



Powerful Sensing Solutions for a Better Life

Mote Processor Radio & Mote Interface Boards User Manual

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About This Document

The following annotations have been used to provide additional information.

◀ NOTE

Note provides additional information about the topic.

☑ EXAMPLE

Examples are given throughout the manual to help the reader understand the terminology.

🚩 IMPORTANT

This symbol defines items that have significant meaning to the user

💣* WARNING

The user should pay particular attention to this symbol. It means there is a chance that physical harm could happen to either the person or the equipment.

The following paragraph heading formatting is used in this manual:

1 Heading 1

1.1 Heading 2

1.1.1 Heading 3

This document also uses different body text fonts (listed in Table 0-1) to help you distinguish between names of files, commands to be typed, and output coming from the computer.

Table 0-1. Font types used in this document.

Font Type	Usage
Courier New Normal	Sample code and screen output
Courier New Bold	Commands to be typed by the user
<i>Times New Roman Italic</i>	TinyOS files names, directory names
Franklin Medium Condensed	Text labels in GUIs

1 Introduction

This *User's Manual* describes the hardware features of the Mote Processor Radio (MPR) platforms and Mote Interface Boards (MIB) for network base stations and programming interfaces. It is intended for understanding and leveraging MEMSIC's Smart Dust hardware design in real-world sensor network, smart RFID, and ubiquitous computing applications. Table 1-1 below lists the models in this *Manual*.

Table 1-1. *This User's Manual covers these MPR models.*

MPR	2400	XM2110	LPR2400
	(MICAz)	(IRIS)	(LOTUS)

The Table 1-2 below summarizes the main features of each Mote.

Table 1-2. *Mote Product Summary*

Mote Hardware Platform		IRIS	MICAz	LOTUS
Models (as of April 2005)		XM2110	MPR2400	LPR2400
	Chip	ATMega1281	ATMega128L	ARM7 Cortex M3
MCU	Type	7.37 MHz, 8 bit		100MHz, 32 bit
	Program Memory (kB)	128		32MBpbytes
	SRAM (kB)	8	4	64Kbytes
Sensor Board Interface	Type	51 pin		
	10-Bit ADC	7, 0 V to 3 V input		
	UART	2		
	Other interfaces	DIO, I2C		
RF Transceiver (Radio)	Chip	RF230	CC2420	RF231
	Radio Frequency (MHz)	2400		
	Max. Data Rate (kbits/sec)	250		
	Antenna Connector	MMCX		N/A
Flash Data Logger Memory	Chip	AT45DB014B		W25Q64CVSSI
	Connection Type	SPI		
	Size	512		64Mb
Default power source	Type	AA, 2x		

This *Manual* is **not** a software guide to programming the motes in TinyOS/nesC, nor is it a guide to pre-built software packages that run on top of the Motes. The following two resources are available regarding software:

- ❑ *MoteWorks Getting Started Guide* by MEMSIC, Inc. available on the WSN Kit CDROM or the MEMSIC web site at www.memsic.com under Support>User's Manuals.
- ❑ The TinyOS web site at <http://www.tinyos.net/>



2.1 Product Summary

The IRIS is the latest generation of Motes from MEMSIC. The XM2110 (2400 MHz to 2483.5 MHz band) uses the Atmel RF230, IEEE 802.15.4 compliant, ZigBee ready radio frequency transceiver integrated with an Atmega1281 micro-controller. These enhancements provide up to three times improved radio range and twice the program memory over previous generation MICA Motes. The same MICA family, 51 pin I/O connector, and serial flash memory is used; all application software and sensor boards are compatible with the XM2110.

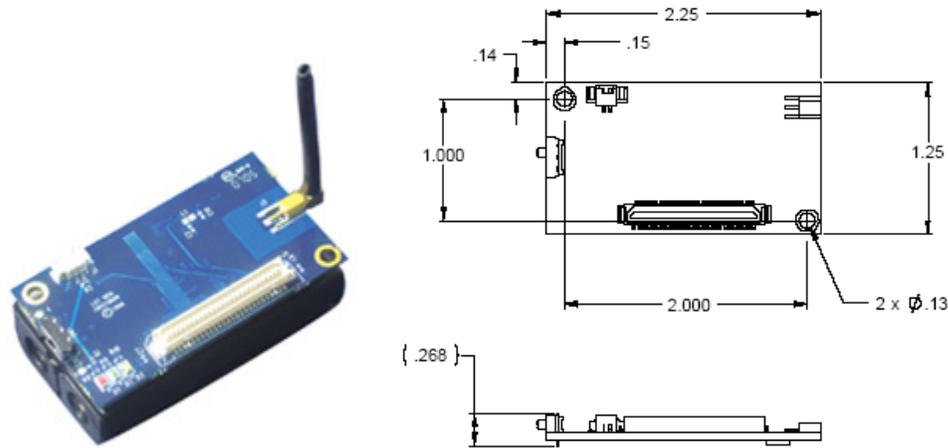


Figure 2-1. Photo of the XM2110—IRIS with standard antenna

2.2 Block Diagram and Schematics for the XM2110 / IRIS

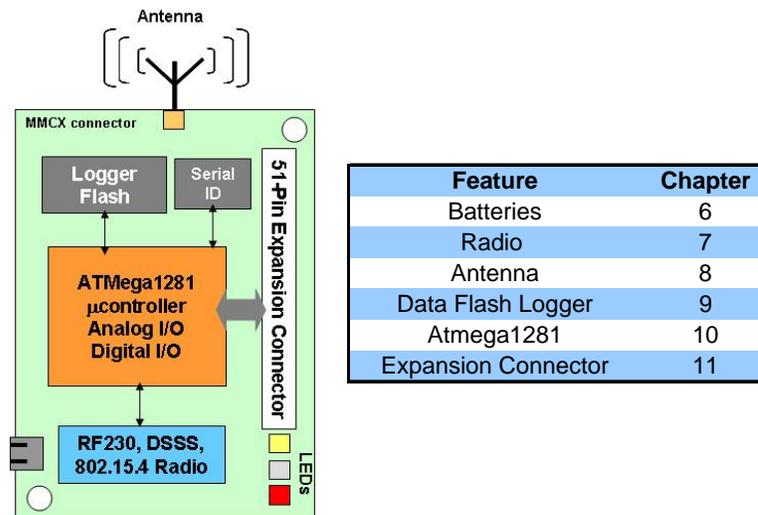
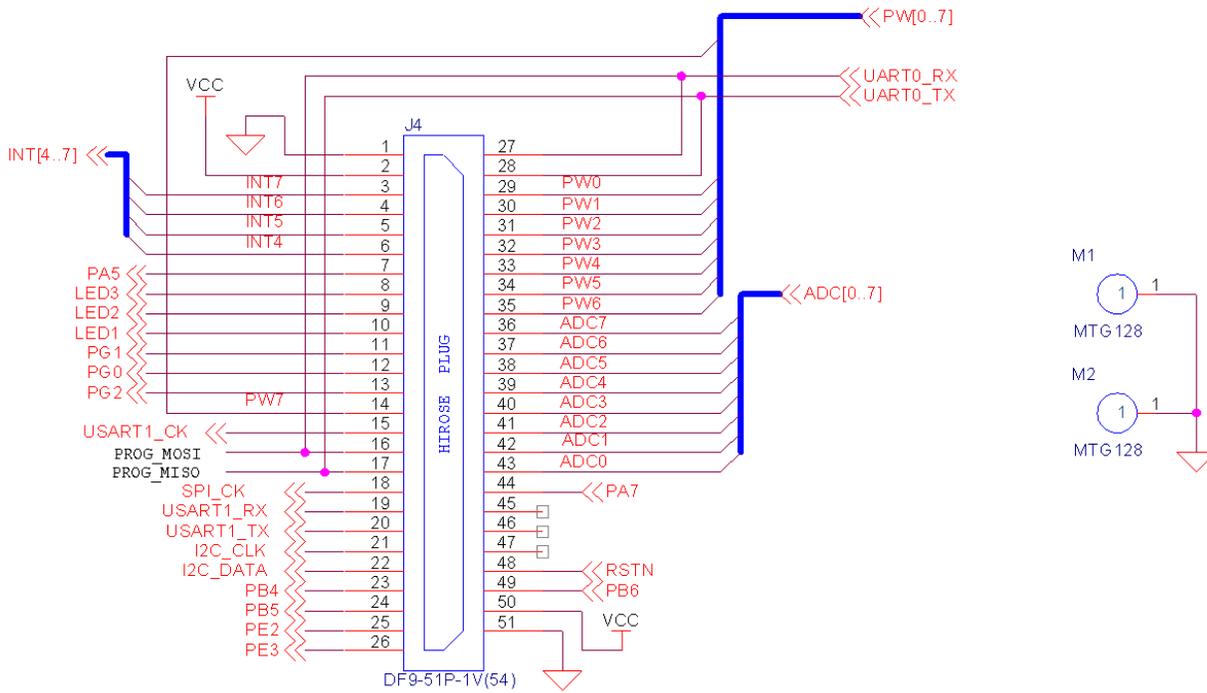
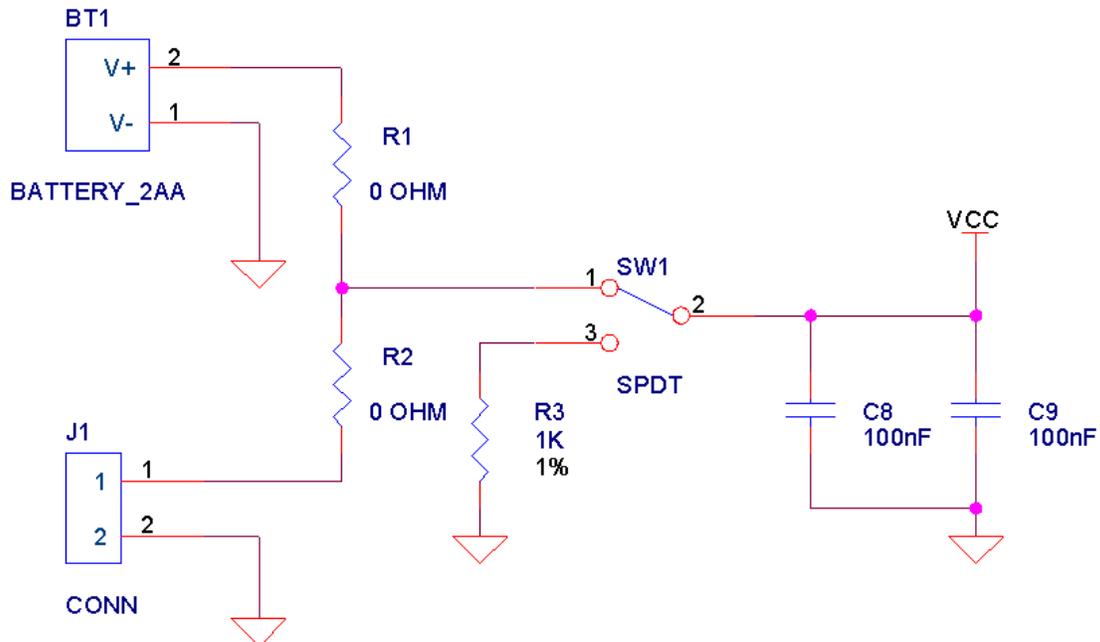


Figure 2-2. Block diagram of the IRIS and listing of Chapters that discuss the components in greater detail.

2.2.1 51-pin Expansion Connector



2.2.2 Battery



3 MPR2400 (MICAz)

3.1 Product Summary

The MICAz is the latest generation of Motes from MEMSIC. The MPR2400 (2400 MHz to 2483.5 MHz band) uses the Chipcon CC2420, IEEE 802.15.4 compliant, ZigBee ready radio frequency transceiver integrated with an Atmega128L micro-controller. The same MICA2, 51 pin I/O connector, and serial flash memory is used; all MICA2 application software and sensor boards are compatible with the MPR2400.

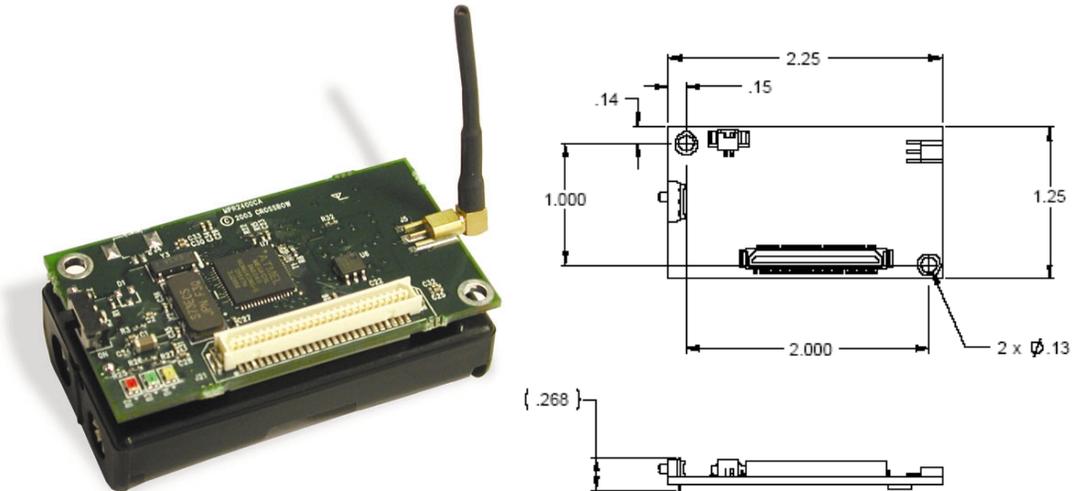


Figure 3-1. Photo of the MPR2400—MICAz with standard antenna.

3.2 Block Diagram and Schematics for the MPR2400 / MICAz

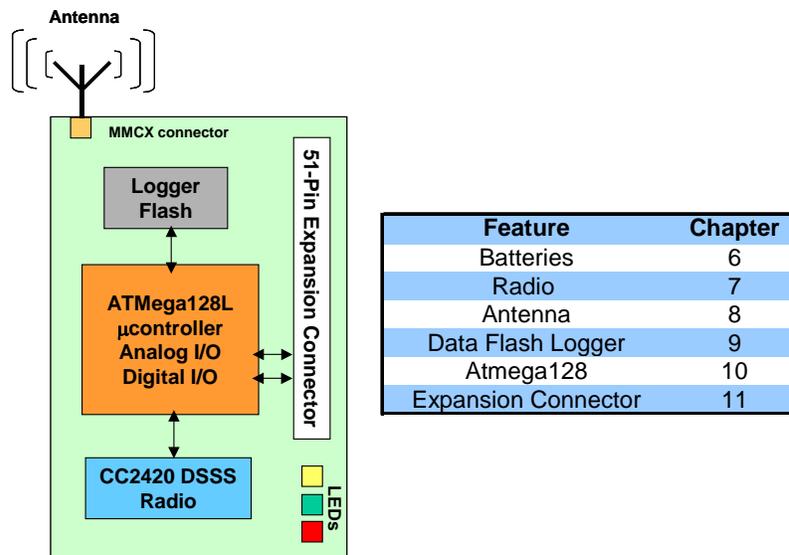
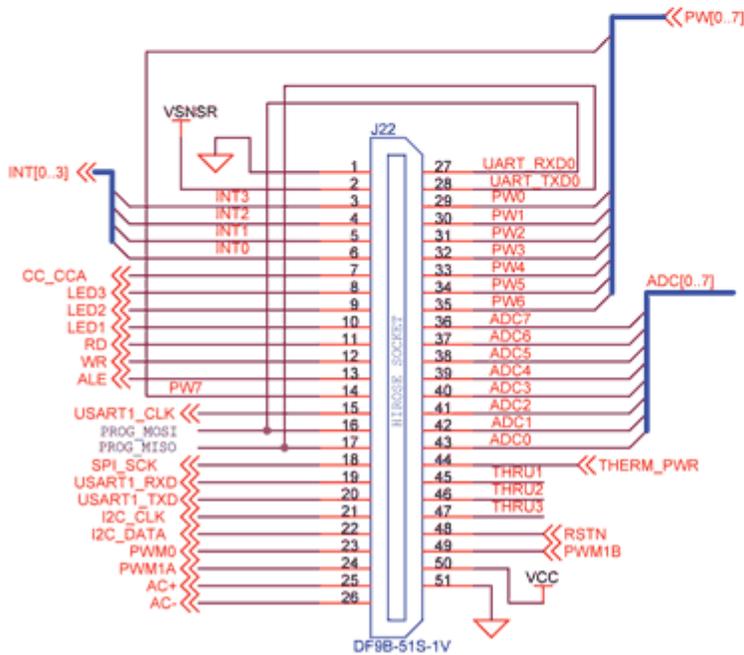
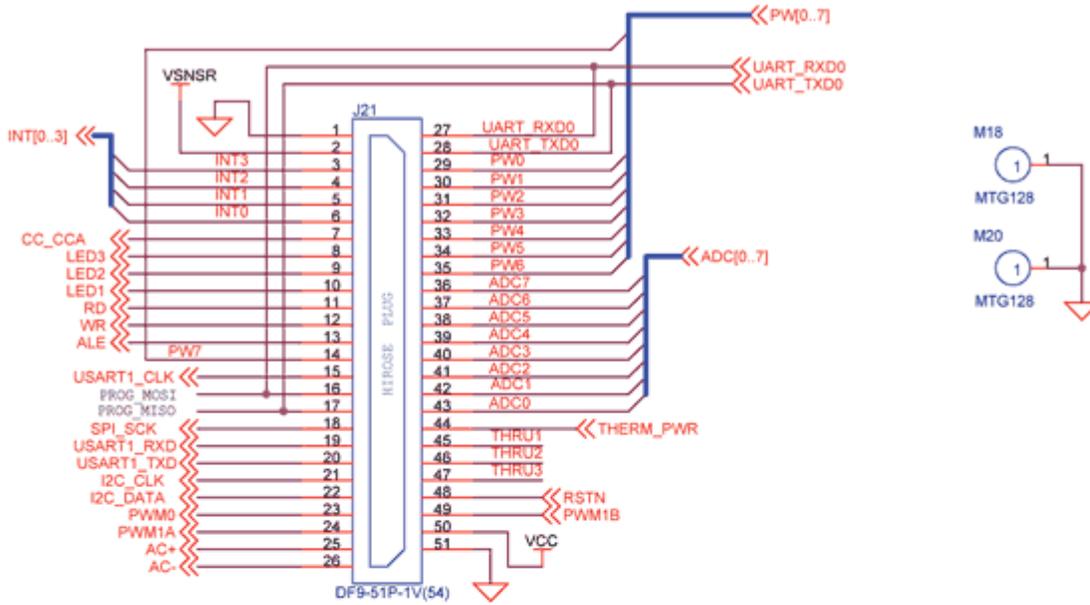
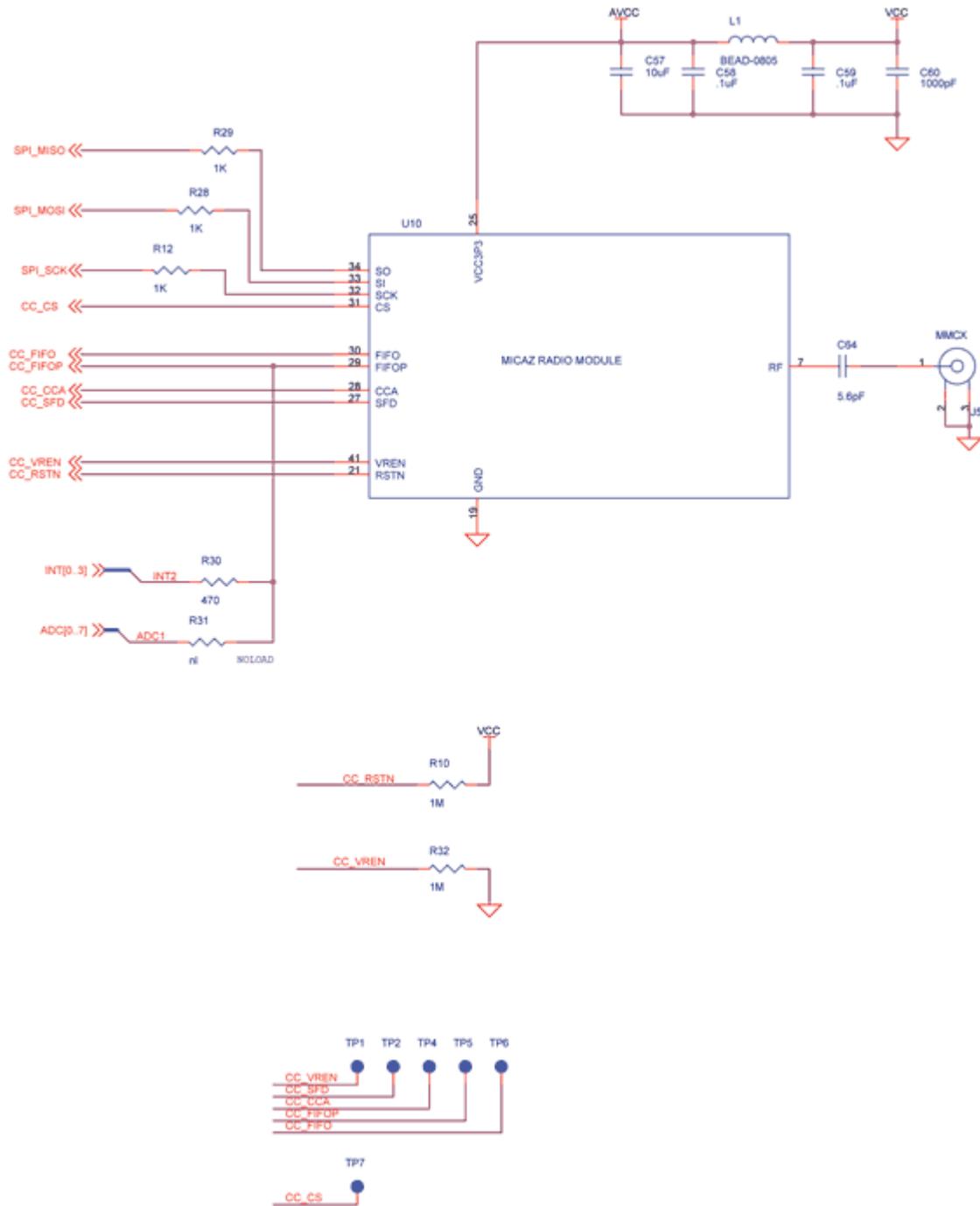


Figure 3-2. Block diagram of the MICAz and listing of Chapters that discuss the components in greater detail.

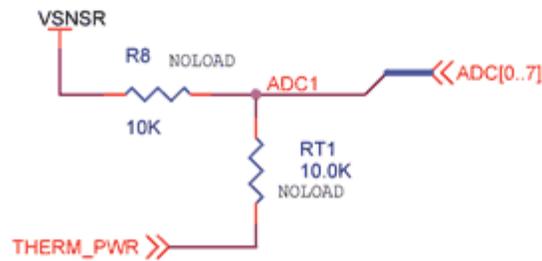
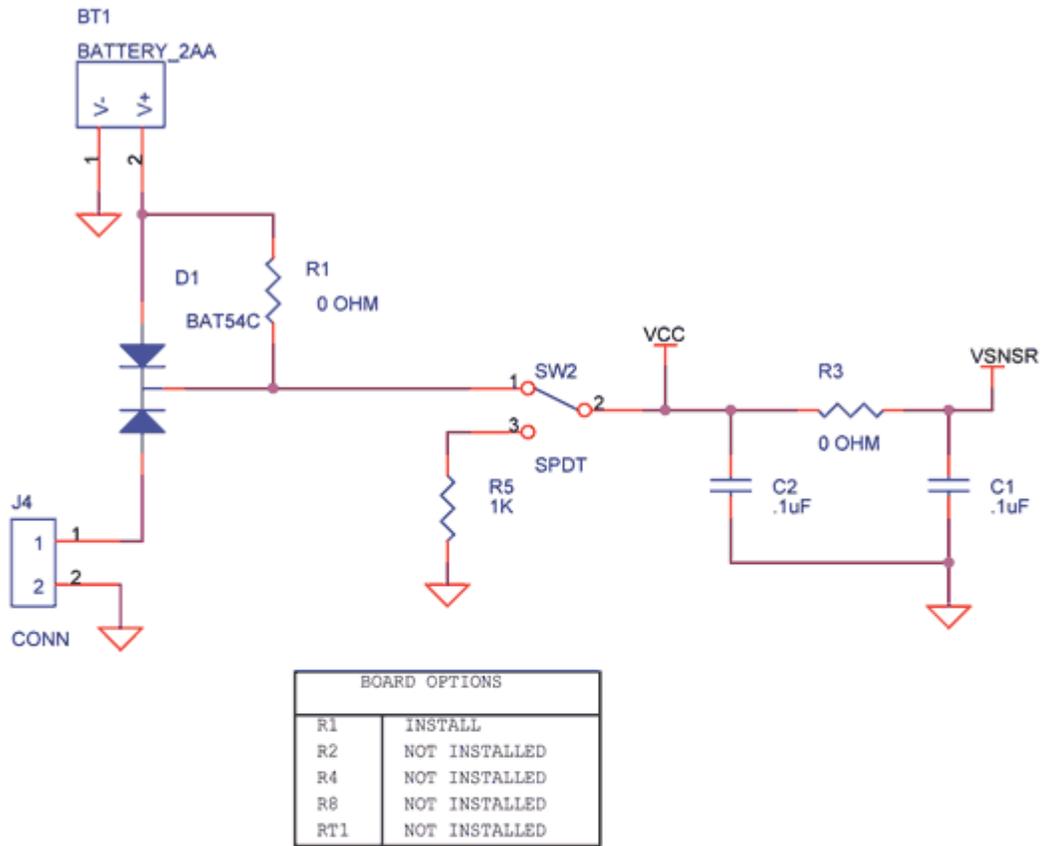
3.2.1 51-pin Expansion Connector



3.2.2 CC2420 Radio



3.2.3 Battery, ADC1



4 Power

4.1 Battery Power

All motes are designed for battery power. The IRIS and MICAz form factors are designed to match up with two AA batteries; however any battery combination (AAA, C, D, etc., cells) can be used provided that the output is between 2.7 VDC to 3.6 VDC.

Table 4-1. *Batteries for the Mote Platforms.*

Mote Hardware Platform	Standard Battery (# required)	Typical Battery Capacity (mA-hr)	Practical Operating Voltage Range (V)
IRIS	AA (2)	2000, Alkaline	3.6 to 2.7
MICAz	AA (2)	2000, Alkaline	3.6 to 2.7

Care should be used in selecting the battery and its capacity to match the energy needs of the motes and their required operating span. Also make sure that the temperature range and associated capacity degradation are looked at prior to deployment. Table 4-2 below provides some useful guidance on current consumption of various system components.

Table 4-2. *Current Requirements for the Motes under Various Operations.*

Operating Current (mA)	IRIS	MICAz
Processor, full operation	8 (7.37 MHz)	12 (7.37 MHz)
Processor, sleep	0.008	0.010
Radio, receive	16	19.7
Radio, transmit (1 mW power)	17	17
Radio, sleep	0.001	0.001
Serial flash memory, write	15	
Serial flash memory, read	4	
Serial flash memory, sleep	0.002	

Table 4-3 below provides some useful guidance on how to predict battery life. The spreadsheet can be found at www.memsic.com under the Support section.

Table 4-3. Estimate of battery life operation for a Mote.

SYSTEM SPECIFICATIONS		
Currents		Example Duty Cycle
Processor		
Current (full operation)	8 mA	1
Current sleep	8 μ A	99
Radio		
Current in receive	8 mA	0.75
Current transmit	12 mA	0.25
Current sleep	2 μ A	99
Logger Memory		
Write	15 mA	0
Read	4 mA	0
Sleep	2 μ A	100
Sensor Board		
Current (full operation)	5 mA	1
Current sleep	5 μ A	99
Computed mA-hr used each hour		
Processor		0.0879
Radio		0.0920
Logger Memory		0.0020
Sensor Board		0.0550
Total current (mA-hr) used		0.2369
Computed battery life vs. battery size		
Battery Capacity (mA-hr)		Battery Life (months)
250		1.45
1000		5.78
3000		17.35

NOTE: In most Mote applications, the processor and radio run for a brief period of time, followed by a sleep cycle. During sleep, current consumption is in the micro-amps as opposed to milli-amps. This results in very low-current draw the majority of the time, and short duration spikes while processing, receiving, and transmitting data. This method extends battery life; however, due to the current surges, it reduces specified battery capacity. Battery capacity is typically specified by the manufacturer for a constant nominal current drawn.

4.2 External Power

The MICAz can be externally powered through either:

1. The 51-pin connector will supply power and ground to the unit. Refer to connector description.
2. The 2-pin Molex connector. Molex part number 53261-0290, Digi-Key part number WM1753-ND. (See Figure 4-4 below.)

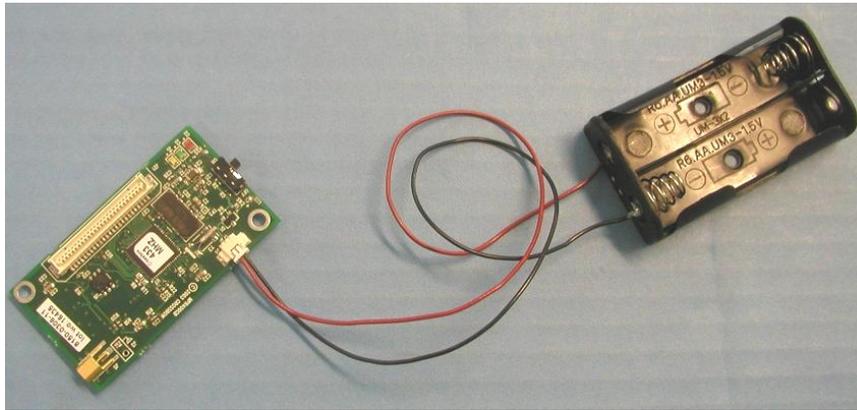


Figure 4-4. Photo of using the Molex connector to attach the AA battery pack. Photo courtesy of Nick Sitar, UC Berkeley, 2004.

4.3 MICAz Battery Voltage Monitor

The MICAz has an accurate internal voltage reference that can be used to measure battery voltage (V_{batt}). Since the eight-channel ADC on the ATmega128L uses the battery voltage as a full scale reference, the ADC full scale voltage value changes as the battery voltage changes. In order to track the battery voltage, the precision voltage reference (band gap reference) is monitored to determine the ADC full-scale (ADC_FS) voltage span which corresponds to V_{batt} .

To compute the battery voltage:

1. Program the application code to measure ADC channel 30 – the Internal Bandgap Voltage reference.
2. Compute battery voltage, V_{batt} , from ADC reading (ADC_Count) by:

$$V_{batt} = V_{ref} \times ADC_FS / ADC_Count$$

where:

V_{batt} = Battery voltage

ADC_FS = 1024

V_{ref} = Internal voltage reference = 1.223 volts

ADC_Count = Data from the ADC measurement of Internal Voltage reference

The TinyOS component *VoltageM.nc* can be wired into an application to provide this measurement capability. The reserved keyword `TOS_ADC_VOLTAGE_PORT` is mapped to ADC Channel 30 in the MICAz.

4.4 MICAz

The radio used by the MPR2600 is an IEEE 802.15.4 compliant RF transceiver designed for low-power and low-voltage wireless applications. It uses Chipcon's CC2420 radio that employs O-QPSK ("offset quadrature phase shift keying") with half sine pulse shaping. The 802.15.4 radio includes a DSSS (digital direct sequence spread spectrum) baseband modem providing a spreading gain of 9 dB and an effective data rate of 250 kbps. The radio is a highly integrated solution for wireless communication in the 2.4 GHz unlicensed ISM band. It complies with worldwide regulations covered by ETSI EN 300 328 and EN 300 440 class 2 (Europe), FCC CFR47 Part 15 (US) and ARIB STD-T66 (Japan).

4.4.1 Radio RF Channel Selection

The MPR2600's CC2420 radio can be tuned within the IEEE 802.15.4 channels that are numbered from 11 (2.405 GHz) to 26 (2.480 GHz) each separated by 5 MHz.

4.4.2 Radio Transmission Power

RF transmission power is programmable from 0 dBm (1 mW) to -25dBm. Lower transmission power can be advantageous by reducing interference and dropping radio power consumption from 17.5 mA at full power to 8.5 mA at lowest power.

Table 4-5. Chipcon® CC2420 Output Power Settings and Typical Current Consumption

RF Power (dBm)	Power Register (code)	Current Consumption (mA)
0	31	17.4
-1	27	16.5
-3	23	15.2
-5	19	13.9
-7	15	12.5
-10	11	11.2
-15	7	9.9
-25	3	8.5

IMPORTANT

For MPR2400J, the power is constant at 0dBm and any questions be directed to MEMSIC, Japan.

<http://www.xbow.com/jp>.

The RF received signal strength indication (RSSI) is read directly from the CC2420 Radio. In TinyOS the RSSI is automatically returned in the TOSMsg->strength field with every radio packet received. Typical RSSI values for a given RF input level are shown in Figure 4-1 below.

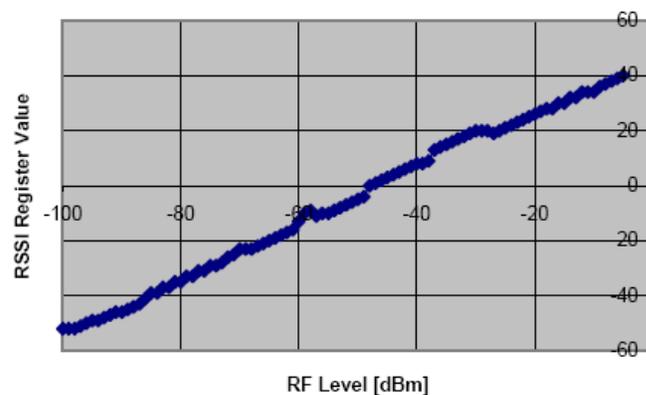


Figure 4-1. Typical RSSI value versus input RF level in dBm.

4.5 IRIS

The radio used by the IRIS is an IEEE 802.15.4 compliant RF transceiver designed for low-power and low-voltage wireless applications. It uses Atmel's AT86RF230 radio that employs O-QPSK ("offset quadrature phase shift keying") with half sine pulse shaping. The 802.15.4 radio includes a DSSS (digital direct sequence spread spectrum) baseband modem providing a spreading gain of 9 dB and an effective data rate of 250 kbps. The radio is a highly integrated solution for wireless communication in the 2.4 GHz unlicensed ISM band. It complies with worldwide regulations covered by ETSI EN 300 328 and EN 300 440 class 2 (Europe), FCC CFR47 Part 15 (US) and ARIB STD-T66 (Japan).

4.5.1 Radio RF Channel Selection

The M2110's Atmel radio can be tuned within the IEEE 802.15.4 channels that are numbered from 11 (2.405 GHz) to 26 (2.480 GHz) each separated by 5 MHz.

4.5.2 Radio Transmission Power

RF transmission power is programmable from 3 dBm to -17.2 dBm. Lower transmission power can be advantageous by reducing interference and dropping radio power consumption.

Table 4-6. Atmel® AT86RF230 Output Power Settings

RF Power (dBm)	Power Register (code)
3.0	0
2.6	1
2.1	2
1.6	3
1.1	4
0.5	5
-0.2	6
-1.2	7
-2.2	8
-3.2	9
-4.2	10
-5.2	11
-7.2	12
-9.2	13
-12.2	14
-17.2	15

The RF received signal strength indication (RSSI) is read directly from the AT86RF230 Radio and sent with every radio packet received.

5 Antennas

5.1 Radio/Antenna Considerations

Care should be taken to provide an antenna that provides proper coverage for the environment expected. Range and performance are strongly affected by choice of antenna and antenna placement within the environment. In addition, care must be taken to ensure compliance with FCC article 15 regulations for intentional radiators. Because of its small physical size, the usual antenna chosen is a length of insulated wire one-quarter wavelength long for the frequency of interest. This type of antenna is often called a *monopole* antenna, and its gain is ground plane dependent.

Antenna lengths for the different radio frequencies are provided in Table 5-1.

Table 5-1. Antenna lengths for quarter wavelength whip antennas. The part numbers for the connectorized antennas are listed.

Name	Model	Whip Antenna Length (inches)	MEMSIC Part No.
MICAz	MPR2400	1.2	8060-0011-04
IRIS	XM2110 (2400 MHz)	1.2	8060-0011-04

Antennas are also available from Linx Technologies, such as part number ANT-433-PW-QW for 433 MHz and ANT-916-PW-QW for 916 MHz. These antennas are terminated in a coax pigtail, and must have an MMCX connector installed. They also function best with a ground plane installed, as shown in Figure 5-2. The ground plane can be a layer of aluminum or copper tape attached to the lid of a plastic enclosure, or the lid of a metal enclosure.

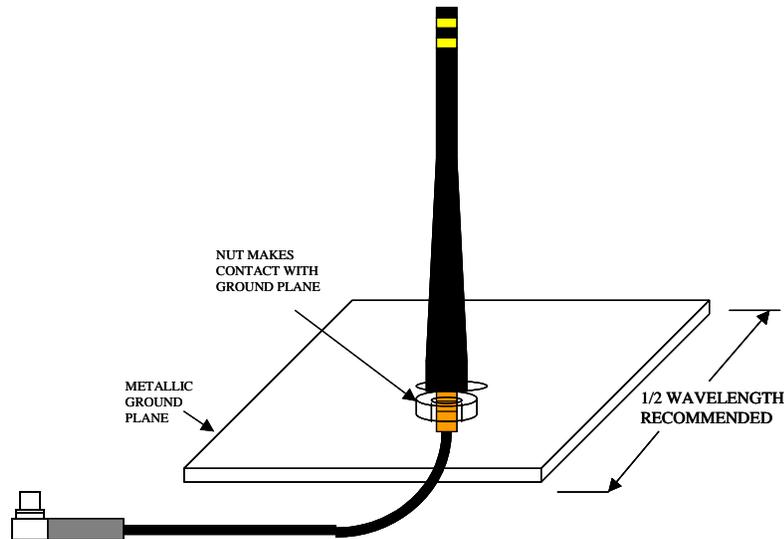


Figure 5-2. Illustration of an antenna option for the motes using a Linx antenna and ground plane.

5.2 Connectors for the IRIS Whip Antennas

The IRIS has an MMCX connector for attaching an external antenna. These mating connectors can be purchased from Digi-Key. There are two manufacturers—Johnson Components and Hirose Electric Ltd. The mating

connectors come in straight and right angle. They also support two different standard varieties of Coaxial cable—RG178 /U and RG 316/U. There are also other vendors who sell MMCX to SMA conversion cables.

Table 5-3. Johnson Components' MMCX mating connectors*

Type	Coax	Digi-Key PN	Johnson PN
Straight Plug	RG178/U	J589-ND	135-3402-001
Straight Plug	RG316/U	J590-ND	135-3403-001
Right Angle	RG178/U	J593-ND	135-3402-101
Right Angle	RG316/U	J594-ND	135-3403-101
Right Angle	RG 316 DS	J595-ND	135-3404-101

*These connectors require the following hand crimp and die set (Digi-Key part # / Johnson part #): a) Hand crimp (J572-ND / 140-0000-952), b) Die (JD604-ND / 140-0000-953).

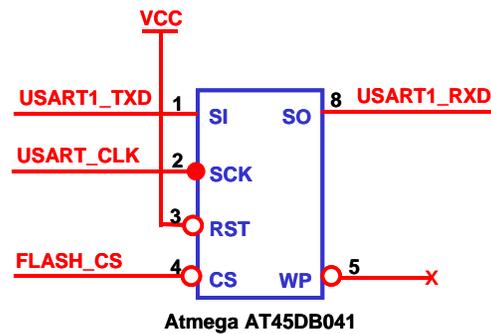
Table 5-4. Hirose MMCX connectors.

Type	Coax	Digi-Key PN	Hirose PN
Straight Plug	RG178/U	H3224-ND	MMCX-J-178B/U
Right Angle	RG178/U	H3221-ND	MMCX-LP-178B/U
Right Angle	RG316/U	H3222-ND	MMCX-LP-316/U

6 Flash Data Logger and Serial ID Chip

All Motes feature a 4-Mbit serial flash (Atmel AT45DB041) for storing data, measurements, and other user-defined information. It is connected to one of the USART on the ATmega128L/1281. This chip is supported in TinyOS which uses this chip as micro file system. The serial flash device supports over 100,000 measurement readings. This chip is also used for over-the-air reprogramming services available in TinyOS.

◀ **NOTE:** This device consumes 15 mA of current when writing data.



7 Fuses

7.1 ATmega128L Fuses

The ATmega128L processor on the MICAz Motes has many programmable fuses to control various parameters. Refer to Atmel's technical information for the ATmega128L for a complete discussion of the fuses. There are few fuses that users should be aware of as setting these fuses incorrectly will cause the unit to not operate correctly.

7.1.1 JTAG fuse

This fuse enables users to use the Atmel JTAG pod for in-circuit code debugging. Units are shipped with JTAG enabled. As discussed in the previous section on battery voltage monitoring, if JTAG is enabled, it will cause inaccurate measurements on ADC channel 7.

7.1.2 Using UISP to set fuses

The UISP utility used to download code to the MICAz on a programming board can also be used to set and unset fuses of the Atmel[®] ATmega128.

Table 7-1. UISP Commands for Setting the ATmega128's Fuses.

Action	Command
Disable JTAG fuse	<code>uisp -dprog=<programmer> --wr_fuse_h=0xD9</code>
Enable JTAG fuse	<code>uisp -dprog=<programmer> --wr_fuse_h=0x19</code>
Enable native 128 mode	<code>uisp -dprog=<programmer> --wr_fuse_e=ff</code>
Use internal clock	<code>uisp -dprog=<programmer> --wr_fuse_l=0xc4</code>
Use external clock	<code>uisp -dprog=<programmer> --wr_fuse_l=0xff</code>

<programmer> is the device you are using to interface to the Mote from a computer. The current option is **EPRB** for a MIB600.

Users can also edit the file called *profile* in the *cygwin/etc/* directory and enter an alias. One example is this alias to disable the JTAG fuse:

```
alias fuse_dis="uisp -dprog=<programmer> --wr_fuse_h=0xD9"
```

Therefore, when `fuse_dis` and is entered into a Cygwin command line, the script will be executed.

7.2 ATmega1281 Fuses

The ATmega1281V processor on the IRIS has many programmable fuses to control various parameters. Refer to Atmel's technical information for the ATmega1281V for a complete discussion of the fuses. There are few fuses that *MoteWorks* users should be aware of as setting these fuses incorrectly will cause the unit to not operate correctly.

7.2.1 JTAG fuse

This fuse enables users to use the Atmel JTAG pod for in-circuit code debugging. Units are shipped with JTAG enabled. As discussed in the previous section on battery voltage monitoring, if JTAG is enabled, it will cause inaccurate measurements on ADC channel 7.

7.2.2 Using UISP to set fuses

The UISP utility used to download code to the OEM edition modules via a programming board can also be used to set and unset fuses of the Atmel® ATmega1281.

Table 7-2. UISP Commands for Setting the ATmega1281's Fuses

Action	Command
Disable JTAG fuse	<code>uisp -dprog=<programmer> --wr_fuse_h=0xd9</code>
Enable JTAG fuse	<code>uisp -dprog=<programmer> --wr_fuse_h=0x19</code>
Enable native 128 mode	<code>uisp -dprog=<programmer> --wr_fuse_e=0xff</code>
Use internal clock	<code>uisp -dprog=<programmer> --wr_fuse_l=0xc2</code>
Use external clock	<code>uisp -dprog=<programmer> --wr_fuse_l=0xff</code>

<programmer> is the device you are using to interface to the Mote from a computer. The current option is **EPRB** for a MIB600.

Users can also edit the file called *profile* in the *cygwin/etc/* directory and enter an alias. One example is this alias to disable the JTAG fuse:

```
alias fuse_dis="uisp -dprog=<programmer> --wr_fuse_h=0xd9"
```

Therefore, when `fuse_dis` and is entered into a Cygwin command line, the script will be executed.

8 Sensor Boards & Expansion Connectors

MEMSIC supplies a variety of sensor and data acquisition boards for the Motes. This Chapter describes the connectors and the functions of the pins for the IRIS and MICAz.

Information for customized sensor board design is available on the MEMSIC web site.

8.1 Sensor Board Compatibility

Table 8-1. *Sensor board compatibility.*

Mote Platform	Mote Interface Connector	Hardware Compatibility with:	Section
MICA2	Use 51 pin connector	MICAz sensor boards	11.2
MICAz/IRIS	Use 51 pin connector	MICAz sensor boards	11.2

8.2 IRIS and MICAz Expansion Connector

Connection to the IRIS, MICAz and MICA2 Motes is by a 51-pin connector (see Table 8-1 below).

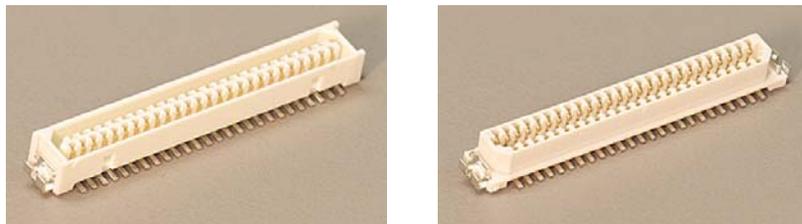


Figure 8-1. *Hirose DF-51P-1V(54)—Digi-Key part no. H2175-ND—on left is used on the MICAz, and MICA Motes boards. The Hirose DF9-51S-1V(54)—Digi-Key part no. H2163-ND—on right is the corresponding connector used on the MIB Interface Boards and Stargate Gateways.*

The expansion connector provides a user interface for sensor boards and base stations. The connector includes interfaces for power and ground, power control of peripheral sensors, ADC inputs for reading sensor outputs, UART interfaces, and I2C interface, general-purpose digital IO, and others.

8.2.1 IRIS and MICAz Sensor Interface.

Table 8-2. IRIS/MICAz Sensor Interface.

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	27 [†]	UART_RXDO	UART_0 Receive
2	VSNR	Sensor Supply	28 [†]	UART_TXDO	UART_0 Transmit
3	INT3	GPIO	29	PW0	GPIO/PWM
4	INT2	GPIO	30	PW1	GPIO/PWM
5	INT1	GPIO	31	PW2	GPIO/PWM
6	INT0	GPIO	32	PW3	GPIO/PWM
7 ^{††}	CC_CCA	Radio Signal	33	PW4	GPIO/PWM
8 [†]	LED3	Green LED	34	PW5	GPIO/PWM
9 [†]	LED2	Yellow LED	35	PW6	GPIO/PWM
10 [†]	LED1	Red LED	36 [†]	ADC7	ADC CH7, JTAG TDI
11	RD	GPIO	37 [†]	ADC6	ADC CH6, JTAG TDO
12	WR	GPIO	38 [†]	ADC5	ADC CH5, JTAG
13	ALE	GPIO	39 [†]	ADC4	ADC CH4, JTAG
14	PW7	GPIO	40	ADC3	GPIO/ADC CH3
15	USART1_CLK	USART1 Clock	41	ADC2	GPIO/ADC CH2
16 ^{††}	PROG_MOSI	Serial Program MOSI	42	ADC1	GPIO/ADC CH1
17 ^{††}	PROG_MISO	Serial Program MISO	43	ADC0	GPIO/ADC CH0
18 ^{††}	SPI_CLK	SPI Serial Clock	44	THERM_PWR	Temp Sensor Enable
19	USART1_RXD	USART1 Receive	45	THRU1	Thru Connect 1
20	USART1_TXD	USART1 Transmit	46	THRU2	Thru Connect 2
21	I2C_CLK	I2C Bus Clock	47	THRU3	Thru Connect 3
22	I2C_DATA	I2C Bus Data	48 ^{††}	RSTN	Reset (Neg.)
23	PWM0	GPIO/PWM0	49	PWM1B	GPIO/PWM1B
24	PWM1A	GPIO/PWM1A	50	VCC	Digital Supply
25	AC+	GPIO/AC+	51	GND	Ground
26	AC-	GPIO/AC-			

(†OK to use but has shared functionality. ††Do not use)

9.3 MIB520 Use

9.3.1 Install FTDI USB Virtual COM Port Drivers

MIB520 uses FTDI FT2232C to use USB port as virtual COM port. Hence you need to install FT2232C VCP drivers.

- When you plug a MIB520 into your PC for the first time, the Windows detects and reports it as a new hardware. Please select “Install from a list or specific location (Advanced)” and browse to “MIB520 Drivers” folder of the WSN Kit CDROM. Install shield wizard will guide you through the installation process.
- When the drivers are installed, you will see two serial ports added under the Control Panel → System → Hardware → Device Manager → Port. Make a note of the assigned COM port numbers.
- The two virtual serial ports for MIB520 are com_n and $com_{(n+1)}$; com_n is for Mote programming and $com_{(n+1)}$ is for Mote communication.

9.4 Reset

The “RESET” push button switch resets both the ISP and Mote processors. It also resets the monitoring software which runs on the host PC.

9.5 JTAG

The MIB520 has a connector, J3 which connects to an Atmel JTAG pod for in-circuit debugging. This connector will supply power to the JTAG pod; no external power supply is required for the pod.

⚠ **WARNING:** The MIB520 also has JTAG and ISP connectors for the ISP processor. These are for factory use only.

9.6 Power

The MIB520 is powered by the USB bus of the host.

⚠ **WARNING:** When programming an IRIS/MICAz/ MICA2 with the MIB520, turn off the battery switch.

9.7 USB Interface

The MIB520 offers two separate ports: one dedicated to in-system Mote programming and a second for data communication over USB.

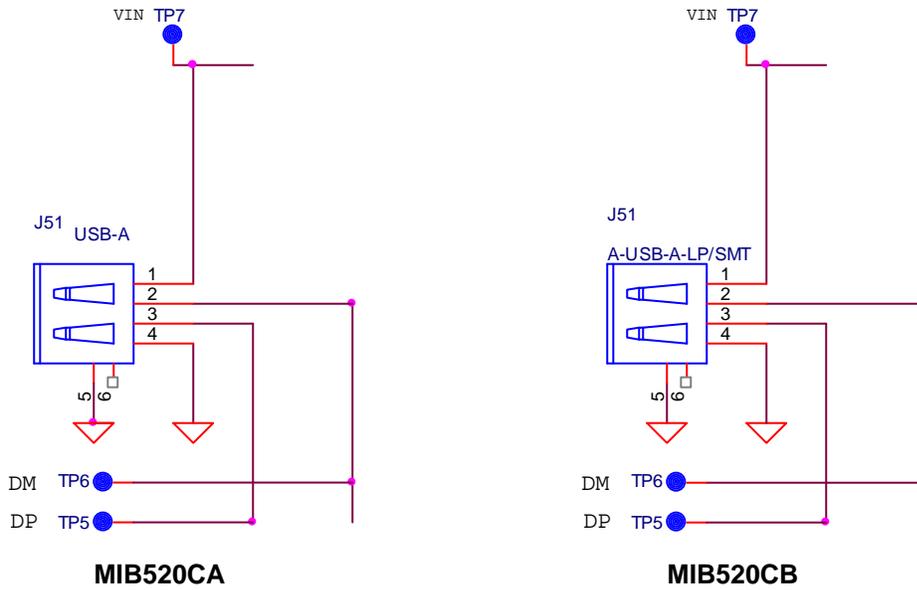
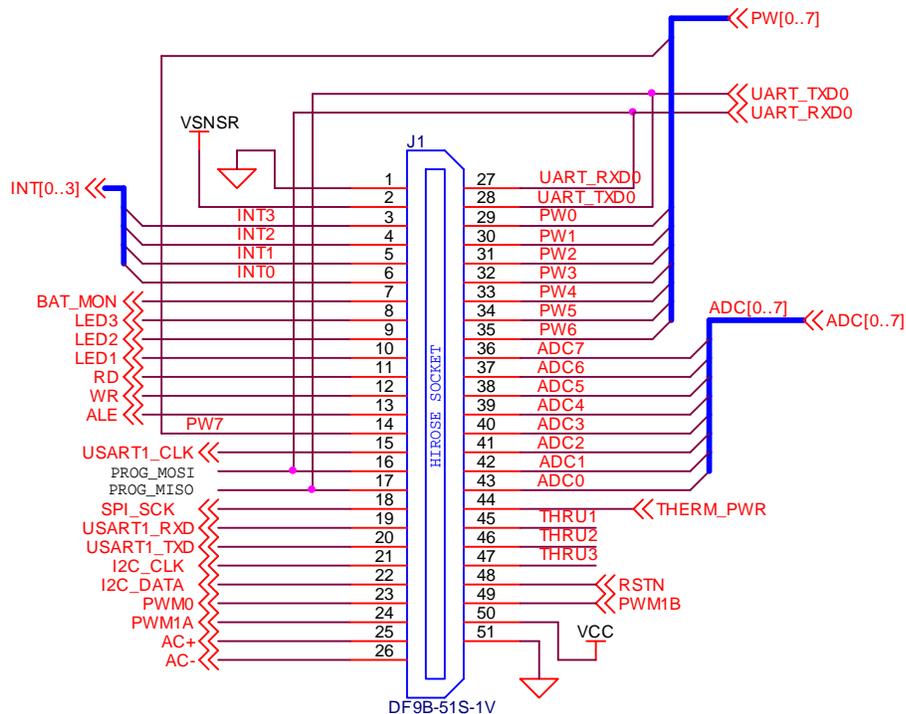


Table 9-3. Pin Outs for a USB Connection

Pin No.	Name	Description
1	VBUS	Powered Supply Pin
2	USBDM	USB Data Signal Minus
3	USBDP	USB Data Signal Plus
4	GND	Ground Supply Pin

9.8 51-Pin Mote Connector Interface



PIN	NAME	DESCRIPTION
1	GND	GROUND
2	VNSNR	SENSOR SUPPLY
3	INT3	GPIO
4	INT2	GPIO
5	INT1	GPIO
6	INT0	GPIO
7	BAT_MON	BATTERY VOLTAGE MONITOR ENABLE
8	LED3	LED3
9	LED2	LED2
10	LED1	LED1
11	RD	GPIO
12	WR	GPIO
13	ALE	GPIO
14	PW7	POWER CONTROL 7
15	USART1_CLK	USART1 CLOCK
16	PROG_MOSI	SERIAL PROGRAM MOSI
17	PROG_MISO	SERIAL PROGRAM MISO
18	SPI_SCK	SPI SERIAL CLOCK
19	USART1_RXD	USART1 RX DATA
20	USART1_TXD	USART1 TX DATA
21	I2C_CLK	I2C BUS CLOCK
22	I2C_DATA	I2C BUS DATA
23	PWM0	GPIO/PWM0
24	PWM1A	GPIO/PWM1A
25	AC+	GPIO/AC+
26	AC-	GPIO/AC-

PIN	NAME	DESCRIPTION
27	UART_RXD0	UART_0 RECEIVE
28	UART_TXD0	UART_0 TRANSMIT
29	PW0	POWER CONTROL 0
30	PW1	POWER CONTROL 1
31	PW2	POWER CONTROL 2
32	PW3	POWER CONTROL 3
33	PW4	POWER CONTROL 4
34	PW5	POWER CONTROL 5
35	PW6	POWER CONTROL 6
36	ADC7	ADC INPUT 7 - BATTERY MONITOR/JTAG TDI
37	ADC6	ADC INPUT 6 / JTAG TDO
38	ADC5	ADC INPUT 5 / JTAG TMS
39	ADC4	ADC INPUT 4 / JTAG TCK
40	ADC3	ADC INPUT 3
41	ADC2	ADC INPUT 2
42	ADC1	ADC INPUT 1
43	ADC0	ADC INPUT 0 / RSSI MONITOR
44	THERM_PWR	TEMP SENSOR ENABLE
45	THRU1	THRU CONNECT 1
46	THRU2	THRU CONNECT 2
47	THRU3	THRU CONNECT3
48	RSTN	RESET (NEG)
49	PWM1B	GPIO/PWM1B
50	VCC	DIGITAL SUPPLY
51	GND	GROUND

10 MIB600 Ethernet Interface Board

10.1 Introduction

The MIB600 provides Ethernet (10/100 Base-T) connectivity to IRIS and MICA family Motes for communication and in-system programming. Its two standard configurations are (a) an Ethernet Gateway for a Mote network and (b) a Mote network programming and out-band diagnostic channel.

The MIB600CA device contains, on a 4.5" × 2.25" platform a

- ❑ MICA2 mote 54-pin connector (J1),
- ❑ Mote target JTAG port (J12),
- ❑ TCP/IP serial server,
- ❑ In-system programmer compatible with UISP STK500,
- ❑ On-board power regulation and monitor, and a
- ❑ Power Over Ethernet (POE) power supply

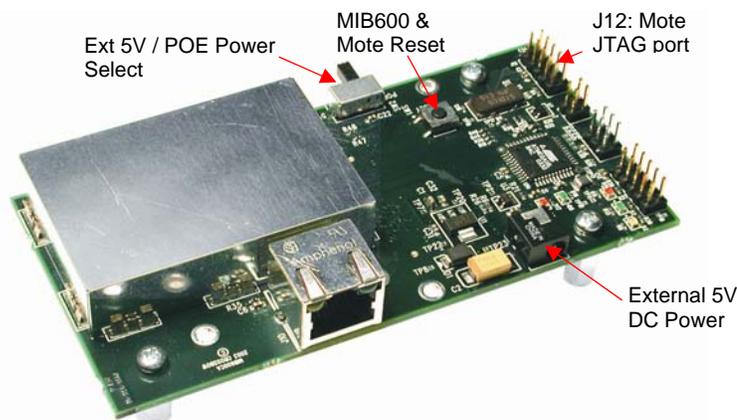


Figure 10-1. Photo of top side of an MIB600CA.

10.1.1 Mote Network – Ethernet Gateway

An IRIS, MICAz or MICA2 Mote running *TOSBase* or *XMeshBase* is permanently installed on the MIB600. This forms a Mote RF to Ethernet bridge.

10.1.2 Mote Network Programming and Out-Band Diagnostic Channel

The IRIS, MICAz and MICA2 Motes connect to the MIB600 for UISP programming from LAN connected host computers. Out band (non-RF) diagnostics can be forwarded from the Mote via its UART port over the LAN to host monitor/control computers.

10.2 Setup / Installation

This section describes MIB600 installation and configuration for use in a TinyOS environment.

10.2.1 Physical

For other than temporary installations, the MIB600 should be installed in a ground isolated enclosure.

10.2.2 Mote Connection

The IRIS and MICAz Motes connect to the MIB600 directly via the standard mote 51-pin HIROSE connector at J1. Two mounting holes are provided for securing the Motes when installed at J1. It is recommended that these mounting points be used for longer term installations to ensure a reliable mechanical and electrical connection to the MIB600.

10.2.3 Power

Two power supply sources are available with the MIB600

- External 5VDC from AC wall-power adaptor
- Power Over Ethernet

External 5VDC Power Supply

- Connect the external 5VDC power supply to an AC 110-240V power source.
- Place the MIB600 SW2 in the POE position
- Connect the DC plug to J7 of the MIB600

◀ **NOTE:** Turn-on the MIB by placing the SW2 in the 5V position. Turn-off by placing the SW2 in the POE position.

Power Over Ethernet / IEEE802.3af (POE).

⚠ **WARNING!** The Mote “ground” is at POE potential (-48 V). Do not connect MIB600 to facility/building ground when using POE.

An IEEE 802.3af compliant power supply is provided for POE equipped facilities. Ethernet appliance power (-48 V) is supplied at pins 4/5 and 7/8 of the 10/100 Base-T RJ45 plug. Refer to Appendix A for Base-T wiring information.

The MIB600 POE circuit contains IEEE 802.13f compliant power sequencing and classification circuitry. Reversed and over-voltage protection is provided.

◀ **NOTE:** The MIB600 only supports POE over the “spare wires” 4/5 and 7/8. It does not support POE shared on the Base-T signaling lines.

- Connect the MIB600 to a POE-equipped LAN port.
- Turn-On the MIB600 by placing the MIB600 SW2 in the POE position
- Turn-Off by placing SW2 in 5V position (with External 5VDC supply disconnected)

10.2.4 MIB600-LAN Connection

The MIB600 Serial Server connects directly to a 10 Base-T LAN as any other network device. Straight cables are used to connect to a hub or switch. If your connection is an MIB600 to PC you **must** use a crossed cable. Refer to Appendix A for LAN wiring information.

Table 10-2. Pin Outs for a LAN Connection

Pin No.	Strand Color	Name
1	White and orange	TX+
2	Orange	TX-
3	White and green	RX+
4	Blue	0V POE
5	White and blue	0V POE
6	Green	RX-
7	Brown and white	-48V POE
8	Brown	-48V POE

10.3 MIB600 Use

10.3.1 Controls and Indicators

Power. MIB600 power (and power to attached mote) is controlled by the switch labeled “SW2.”

***WARNING!** Always turn-off the MIB600's power before installing/removing a mote.

Table 10-3. SW2 Switch Settings.

Position	Function
5V	External 5V DC power supply selected
POE	<u>P</u> ower <u>O</u> ver <u>E</u> thernet supply selected

When valid power is detected, the green LED at D5 is ON.

LAN Activity Indicators (RJ45). Green indicates a network connection is present. Yellow indicates Active ISP serial port traffic is present.

RESET. Pressing the RESET pushbutton (SW1) causes the MIB600 and any installed/attached MOTE to reset. Note the Serial Server is NOT reset.

Serial Server RESET. Pressing the S1 switch on the server sub-module (U15) manually resets the Ethernet serial server.

NOTE The MIB600 and attached Mote are not reset. The serial server can also be reset via Telnet at Port 9999.

ISP LED. During in-system programming of a Mote the ISP LED (D3) is ON.

Mote LEDs. Three LEDs (red, green, yellow) correspond to the attached Mote's indicators.

10.3.2 Mote UART (Serial Port)

The Mote's serial port can be accessed via Telnet using Port# 10002.

Factory default serial rate on the Serial Server is 57.6 kbaud for compatibility with the standard *TOSBase* and *XMeshBase*.

If other baud rates or communication parameters are used in your Mote application, the serial server configuration must be changed.

10.3.3 In-System Programming

The MIB600 ISP micro-controller is attached to Port#10002. UISP assumes this port assignment by default. Programming using MIB600 requires assigning an IP address to the device first followed by commands via Cygwin. Instructions can be found in MEMSIC's Getting Started Guide.

10.4 JTAG

JTAG connection to the attached IRIS/MICAz Mote is via J12. Note PIN1 orientation (square pad) is indicated by the J12 legend. Power for the JTAG pod is provided by the MIB600 at J12 pin 4. Please use the tables in this section as references when using the JTAG connection. Table 10-4 has information about the controls, indicators, and connector summary;

Table 10-5 has information on the JT12 Mote JTAG pins.

Table 10-4. Controls, Indicators, and Connector Summary.

ID	NAME	DESCRIPTION
CONTROLS		
SW1	RESET	MIB600 Manual RESET pushbutton. Resets MIB600 ISP controller and attached MOTE.
SW2	POWER SELECT	
	5V	Selects External 5VDC power source at J7
	POE	Selects Power Over Ethernet provided at RJ45/J10
	Serial Server Reset	Reset Serial Server. Located on Server sub module U15
CONNECTORS		
J1	MOTE I/O 51	Standard 51 Position MICAx-series Mote interface
J7	External 5VDC Input	Connects to external 5VDC +/-20% power supply
J9	JTAG-ISP	JTAG connection to MIB600 ISP Controller. For Factory Test only
J10	RJ45 / LAN	Ethernet 10Base-T connection (w/ IEEE 802.3af option)
J11	MOTE Umbilical	Umbilical connection to Mote Adapter PCB. Used for connection to MICA2 and MICA2DOT motes.
J12	JTAG-MOTE	JTAG connection to attached MICA2/MICA2DOT Mote. Provides JTAG connectivity between external JTAG pod and Mote.
	COM1	Factory use only. Do not use
INDICATORS		
D2	MOTE-YELLOW	Corresponds to attached Mote's Yellow LED
D4	MOTE-RED	Corresponds to attached Mote's Red LED
D7	MOTE-GREEN	Corresponds to attached Mote's Green LED
D3	ISP Active	Indicates MIB600 in PROGRAMMING mode – RED
D5	Power OK	Indicated MIB600 input power is OK

Table 10-5. J12 Mote JTAG

PIN	NAME	DESCRIPTION
1	TCK/ADC4	Mote JTAG Clock
2	GND	Ground
3	TDO	Mote JTAG Data Out
4	VCC	3.3V Power
5	TMS	Mote JTAG Sync
6	RSTN	Mote Reset
7	VCC	3.3V Power to JTAG Pod
8	N/C	Not connected
9	TDI	Mote JTAG Data In
10	GND	Ground

11 Appendix A: 10/100 Base-T Cabling Standards

Category 5(e) (UTP) color coding table

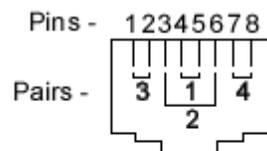
TIA/EIA 568A Wiring

1		White and Green
2		Green
3		White and Orange
4		Blue
5		White and Blue
6		Orange
7		White and Brown
8		Brown

TIA/EIA 568B Wiring

1		White and Orange
2		Orange
3		White and Green
4		Blue
5		White and Blue
6		Green
7		White and Brown
8		Brown

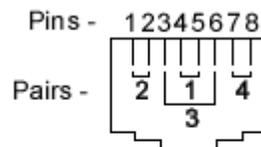
EIA/TIA 568A



Pin Colours

1	White and Green
2	Green
3	White and Orange
4	Blue
5	White and Blue
6	Orange
7	White and Brown
8	Brown

EIA/TIA 568B



Pin Colours

1	White and Orange
2	Orange
3	White and Green
4	Blue
5	White and Blue
6	Green
7	White and Brown
8	Brown

12 Appendix B. Warranty and Support Information

12.1 Customer Service

As a MEMSIC customer you have access to product support services, which include:

- Single-point return service
- Web-based support service
- Same day troubleshooting assistance
- Worldwide MEMSIC representation
- Onsite and factory training available
- Preventative maintenance and repair programs
- Installation assistance available

12.2 Contact Directory

United States:	Phone:	1-408-964-9700 (8 AM to 5 PM PST)
	Fax:	1-408-854-7702 (24 hours)
	Email:	techsupportca@memsic.com
Non-U.S.:	refer to website	www.memsic.com

12.3 Return Procedure

12.3.1 Authorization

Before returning any equipment, please contact MEMSIC to obtain a Returned Material Authorization number (RMA).

Be ready to provide the following information when requesting a RMA:

- Name
- Address
- Telephone, Fax, Email
- Equipment Model Number
- Equipment Serial Number
- Installation Date
- Failure Date
- Fault Description

12.3.2 Identification and Protection

If the equipment is to be shipped to MEMSIC for service or repair, please attach a tag **TO THE EQUIPMENT**, as well as the shipping container(s), identifying the owner. Also indicate the service or repair required, the problems encountered and other information considered valuable to the service facility such as the list of information provided to request the RMA number.

Place the equipment in the original shipping container(s), making sure there is adequate packing around all sides of the equipment. If the original shipping containers were discarded, use heavy boxes with adequate padding and protection.

12.3.3 Sealing the Container

Seal the shipping container(s) with heavy tape or metal bands strong enough to handle the weight of the equipment and the container.

12.3.4 Marking

Please write the words, "**FRAGILE, DELICATE INSTRUMENT**" in several places on the outside of the shipping container(s). In all correspondence, please refer to the equipment by the model number, the serial number, and the RMA number.

12.3.5 Return Shipping Address

Use the following address for all returned products:

MEMSIC, Inc.
1759 McCarthy Blvd.
Milpitas, CA 95035
Attn: RMA Number (XXXXXX)

12.4 Warranty

The MEMSIC product warranty is one year from date of shipment.



1759 McCarthy Blvd.

Milpitas, CA 95035

Phone: 408.964.9700

Fax: 408.854.7702

Website: www.memsic.com

Email: info@memsic.com