

MSI9020

CELLMODEM

User Guide



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Introduction

The MSI9020 CellModem is a component of the CellScale System that provides a wireless comport for a master CellScale device (i.e. MSI9000, MSI9300, MSI6260CS). The CellModem utilizes the 2.4 GHz Spread Spectrum, frequency hopping modem standard in the CellScale family of products to communicate via RF to a CellScale network.

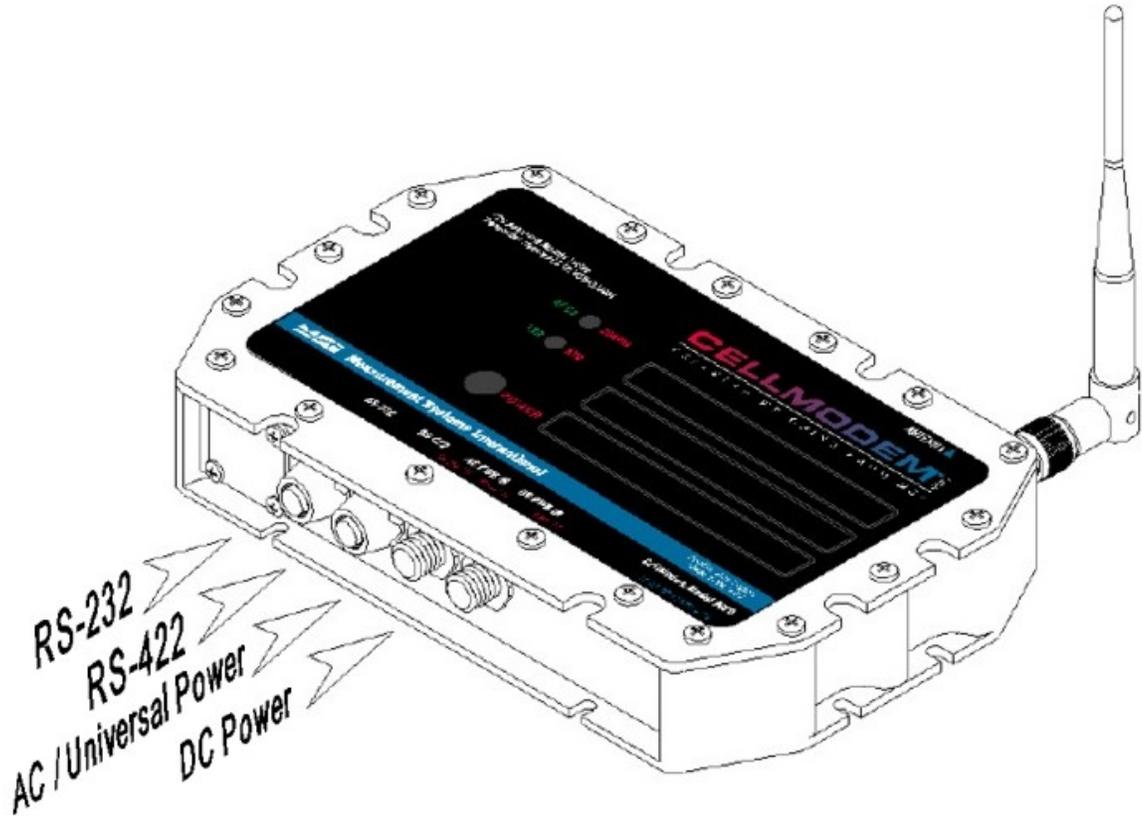


Illustration 1: CellModem Connectors

The CellModem provides either RS-232 or RS-422 serial output to another serial device such as computers, scoreboards and printers. The CellModem has both a 9-30VDC power connector and an AC/Universal power connector.

The modem communicates to a CellScale network via one of three virtual comports on the master CellScale device. Each virtual comport on the master CellScale device can support multiple CellModem devices. This provides the flexibility to communicate to more than three devices via the CellModem as illustrated below.

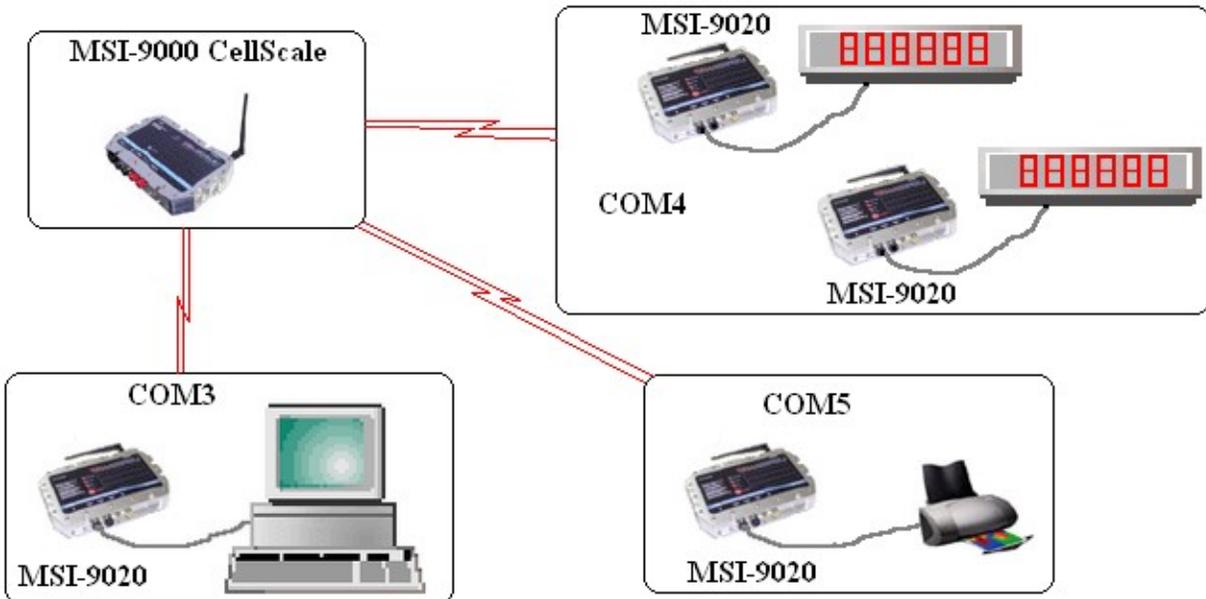


Illustration 2: CellModem Virtual Comport

The modem uses the standard MSI host commands to retrieve all forms of weight data such as gross/net/tare weight or total and statistics data. Additionally, a command set provides the ability to perform available scale functions and configure scale parameters. A brief list of host commands and uses is shown under the 'Host Command Notes' section. For detailed information about the host commands, please refer to the User Guide for the master CellScale device.

LED Indicators

The CellModem has three LED's that provide an indication of power, data transfer, configuration mode, and carrier detection.

The Power LED blinks approximately once per second to indicate that the unit has power. The TXD/RXD LED indicates data being transmitted (green) or received (red). The RF CD/CONFIG LED indicates if the modem has detected a master device to communicate to (green) and to indicate if the modem is in configuration/setup mode (red). Note that if the LED appears orange, both the green and red LED's are on.

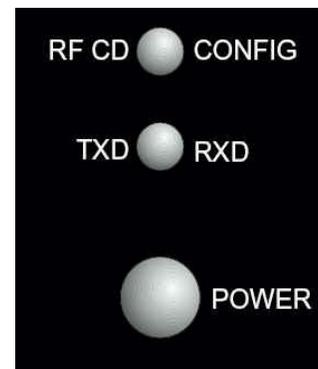
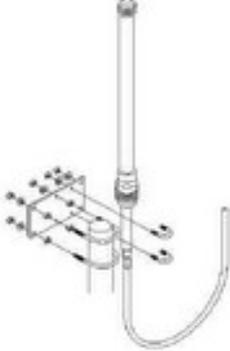


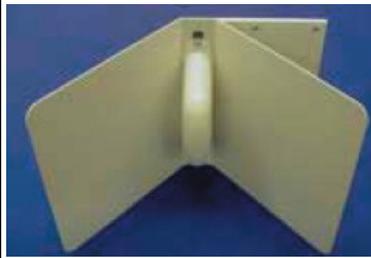
Illustration 3: Indicator Lights

Antennas

The CellModem come standard with a half wave antenna with TNC connector that mounts directly to the CellModem. Additional antenna options are available to meet the communications and environmental requirements for any installation.

To meet FCC licensing rules, you must use only antennas supplied or recommended by MSI. MSI offers the CellModem with a variety of antenna choices:

 A line drawing of a standard antenna, which is a vertical tube with a TNC connector at the bottom.	<p>Standard Antenna</p> <p>An articulated 1/2 wave antenna (MSI P/N 11953) that mounts directly on the CellModem enclosure and is suitable for most short to medium range applications. This antenna and Coax connector, though resistant to water, is not water-proof. Seal the TNC base with an adhesive heat shrink boot if this antenna is exposed to rain. This Antenna should be vertically oriented.</p>
 A line drawing of a long range antenna, showing a vertical pole-mounted antenna connected to a coaxial cable.	<p>Long Range Antenna</p> <p>A high gain antenna (MSI P/N 12147) that is remotely mounted from the CellModem with a low loss coaxial cable. This omni-directional antenna increases the range up to 4 times. The 10' (3m) coax cable allows placement of the antenna above the CellModem for ease of clearing possible obstacles to data transmission.</p> <p>The Long Range Omni directional antenna is pole mounted (up to 2" diameter) and extends the range of CellScale transmissions. MSI supplies this antenna with a 10' (3m) coax cable pre-attached. This antenna must be vertically mounted. The vertical beam width (-3dB point) is 14 degrees.</p> <p>Also available with an N connector (MSI P/N 12037) for applications requiring longer coax cable lengths.</p>
 A photograph of a white Yagi antenna mounted on a metal mast against a blue sky.	<p>Yagi Antenna</p> <p>A highly directional YAGI Antenna is available by special order. This antennas offers both high gain (14dBi) and controllable transmission patterns. This antenna must be carefully aligned for long distance applications. The beam width of the Yagi is 30° Elevation, and 34° Azimuth. The Yagi is mast mounted for masts up to 2-1/8" (5.4cm) in diameter. The Yagi is connected to CellScale equipment with adapter coax P/N 12751 (6', longer lengths available by special order).</p>



Corner Reflector Antenna

Two Corner Reflector Antennas are available by special order. These antennas offer both high gain and controllable transmission patterns. These antennas are the best choice when antenna placement is against a wall or other surface. These antennas come with a Pipe mount for pipe up to two inches (5cm) in diameter. Standard Coax cable length is 3m (9' 10"). The 14dBi Model (**MSI P/N 13204**) features a beam width of 44° Elevation, and 35° Azimuth. The 9dBi Model (**MSI P/N 13205**) has a beam width of 75° Elevation, and 65° Azimuth. These must be used with adapter coax P/N 12751 (6', longer lengths available by special order).



Vehicle Mount Whip Antenna

A vehicle mount whip antenna is approved for use with MSI CellScale equipment and is available by special order. This 5 dB i gain whip is rugged and waterproof and mounts in a 3/4" hole on the roof of mobile vehicles. MSI P/N 13206 (Antenna) and P/N 13207 (mount). The mount includes 17' of low loss coax terminated in a TNC Connector.



STANDARD ANTENNA BULKHEAD EXTENSIONS

MSI offers short Coaxial cable assemblies to extend the antenna connector when the CellScale equipment is mounted in an industrial enclosure. These Coaxial assemblies are designed for 2.4Ghz use and have TNC Male connectors at both ends. These mate with a through panel TNC to TNC Bulkhead Adapter. TNC to TNC Flange Mount Bulkhead Adapter – MSI P/N 13140 TNC to TNC Jam Nut Mount Bulkhead Adapter – MSI P/N 13141 Extension Coax Cable Assemblies – 1' (30cm) P/N 13142, 2' (61cm) P/N 13143, 3' (.9m) P/N 13144, 4' (1.2m) P/N 13145

OTHER ANTENNAS

Other antennas are available for special applications. One antenna MSI often uses is a small Patch antenna. This antenna is suitable for rugged applications where standard antennas will often be destroyed. This is the antenna used in our Crane Scales. Special antennas for rugged applications, or long range transmission are available. Contact MSI for more information.

Antenna Installation Notes

Antenna placement is critical to problem free use of your CellScale system.

1. Be sure a relatively clear transmission path exists between the 3750CS and associated CellScale master devices. The radio signals travel primarily by line of sight (LOS), and obstructions between stations will degrade the system performance. LOS is less important as distances decrease.
2. When using the long range antenna, mount the antenna on a tower or other elevated structure to ensure that you have a clear LOS transmission path. This will raise the antenna to a level sufficient to clear surrounding terrain and other obstructions. It is not necessary or desirable to provide a ground plane for the antenna.
3. Never use a directional antenna (e.g. a Yagi, or a corner reflector) on a mobile system. However, fixed station locations can often benefit from directional antennas when the location of the other components of the RF network are always in the same general direction.
4. If using the meter mounted standard antenna, ensure that the antenna is not blocked by any metal. Transmission is good through most kinds of glass so mounting a meter next to a window should work fine. If there is no clear line of sight place to mount the 3750CS, consider switching to the long range antenna so the antenna can be remotod.
5. The standard and long range antennas are vertical plane devices. Do not mount them sideways. They should always point up. It also works to point them down, when high off the ground (such as on the underside of a large bridge crane). The long range 9dBi Antenna is particularly sensitive to off axis mounting. Use a carpenters level to ensure the antenna is exactly 90° perpendicular to the earth.
6. Do not mount an omni directional Antenna next to a metallic or concrete surface. This can result in reflections and undesired RF characteristics. For this application, use a Corner Reflector.
7. After installation, you must seal the Antenna connection with an Adhesive Heat Shrink Boot. Failure to seal the Antenna may result in liquid destroying the Antenna, or the CellScale.

MSI does not recommend extending the coaxial cable beyond 3 meters. At 2.4GHz more loss will result from coax losses than are gained by raising the antenna. If you must extend the antenna, use a very low loss 50Ω coax such as RG-214 low loss varieties. For very short extensions (<1m), cables made with RG-316 are suitable.

FCC STATEMENT

FCC ID: HSW-2400M

Note: This unit has been tested and found to comply with the limits for a class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. Commensurate with EIRP limits specified in FCC Rules 15.247b, this device may not be used with antennas that exceed 36dB of gain in point-to-point applications or 16dB of gain in multi-point applications. The Transmitter Module is licensed as FCC ID: HSW-2400M.

FCC'S MPE REQUIREMENTS

Information to user/installer regarding FCC's Maximum Permissible Exposure (MPE) limits.

Standard 1/2 Wave Dipole, Patch Antenna, Vehicle Whip, or Long Range 9dBi Omni: The field strength radiated by any one of these antennas, when connected to MSI RF products, may exceed FCC mandated RF exposure limits. FCC rules require professional installation of these antennas in such a way that the general public will not be closer than 20 cm from the radiating aperture of any of these antennas. End users of these systems must also be informed that RF exposure limits may be exceeded if personnel come closer than 20 cm to the apertures of this antenna.

Corner Reflectors or 15dbi Yagi: The field strength radiated by any one of these antennas, when connected to MSI RF products, may exceed FCC mandated RF exposure limits. FCC rules require professional installation of these antennas in such a way that the general public will not be closer than 2 m from the radiating aperture of any of these antennas. End users of these systems must also be informed that RF exposure limits may be exceeded if personnel come closer than 2 m to the apertures of either of these antennas.

Connecting Power

The CellModem comes standard with a 9-30VDC power input with 2 switch connections for power/configuration control. A universal power connection that provides 86-265 VAC or 110-340VDC. An optional 9-36VDC Isolated or 18-72VDC Isolated power interface or UPS connection can be ordered. Contact the factory for details.

DC Power and External Switch Connections

The DC power connections are the same for the MSI9020 CellModem and the MSI9000 CellScale. The standard power ranges from 9-30VDC. There is an optional isolated DC ranging from 9-36VDC or 8-75VDC. The MSI part number for this connector is 12019.

The pin out for the connector is shown below:

Pin Number	12020 Wire Color	Signal Description
1	Brown	Positive DC Power
2	White	Switch 2
3	Blue	Negative (or common) DC Power
4	Black	Switch 1
5	Gray (or Green)	External LED

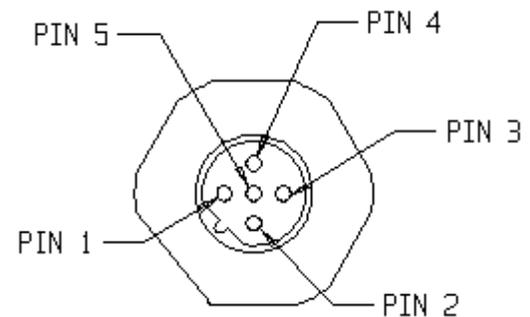


Illustration 4: DC Power Connector

Table 1: DC Power Connector and Cordset

The mating cable to the DC power connector is MSI part number 12020. This cable assembly follows the color code listed in the table above. The following is a pin diagram for the cordset.

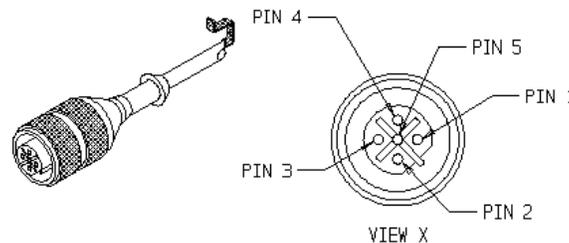


Illustration 5: DC Power Cordset

The negative (or common) DC power is connected to the case of the 9020 via a 6A ferrite filter with a maximum DC resistance of .01 ohms.

AC/Universal Power Connections

The AC power connections are the same for the MSI9020 CellModem and the MSI9000 CellScale. The AC/Universal input power specifications are as follows:

Input Voltage	86-265 VAC or 110-340VDC
Frequency	Range 47-440 Hz, switching frequency 100kHz
Inrush Current <i>typical</i>	20A @100 VAC

The connector on the CellModem mates with the cordset (MSI P/N 12434). The following table and diagram describe the connections, and cordset wire colors.

Pin Number	Cordset 12434 Color	Signal Description
1	Blue	Neutral
2	Brown	Line
3	Bare	Shield
4	Green/Yellow	Ground

Table 2: AC/Universal Connector and Cordset

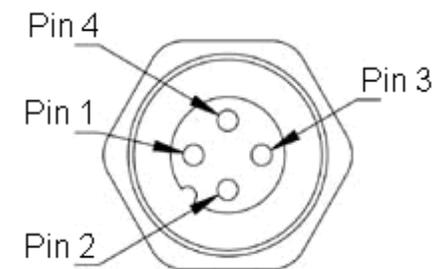


Illustration 6: AC/Universal Connector

The mating cable to the AC power connector is MSI part number 12434. This cable assembly follows the color code listed in the table above. The following is a pin diagram for the cordset.

The ground and shield connections are tied directly to the 9020 case.

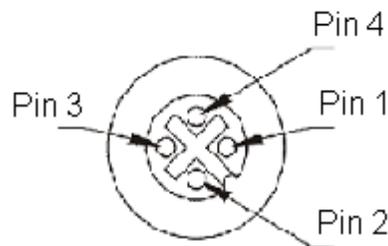


Illustration 7: AC/Universal Cordset

Connecting Communications Equipment

The MSI9020 CellModem comes standard with one serial comport that breaks out to two connections, RS-232 and RS-422. Only one interface should be used at a time.

RS-232 Interface

The CellModem is wired as a DCE device. Thus, it will connect directly to a PC or other DTE device with a standard modem cable, but will require a Null modem adapter to connect to another DCE device such as a modem, printer, or scoreboard.

The RS-232 serial connector mounted on the 9020 is MSI part number 12426. The pin diagram for the connector is shown to the right.

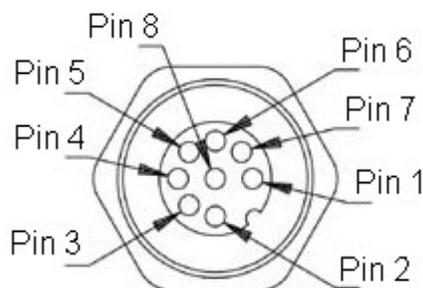


Illustration 8: RS-232 Connector

The connections and wire colors for the RS-232 serial connector are detailed in the following table:

CellModem I/O Function	Pin Number	Wire Color	9 pin D-sub Pin Number
RXD Output to DTE	3	Green	2
CTS Output to DTE	7	Blue	8
TXD Input from DTE	2	Brown	3
RTS Input from DTE	8	Red	7
Ground Common	5	Grey	5
DCD Output to DTE	1	White	1
DTR Input from DTE	4	Yellow	4
DSR Output to DTE or Configuration Input depending on JP2, FB20 and FB21	6	Pink	6

Table 3: RS-232 Connector and Cordset

The RS-232 serial cable supplied by MSI is part number 502046. The cordset used for this connection is MSI part number 12465. The pin diagram for the cordset is shown to the right.

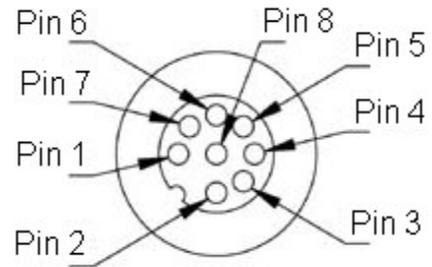


Illustration 9: RS-232 Cordset

The required connections to use the 9020 in full duplex mode are TXD, RXD and GND. If hardware flow control is required, the CTS and RTS wires will be needed.

RS-422 Interface

The standard RS422 port is capable of driving communications over much longer distance than the standard RS-232 lines. The following details the connections to the RS-422 port.

The RS422 connector is MSI part number 12022. The pin diagram for the RS-422 connector on the 9020 is shown to the right.

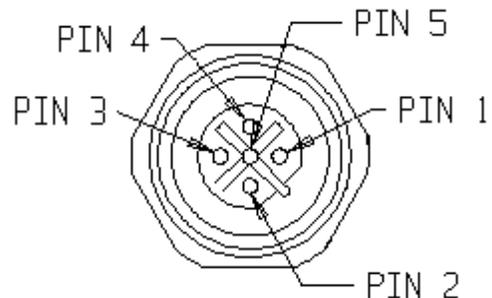


Illustration 10: RS-422 Connector

The following table shows the color coding and function for the RS422 connector and cordset.

Modem I/O Function	Pin Number	Wire Color
T+	1	Brown
T-	2	White
R+	4	Black
R-	5	Gray
GND	3	Blue

Table 4: RS-422 Connector and Cordset

The cordset used to connect to the RS422 port on the 9020 is MSI part number 12023. The pin diagram for this cable is shown to the right.

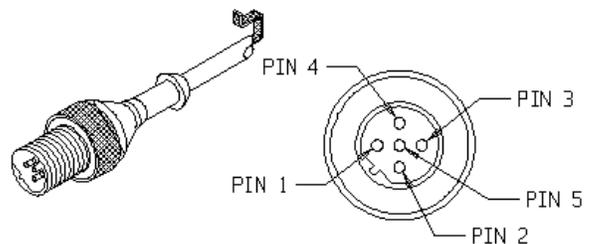


Illustration 11: RS-422 Cordset

Accessing 9020 Modem Setup

The CellModem is configured through the serial port, via a terminal program, with a command interface detailed in the section 'CellModem Configuration Commands'. To access the modem setup one of the following methods must be used.

- Transmit Setup String on Power Up
- Transmit Setup String after Toggling the DTR line
- Setting the Configuration Line (*not available standard, requires PCA modification*)
- External Configuration Switch (*not available standard, requires PCA modification*)

Transmit Setup String on Power Up

The modem setup mode can be accessed by sending a specific string to the modem when power is first applied to the unit.

Note: read the following steps completely before proceeding.

1. Connect the CellModem to a computer running a terminal program such as Hyperterminal. The default protocol is 9600 baud, no parity, 8 data bits, 1 stop bit. For RS-232 hardware (CTS/RTS) handshaking
2. Apply power to the CellModem.
3. If communications are setup properly, the modem will print a setup header string of the format
WIT2400 v3.76 Digital Wireless (c) 1998 :REMOTE
or something similar depending on the modem configuration. *Note: It is possible to change this power up banner to a custom string, or disable it, contact factor for details.*
4. After receiving the startup header, type the following command:
:wit2400
Note: It is not necessary to press enter after this string.
Note: This string is case sensitive and should be in all lower case characters.
5. After typing the string, the modem will print an '>' character to indicate it is in the setup mode.

Now that the modem is in setup mode, proceed to setup the modem with the commands listed in the next section 'CellModem Configuration Commands'.

Toggling DTR (i.e. restart modem)

When the DTR line on the modem is set, the modem goes into a sleep mode. When the DTR line is reset, the modem wakes up and again the modem will print a setup header string of the format

WIT2400 v3.76 Digital Wireless (c) 1998 :REMOTE

or something similar depending on the modem configuration. As described in the procedure above, sending the setup string:

:wit2400

will put the modem in setup mode.

Now that the modem is in setup mode, proceed to setup the modem with the commands listed in the next section 'CellModem Configuration Commands'.

Set the CFG/DSR Line (custom)

The configuration (DSR) line allows quick access to the modem setup mode while the modem is operational. This method requires modifications to the PCA that are detailed in the section 'Hardware Configuration'.

External Configuration Switch (custom)

The configuration line allows quick access to the modem setup mode while the modem is operational. If the CellModem is configured via hardware to accept a switch input to enter setup mode, merely press the setup switch to enter setup mode. This method requires modifications to the PCA that are detailed in the section 'Hardware Configuration'.

CellModem Configuration Commands

All CellScale based products that utilize the wireless networking feature require that the radio's be configured properly. Typically a CellScale product requires the network number, and address to be set. Due to the lower level interface in the CellModem, additional parameters that are automatically set in other CellScale products must be manually setup in a CellModem.

Note: All numeric communications with the CellModem are in hexadecimal format.

Please reference appendix A for network number, hop duration and address number reference.

Setting the network number

1. Check the current network by typing: **wn?**
2. Setup the network number using the same wn command. For example, to set the network number to 10, you will require the following command: **wna**
3. If the network number is from 0-15 (i.e. 0 - f), then the hop duration will need to be set to the default 9C. If the network is 16 - 31, the hop duration will need to be set to one half the standard or 4E.
4. To check the hop duration use the following command: **ph?**
5. To set the hop duration use the ph command. For example: **ph4e**

Setting Master/Slave (base/remote)

1. Check if the modem is a base (master) or remote (slave) with the following command: **wb?**
2. To set the modem as a slave or a master use the wb command. For example to set the modem to a remote (slave) use: **wb0**

Setting Master ID (destination address)

1. Check the modem destination address (i.e. the master ID) by using the following command: **wd?**
2. To set the modem's destination address use the wd command. For example to set the destination address to 13, use the following: **wd0d**

Setting Slave ID (My ID)

1. Check the modem source address (i.e. the slave ID) by using the following command: **ws?**
2. To set the modem's source address use the ws command. For example to set the source address to 123, use the following: **ws7b**

Setting Power Level

1. Check the transmit power using the wp command as follows: **wp?**
2. Set the transmit power to high (1) or low (0) by using the wp command. For example to set the transmit power to high use the following: **wp1**

Setting Baud Rate

1. If the baud rate needs to be changed, use the sd command. The baud rate setting is a divisor number that ranges from 009h-3FFh with the following standard values:

<i>Baud Rate</i>	<i>Divisor</i>
2400	215
9600	083
14400	057
19200	040
28800	02B
38400	01F
57600	014
115200	009

Table 5: Baud Rate Divisor

2. Query the current baud rate by using the following command: **sd?**
3. To set the baud rate, use the sd command in conjunction with the appropriate baud rate divisor. For example, to set the baud rate to 19200, use the following command: **sd040**
4. After setting the baud rate to a new setting, the terminal program will also have to be changed in order to communicate with the modem.

Packet Mode

1. Check the packet mode is set appropriately by using the sp command. To check the packet mode use the following command: **sp?**
2. To set the packet mode, use the sp command. For example, to set the packet mode to point to point (slave) use the following command: **sp0**

Storing and Exiting Settings

1. If any changes are made to the setup parameters of the 9020, the changes will need to be saved. To save the changes to the configuration type the following command **m>**
2. After all settings have been made and stored as necessary, it will be necessary to exit the setup mode. This can be done two ways. First send the exit setup command as follows: **z>**
3. After all settings have been changed and stored, it is possible to simply cycle power to the modem to exit the setup mode.

Configuration Command Summary

Command	Description
wn[? 0..f]	Network Number
ph[? 00..ff]	Hop Duration
wb[? 0 1]	Master / Slave
wd[? 00..ff]	Master Address
ws[? 00..fe]	Slave Address
wp[? 0 1]	Transmit Power
sd[? 009..3ff]	Baud Rate
sp[? 0]	Disable Packet Mode
m>	Save configuration
z>	Exit configuration

Table 6: Configuration Command Summary

Hardware Configurations

The 9020 hardware can be configured in different ways to better accommodate user installation requirements. The following configurations describe modifications to the PCA inside the CellModem. It is recommended that modifications to the PCA be done at the factory. However, qualified technicians should be able to complete the required circuit modifications as necessary. The summary of possible hardware configurations is as follows:

- SW2 = CFG (default)
- SW2 = OFF (custom)
- Power Up ON (default)
- Power Up OFF (custom)
- DSR Read Modem Status (default)
- DSR Access CFG Mode (custom)

SW2 = CFG (default)

As described in the 'DC Power and External Switch' section, the CellModem has two switches. Switch one is always configured as a power on function. However, switch two can be set to either enter the configuration mode, or power off the modem.

To set switch 2 (SW2) to access the modem configuration mode, install JP2 position 1-2, and remove R25. Note that this will disable the DSR line accessing the configuration mode. Recommend configuring DSR Read Modem Status.

SW2 = OFF (custom)

As described in the 'DC Power and External Switch' section, the CellModem has two switches. Switch one is always configured as a power on function. However, switch two can be set to either enter the configuration mode, or power off the modem.

To set switch 2 (SW2) to function as a power off switch, install JP2 position 2-3 and install R25.

Power Up ON (default)

By default, the CellModem will automatically turn on when power is applied. It can also be configured to remain powered off when power is applied. To configure the modem to automatically turn on when power is applied, install C8 at JP1 from 2 to 3. Install C9 at JP1 from 1 to 4. This causes the unit to turn on when power is applied.

Power Up OFF (custom)

By default, the CellModem will automatically turn on when power is applied. It can also be configured to remain powered off when power is applied. To configure the modem to remain powered off when power is applied, install C8 at JP1 from 2 to 1. Install C9 at JP1 from 3 to 4. This causes the unit to turn off when power is applied. To turn the unit on, switch 1 must be pressed.

DSR Read Modem Status (default)

The DSR line on the modem port by default will act as a read line that tells the device if the modem is 'awake' or 'asleep'. Alternately, this line can be configured to directly enter the configuration mode, bypassing the setup string.

To set the DSR line to read the modem status, remove FB21 and install FB20.

DSR Access CFG Mode (custom)

The DSR line on the modem port by default will act as a read line that tells the device if the modem is 'awake' or 'asleep'. Alternately, this line can be configured to directly enter the configuration mode, bypassing the setup string.

To set the DSR line to directly access the configuration mode, remove FB20 and install FB21. Then set JP2 to position 2 and 3. Note that this will disable the SW2 if it was also set to enter configuration mode. Recommend configuring SW2 = OFF.

Host Command Notes

For complete details about the CellScale host command language, please reference the documentation for the master CellScale device being used.

Using host commands with a scoreboard.

Most scoreboards only support displaying numeric data. To get this type of data to a scoreboard host commands such as @V are provided to provide numeric only data that a scoreboard can display. The simplest host command string for a scoreboard is @V1@E which will show the current weight on the scale, followed by a carriage return and line feed by default.

Several scoreboards require specific end-of-line characters and some require start-of-line characters. Both of these strings are configured independently in the master CellScale print strings. For details about configuring these print strings, please refer to the user guide for the master CellScale device. The commands to print these strings are as follows:

@E	Host command, end of line string (defaults to CR LF)
@F	Host command, start of line string (defaults to null)

Table 7: End of Line, Start of Line Host Commands

Appendix A: Network Number Translation

<i>Network Number (Decimal)</i>	<i>Actual Network Number (Decimal)</i>	<i>Actual Network Number (Hexadecimal)</i>	<i>Hop Duration (Hexadecimal)</i>
0	0	0	9C
1	1	1	9C
2	2	2	9C
3	3	3	9C
4	4	4	9C
5	5	5	9C
6	6	6	9C
7	7	7	9C
8	8	8	9C
9	9	9	9C
10	10	A	9C
11	11	B	9C
12	12	C	9C
13	13	D	9C
14	14	E	9C
15	15	F	9C
16	0	0	4E
17	1	1	4E
18	2	2	4E
19	3	3	4E
20	4	4	4E
21	5	5	4E
22	6	6	4E
23	7	7	4E
24	8	8	4E
25	9	9	4E
26	10	A	4E
27	11	B	4E
28	12	C	4E
29	13	D	4E
30	14	E	4E
31	15	F	4E

Table 8: Network Number Translation

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