled port on the host computer for the red LED to turn on. Check that the power source is properly connected and is supplying sufficient power to the AirShare module (e.g., replace battery). If the power is okay, make sure the serial port that the AirShare module is connected to is enabled (with DTR high) by the host computer.

Red LED on, Green LED off (or blinking): If the green LED is off, the module is not receiving a signal. Make sure the red LEDs on both AirShare modules in the pair are on, and that both modules are set to the same channel. Check that the modules are within the effective range for the environment, and experiment with the positioning and orientation of the modules as described in Section 5.2, ''Placement, Orientation, and Range'' to achieve a good connection, seen by a solid green LED. Do not move the modules after finding a position where the green LEDs remain solidly on, especially while waiting for the software to establish communications.

Red LED on, Green LED on: Both red and green LED indicators must be on for proper operation. If the modules have recently stopped communicating and the indicators appear normal, the battery voltage may have dropped to a marginal level; replace the battery or switch to another power option. If the modules have not been able to communicate at all, either or both may be picking up interference from other AirShare units or devices operating at the same frequency. Try using a different AirShare channel or turning the interfering devices off. It may also help to move the AirShare modules closer together, and to move the pair as far away from the source of interference as possible. See Section 5.2, ''Placement, Orientation, and Range'' for a list of possible sources of interference.

Red LED off, Green LED on: This case should not occur. The red LED must be on in order for the green LED to be on.

6.0 Packaging

The AirShare enclosure consists of front and back pieces which snap together. The battery pack enclosure consists of three pieces: front, back, and a removable battery cover.

6.1 MATERIAL

The AirShare enclosure is made of a PC/ABS self-extinguishing blend material, including GE cycoloy, C2800, and Sumipex acrylic, LG 2.

The performance of the AirShare module has been designed taking the enclosure material into account. See Section 6.4, ''Guidelines for Customer Enclosure'' for more information.

6.2 SHIELDING

A large area inside the bottom half of the AirShare enclosure is provided with EMI shielding (see *Figure 6-1*). This shielding offers the unit better protection from EMI interference that may originate from whatever the module is mounted to (e.g., backside of portable PC screen).

Figure 6-1 shows the shielded region between the board and the bottom piece of the enclosure. The antenna must be kept clear of the shielding by approximately 12–15 millimeters (see *Figure 6-1*) in order to not affect its radiation pattern.

6.0 Packaging (Continued)

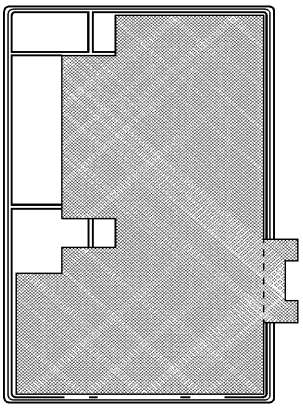

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FIGURE 6-1. Shielded Region Inside the AirShare Bottom Enclosure

6.3 LABELING

The enclosure is pad-printed with the AirShare logo on the front, and channel indicators (A, B, C) on the side. A product label of adhesive-backed mylar located on the underside of the module includes module type (Air vs Share) identification, manufacturer's name, model number, FCC ID, date code, agency compliance and electrical rating.

6.4 GUIDELINES FOR CUSTOMER ENCLOSURE

Using AirShare in the original, factory-provided enclosure is recommended for best performance and adherence to emission and safety guidelines (see Section 9.0, ''Certifications'' for more information).

The AirShare antenna has been optimized taking the type of enclosure material into account. Using a different type of material may adversely affect the performance of the product.

Warning: Emissions and safety approvals apply only to the AirShare module in its factory-provided enclosure. To operate AirShare with a non-factory enclosure or no enclosure at all requires resubmission to the applicable agencies to verify compliance. Contact NSC for more information.

7.0 Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Maximum Supply Voltage (V_{IN})	13.8 V
Maximum Power Dissipation	900 mW
Operating Temperature Range	0°C to 50°C
Operating Relative Humidity	10% to 90% (non-condensing)
Storage Temperature Range	−40°C to +70°C
ESD Rating (air discharge)	12 kV
Mechanical Shock	15g, 11 ms, ½ sine pulse
Vibration	0.5g (Note 2)

Note 1: Stresses beyond those listed under ''Absolute Maximum Ratings'' may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: 20 sweeps of 10 Hz–150 Hz, each of 3 axes, one octave per minute.

8.0 AC/DC Specifications

Unless otherwise noted, limits printed in **boldface** characters are guaranteed for $4.8V < V_{IN} < 9.3V$; $T = 0°C–50°C$ by correlation with 100% electrical testing at $T_A = 25°C$. All other limits are assured by correlation with other production tests and/or product design and characterization

Symbol	Parameter	Conditions	Min	Typ	Max	Units
SYSTEM SPECIFICATIONS						
	Baud Rate		**0.3**		**115.2**	kbps
	DC Supply Voltage		**4.8**		**9.3**	V
	Battery Pack Output Voltage	9V Alkaline Battery		9		V
	Power Adapter Nominal Output Voltage	120V AC Adapter Input		6		V
	RS232 Driver Output Voltage (High Level)	$R_L = 3\ k\Omega$	5.0	7.3		V
	RS232 Driver Output Voltage (Low Level)	$R_L = 3\ k\Omega$		−7.3	−5.0	V
	RS232 Driver Output Resistance	$V_{CC} = V+ = V- = 0V$, $V_{OUT} = \pm 2V$	300			Ω
	RS232 Receiver Input Threshold Voltage (High)	$V_{CC} = 5V$		1.7	2.4	V
	RS232 Receiver Input Threshold Voltage (Low)	$V_{CC} = 5V$	0.8	1.2		V
	RS232 Receiver Input Resistance	$T_A = 25°C$; $V_{CC} = 5V$	3	5	7	kΩ
	Current Drain When Off				**10**	μA
	Current Consumption	RS232 Load of 470 pF/3 kΩ		60	**70**	mA
	Radiated Transmit Power	at Maximum Antenna Gain			**−2.0**	dBm
	Harmonic Transmit Power	Each Harmonic			−42	dBm
	Other Emissions				−52	dBm
	Operating Range	Open Office Environment, No Barriers		10		m
BER	Bit Error Rate	at −70 dBm, No Interferers		10^{-5}	10^{-4}	
	Red LED Threshold (Turns Off)		3.9	4.1	4.3	V
	Rx Signal Level for Green LED Turn On (Radio Sensitivity)		−69	−70	−71	dBm

8.0 AC/DC Specifications

Unless otherwise noted, limits printed in **boldface** characters are guaranteed for $4.8V < V_{IN} < 9.3V$; $T = 0°C$ to $50°C$ by correlation with 100% electrical testing at $T_A = 25°C$. All other limits are assured by correlation with other production tests and/or product design and characterization (Continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
SYSTEM SPECIFICATIONS (Continued)						
	In-Band Desensitization (Note 1)	In-Band Unmodulated Interferer (902 MHz–928 MHz)		15		dBc
	Out-of-Band Desensitization (Note 1)	Out-of-Band Unmodulated Interferer (<902 MHz and >928 MHz)		50		dBc
	Same Channel Interferer			−15		dBc
	Adjacent Channel Rejection	at Threshold; Modulated Interferer		8		dBc
	Image Rejection			0		dB
	Rx/Tx Antenna Pattern	for 80% of Sphere	−10		0	dBi
CENTER FREQUENCIES (F_o)						
Channel A F_o	Air Low Tx Freq, Share Low Rx Freq			923.144		MHz
Channel A F_o	Share Low Tx Freq, Air Low Rx Freq			919.552		MHz
Channel B F_o	Air Mid Tx Freq, Share Mid Rx Freq			912.35		MHz
Channel B F_o	Share Mid Tx Freq, Air Mid Rx Freq			908.8		MHz
Channel C F_o	Air High Tx Freq, Share High Rx Freq			910.294		MHz
Channel C F_o	Share High Tx Freq, Air High Rx Freq			906.752		MHz
	Center Frequency Accuracy	@ 25°C		**F_o-25**	**F_o+25**	kHz
	Center Frequency Accuracy	from 0°C–50°C		**F_o-75**	**F_o+75**	kHz
	Nominal Peak Tx Modulation		420	540	580	kHz-pp

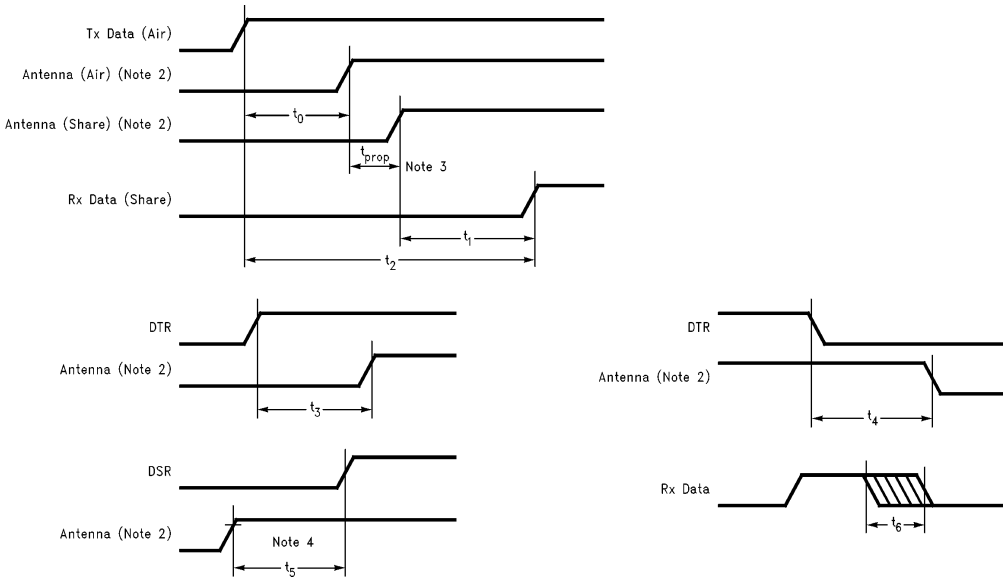
Note 1: Desensitization is the level of interfering signal that degrades data performance.

8.0 AC/DC Specifications

Unless otherwise noted, limits printed in **boldface** characters are guaranteed for $4.8V < V_{IN} < 9.3V$; $T = 0°C$ to $50°C$ by correlation with 100% electrical testing at $T_A = 25°C$. All other limits are assured by correlation with other production tests and/or product design and characterization (Continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
TIMING SPECIFICATIONS						
t_0	Data Delay from TD to Antenna			2.2		μs
t_1	Data Delay in AirShare Unit from Rx Antenna to Digital Output			6.9		μs
t_2	Overall Time Delay from RD to TD	at a Range of 30 Feet		8		μs
t_3	DTR Delay, from Asserted to Normal Operation	Signal Switched at Rates < 100 Hz		1		ms
t_4	DTR Delay, from Deasserted to Off	Signal Switched at Rates < 100 Hz		500		μs
t_5	DSR Delay, from Threshold to Signal Asserted				1	ms
t_6	Jitter	Absolute		1	6	μs
	Transition Region Slew Rate of Rx Data (from AirShare Unit to PC)	$T_A = 25°C$, $V_{CC} = 5V$ $R_L = 3\ k\Omega - 7\ k\Omega$, $C_L = 50\ pF - 2500\ pF$, Measured from $+3V$ to $-3V$ or $-3V$ to $+3V$		4	30	$V/\mu s$

Timing Diagrams



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Note 2: Representation of Antenna signals as logic levels is figurative. See Section 8.0 for actual emissions levels.

Note 3: t_{prop} is based on the distance between the Air and Share units. Propagation of electromagnetic energy in air is approximately equal to 3.33 ns/meter.

Note 4: Threshold value is -70 dBm.

9.0 Certifications

9.1 SAFETY

9.1.1 UL (United States)

AirShare has achieved UL (Underwriters Laboratory Inc.) safety approval for use in the United States.

9.1.2 CSA (Canada)

CSA (Canadian Standard Association) approval for the AirShare module is in progress.

9.2 EMISSIONS

9.2.1 FCC (United States)

AirShare FCC ID#: ED9AIR-SHARE

Note that the following FCC (Federal Communications Commission) approval applies to the AirShare module packaged in its original factory-provided enclosure; if AirShare is used without this enclosure or with a different enclosure, this FCC approval is no longer valid. Contact National for more information.

The AirShare radio module, in its factory-provided enclosure, has been tested and found to comply with the limits for a Class C device, pursuant to Part 15.249 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

Changes or modifications not expressly approved by National Semiconductor could void the user's authority to operate the equipment.

Shielded cables and I/O cords must be used for this equipment to comply with the relevant FCC regulations.

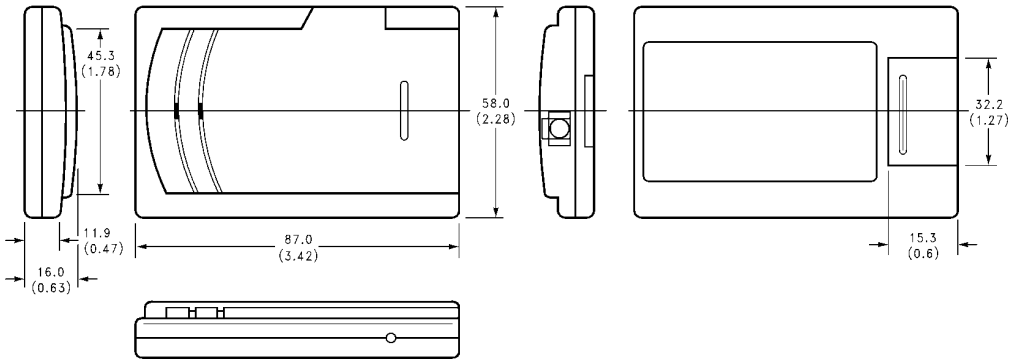
The AirShare module operates near the maximum output power level for FCC approval.

9.2.2 Industry Canada (Canada)

The AirShare module has achieved Industry Canada (formerly Department of Communications—DOC) approval for operation in Canada.

10.0 Physical Dimensions and Weights

10.1 PHYSICAL DIMENSIONS



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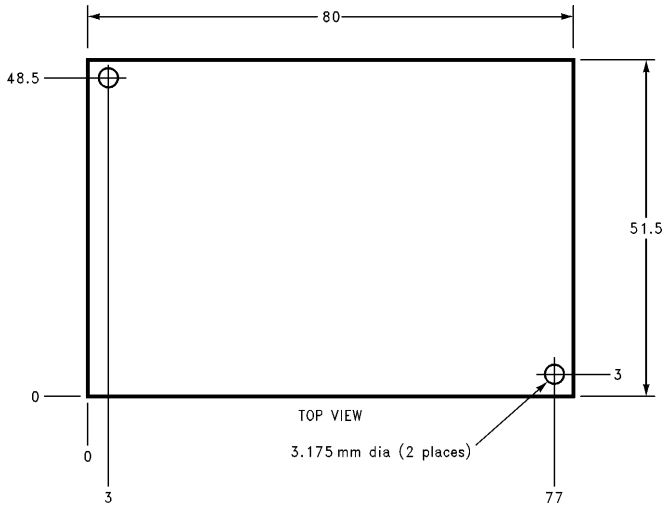
Dimensions: mm (in.)

FIGURE 10-1. AirShare Radio Module Enclosure

10.0 Physical Dimensions and Weights (Continued)



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Dimensions: mm

FIGURE 10-2. AirShare Radio Module Printed Circuit Board

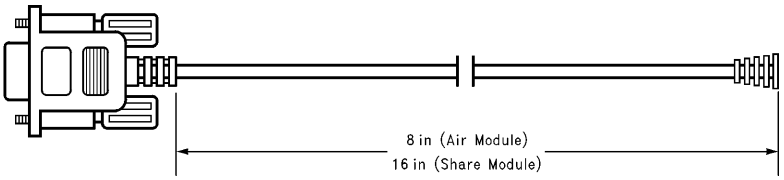

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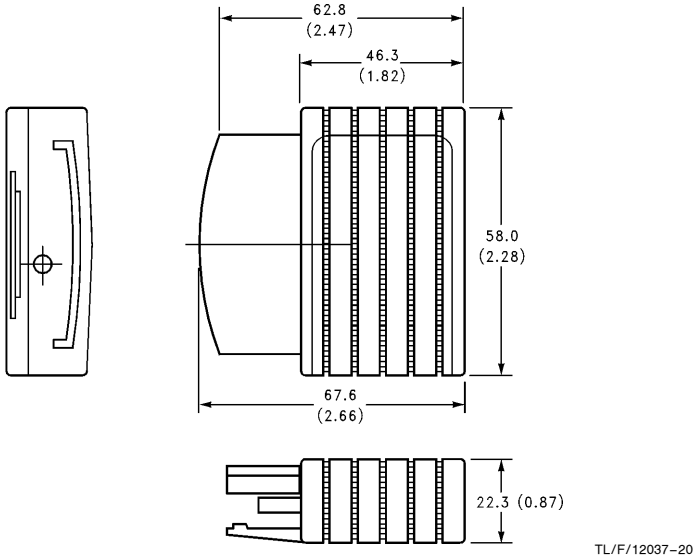
FIGURE 10-3. AirShare DB9 Serial Cable



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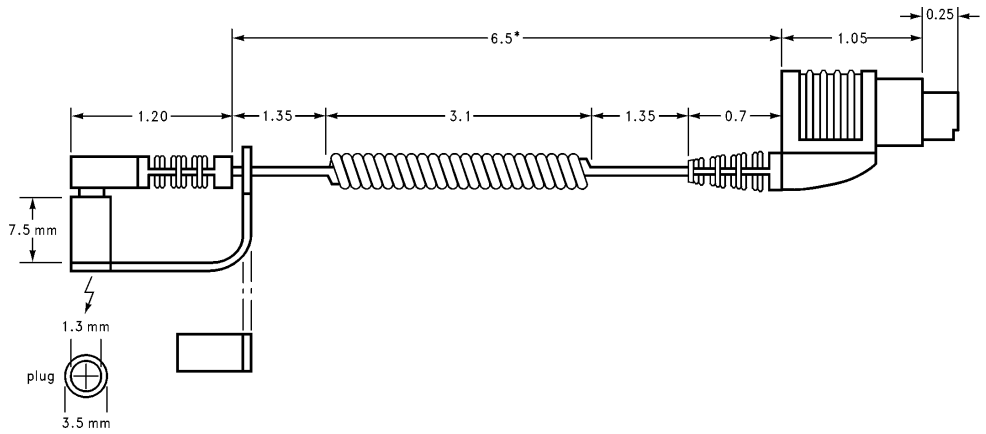
Dimensions: mm (in.)

FIGURE 10-4. Battery Pack

10.0 Physical Dimensions and Weights (Continued)



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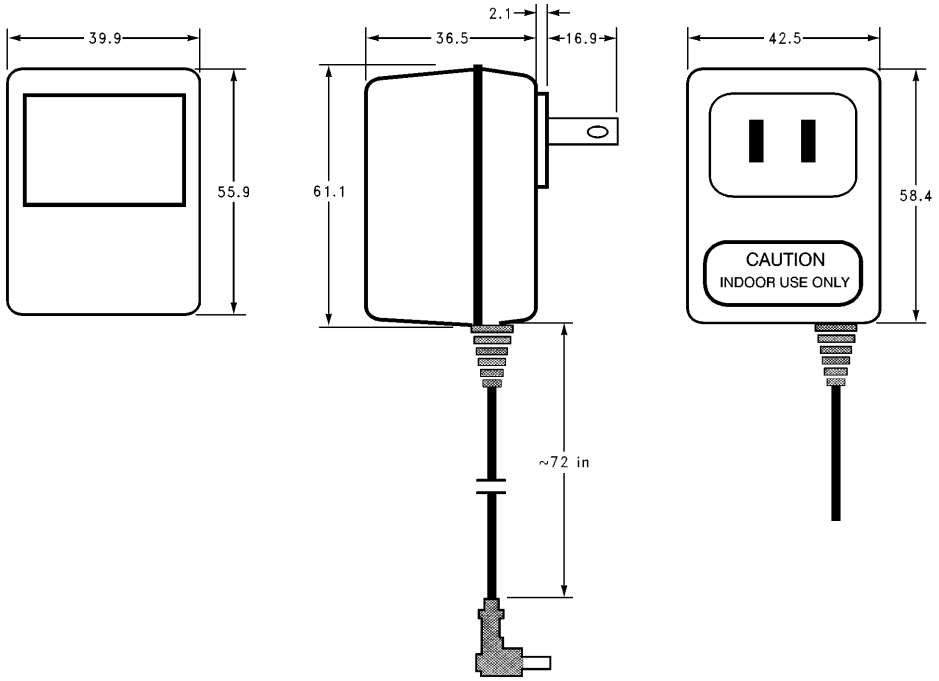
*Retractile cord: 6.5 in. retracted, 33 in. extended

Dimensions: in., unless otherwise indicated

FIGURE 10-5. Mouse Port Power Cable



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Dimensions: mm, unless otherwise specified

FIGURE 10-6. AC Power Adapter

10.0 Physical Dimensions and Weights (Continued)

TL/F/12037–23

Inner pin diameter: 1.3 mm

Outer barrel diameter: 3.5 mm

FIGURE 10-7. AirShare Mini-DC Power Connector

10.2 WEIGHTS

All weights shown in this section have an error tolerance of ±0.1 oz.

Description	Weight	Units
Air Module	2.8	oz.
Share Module	3.0	oz.
Battery Pack (without 9V battery)	0.9	oz.
Mouse Cable	0.9	oz.
AC Adapter	5.8	oz.

11.0 Ordering Information

AIRSHARE-AIR	Air Module with 9V Battery Pack
AIRSHARE-SHARE	Share Module with Power Adapter
AIRSHARE-PAIR	Air Module and Share Module with 9V Battery Pack and Power Adapter
AIRSHARE-EVAL	AirShare Developer's Kit
AIRSHARE-RTL	LapLink Wireless with AirShare
AIRSHARE-BATT	9V Battery Pack
AIRSHARE-MOUSE	Mouse Port Power Cable
AIRSHARE-AC	Power Adapter

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