1191 Northland Drive
Mendota Heights, MN 55120 Suite 100
FRN: 0017129644
Grantee Code: VUR

Modular Sensor Radio
Design in Specification Manual - Preliminary

The purpose of this document is to provide all the information that a hardware engineer might need to design a PCB that incorporates the Modular Sensor Radio (MSR) product. The document includes both mechanical and electrical specifications.

FCC Statements:

Caution Statement:

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Compliance Statement:

Healthsense, Inc.
1191 Northland Drive, Suite 100
Mendota Heights, MN 55120
Phone: 800-576-1779 / FAX: 800-952-1329
EUT: Modular Sensor Radio
FCC ID: VUR100057

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: 1) This device may not cause harmful interference, and, 2) This device must accept any interference received including interference that may cause undesired operation.

Class B Product Compliance Statement:
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 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 instruction, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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Radio Overview

The Healthsense Modular Sensor Radio (MSR) is designed around the G2 Microsystems G2C543/547 series of Wi-Fi systems on chip. These devices contain identical RF and microcontroller silicon, with the 547 having additional 125 kHz and 900 MHz receivers. These options are not currently implemented in the Healthsense product, meaning the 543 and 547 can be used interchangeably.

In order to minimize current consumption, the MSR contains additional intelligence in an ultra low power Atmel AT-Tiny 861 microcontroller. This device draws significantly less power in a standby state than the G2 chip, and is utilized to wake up the G2 when a Wi-Fi transmission is required. The AT-Tiny handles button pushes, connector insertions, and all basic I/O on the MSR. It is the G2's gatekeeper.

Programming of the MSR happens in two steps. First, the G2 chip must be loaded with firmware, via either the G2 debug port or over-the-air (OTA) upgrade. This firmware includes the entire AT-Tiny load. The G2 then programs the AT-tiny over the SPI bus. For communication protocols and detailed programming specifications, contact Healthsense.

Electrical connection to the MSR is provided by castellation style SMT pads on the bottom of the circuit board. Mechanical specifications and land patterns are included at the end of this document.

The naming convention for castellations is specific to Healthsense applications and is given only for ease of reference to Healthsense schematics. The connections to the MSR are shown and listed in Figure 1 and Table 1.

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Castellation Pad Descriptions

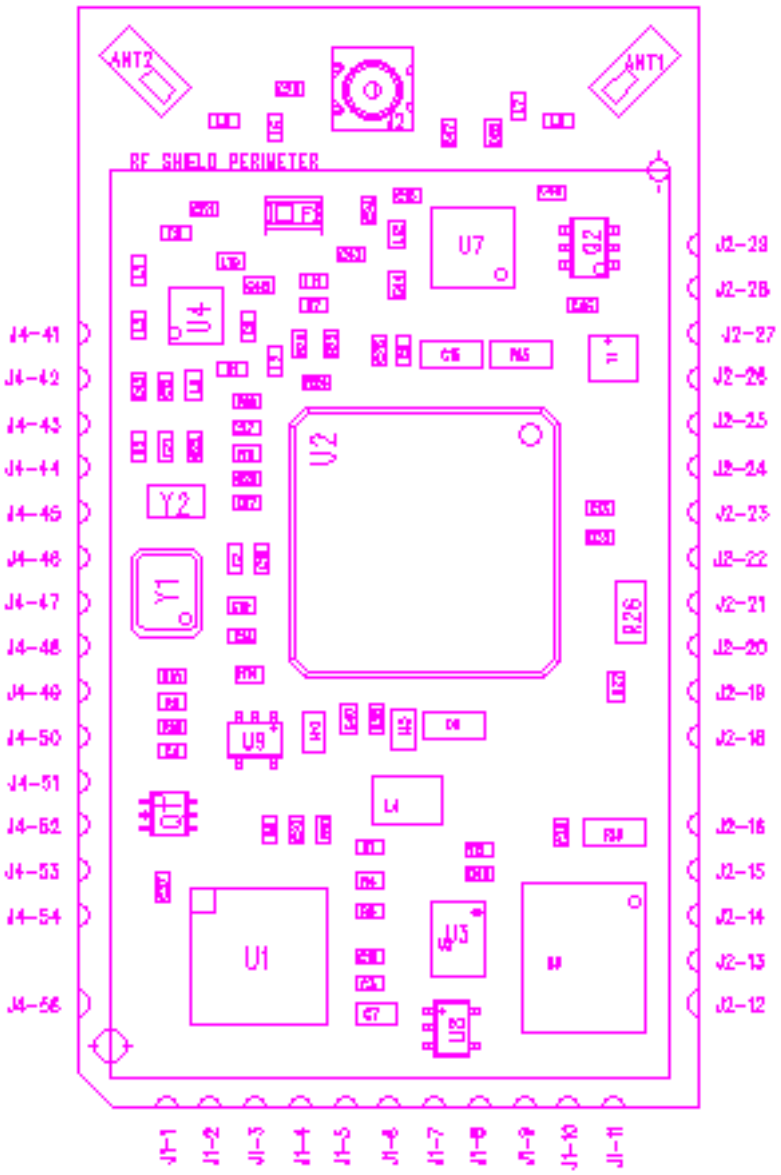

Figure 1. MSR Placement diagram showing pad numbering.

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Pad	Name	Integrated Circuit Pin	Function
1	GND		POWER
2	VBAT		POWER
3	WAKE	AT-TINY PIN 8 (PB5)	TINY I/O
4	ADC1	AT-TINY PIN 17 (PA4)	TINY I/O ADC
5	LIN1	AT-TINY PIN 13 (PA7)	TINY I/O
6	LIN2	AT-TINY PIN 14 (PA5)	TINY I/O
7		AT-TINY PIN 7 (PB4)	TINY I/O
8	LOUT_2	AT-TINY PIN 2 (PA2)	TINY I/O ADC
9	TXD	G2 PIN 65 (GPIO[0])	DATA G2 COMM
10	RXD	G2 PIN 63 (GPIO[1])	DATA G2 COMM
11	GND		
12	!PB	G2 PIN 2 (SENSOR IF1)	G2 I/O
13	LED	AT-TINY PIN 26 (PA0)	TINY I/O ADC
14	BUZZ	AT-TINY PIN 14 (PB3)	TINY I/O
15	BT_EN	G2 PIN 61 (GPIO[3])	G2 I/O
16	BT	AT-TINY PIN 15 (PA5)	TINY I/O ADC
17	SKIPPED		
18	SS1	G2 PIN 62 (GPIO[2])	G2 I/O
19	SPI_CLK	G2 PIN 48 (SPI_SCLK)	DATA SPI
20	SPI_MO	G2 PIN 47 (SPI_MOSI)	DATA SPI
21	SPI_MI	G2 PIN 50 (SPI_MISO)	DATA SPI
22	GND		POWER
23	VBAT		POWER
24	SD_D1	G2 PIN 57 (SD_D1)	DATA G2 SDIO
25	SD_D0	G2 PIN 58 (SD_D0)	DATA G2 SDIO
26	SD_CMD	G2 PIN 59 (SD_CMD)	DATA G2 SDIO
27	SD_D2	G2 PIN 56 (SD_D2)	DATA G2 SDIO
28	SD_D3	G2 PIN 55 (SD_D3)	DATA G2 SDIO
29	SD_CLK	G2 PIN 54 (SD_CLK)	DATA G2 SDIO
30~40	SKIPPED		
41		G2 PIN21 (RFID_ANT_A)	G2 RFID INTERFACE
42		G2 PIN 22 (RFID_ANT_B)	G2 RFID INTERFACE
43		AT-TINY PIN 31 (PB1)	TINY I/O MISO
44		AT-TINY PIN 30 (PB0)	TINY I/O MOSI
45	VDD_A0	G2 PIN 24 (VDD_AO)	POWER
46	GND		POWER
47		AT-TINY PIN 32 (PB2)	TINY I/O SPI_CLK
48	!RESET	AT-TINY PIN 11 (PB7)	TINY I/O RESET
49	PWRONRST_L	G2 PIN 19 (PWRONRST_L)	G2 RESET
50	FORCE_AWAKE	G2 PIN 31	G2 WAKE
51	DEBUG_TX	G2 PIN 52 (CPU_DEBUG_TX)	DATA G2 DEBUG
52	DEBUG_RX	G2 PIN 53 (CPU_DEBUG_RX)	DATA G2 DEBUG
53	TXD	G2 PIN 65 (GPIO[0])	DATA G2 COMM
54	RXD	G2 PIN 63 (GPIO[1])	DATA G2 COMM
55	SKIPPED		
56	3V3_SW	G2 PIN 43 (VDD_FLASH)	POWER

Table 1. Complete MSR Connections List.

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Detailed Connection Description

1) POWER CONNECTIONS

GND Pads 1, 11, 22, 46

VBAT Pads 2, 23

These pins provide the power to the MSR. The power requirements are as follows:

V max:	3.6V
V min:	2.8V
I max:	500mA

3V3_SW Pad 56

This pin provides power to the MSR Flash memory. In order to conserve energy, the G2 controls this line. This pin is not controllable by the user, but is available for monitoring purposes.

V max:	Vcc
I max:	100mA

VDD_AO Pad 45

This pin provides a regulated 1.3V output from the G2. This output used for the G2 always_on domain and sensor interface. It is not controllable by the user, but is available for monitoring and logic level shifting.

V max:	1.3 V
I max:	10mA

2) DATA CONNECTIONS

TXD Pads 9,53

RXD Pads 10,54

These pads are for the G2 general purpose UART.

V max: 3.6V
V min: 0V
Baud Rate: 115,200 Max
8 bits, 1 stop, no parity
Flow control: none

CPU_DEBUG_TX Pad 51

CPU_DEBUG_RX Pad 52

These pads are for the G2 programming port. This port is only used when programming the G2 chip and has no other purpose.

V max: 3.6V
V min: 0V
Baud Rate: 115,200 Max
8 bits, 1 stop, no parity

SPI_CLK Pad 19

SPI_MO Pad 20

SPI_MI Pad 21

These pads are an SPI bus, with G2 as master. The bus is shared by the G2, AT-tiny, and flash memory chip.

V max: 3.6V
V min: 0V
Maximum clock speed: 44 MHz.

2) DATA CONNECTIONS, CONT'D

SD_D1	Pad 24
SD_D0	Pad 25
SD_CMD	Pad 26
SD_D2	Pad 27
SD_D3	Pad 28
SD_CLK	Pad 29

These pads are the G2 SDIO client interface.

V max: 3.6V
V min: 0V
Maximum clock rate: 25 MHz.

3) GENERAL PURPOSE IO CONNECTIONS

ADC1	Pad 4
LOUT_2	Pad 8
LED	Pad 4
BT	Pad 8

These pads are used for AT-Tiny general purpose I/O and analog to digital conversion.

V max 4.0V
V min: 0V

3) GENERAL PURPOSE IO CONNECTIONS, CONT'D

WAKE	Pad 3
LIN1	Pad 8
LIN2	Pad 4
NOT NAMED	Pad 7

These pads are general purpose AT-Tiny I/O.

V max	3.6V
V min:	0V

NOT NAMED	Pad 43
NOT NAMED	Pad 44
NOT NAMED	Pad 47
!RESET	Pad 48

These pads are used for AT-Tiny SPI programming. They can be utilized to program the AT-Tiny via a commercially available debugger, as long as the G2 is held in a sleep state.

V max	3.6V
V min:	0V

3) GENERAL PURPOSE IO CONNECTIONS, CONT'D

!PB Pad 12

BT_EN Pad 15

SS1 Pad 18

The !PB interface is used for a pushbutton wakeup of the G2. SS1 and BT_EN are G2 general purpose I/O.

V max 3.6V
V min: 0V

4) G2 SPECIAL PURPOSE PINS

NOT NAMED Pad 41

NOT NAMED Pad 42

These pads are for connection to RFID antennas, an optional G2 interface offered only in the 547 chip. This is not currently implemented in any Healthsense product.

PWRONRST_L Pad 49

FORCE_AWAKE Pad 50

PWRONRST_L, when cleared, resets the G2 chip.
FORCE_AWAKE, when held high, holds the G2 in an on state.

V max 3.6V
V min: 0V

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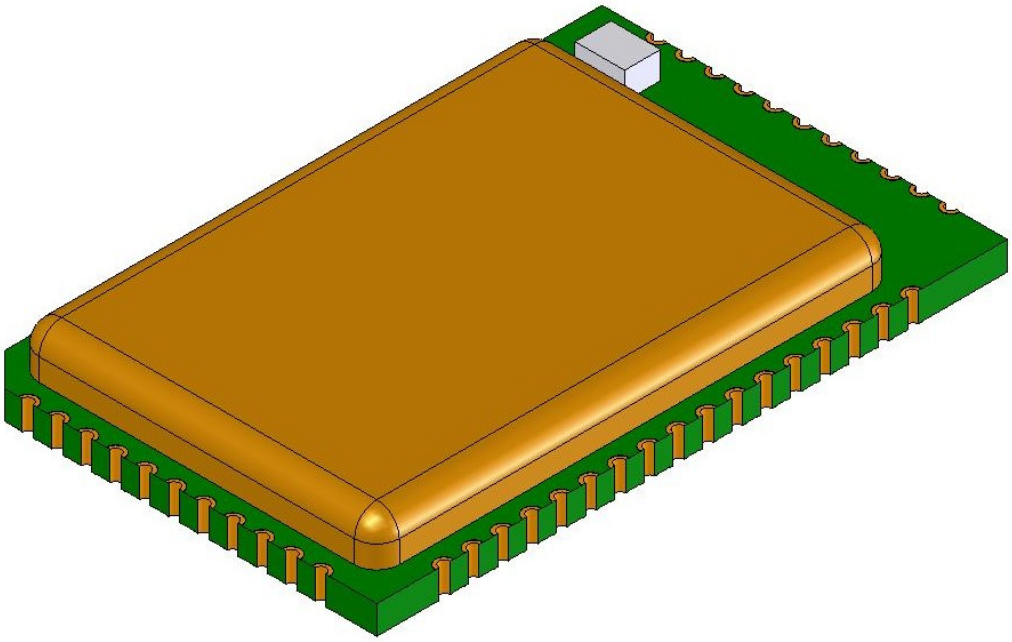
MSR Mechanical Details

This section provides the mechanical and board layout details for the MSR design

The following is a picture of the module.



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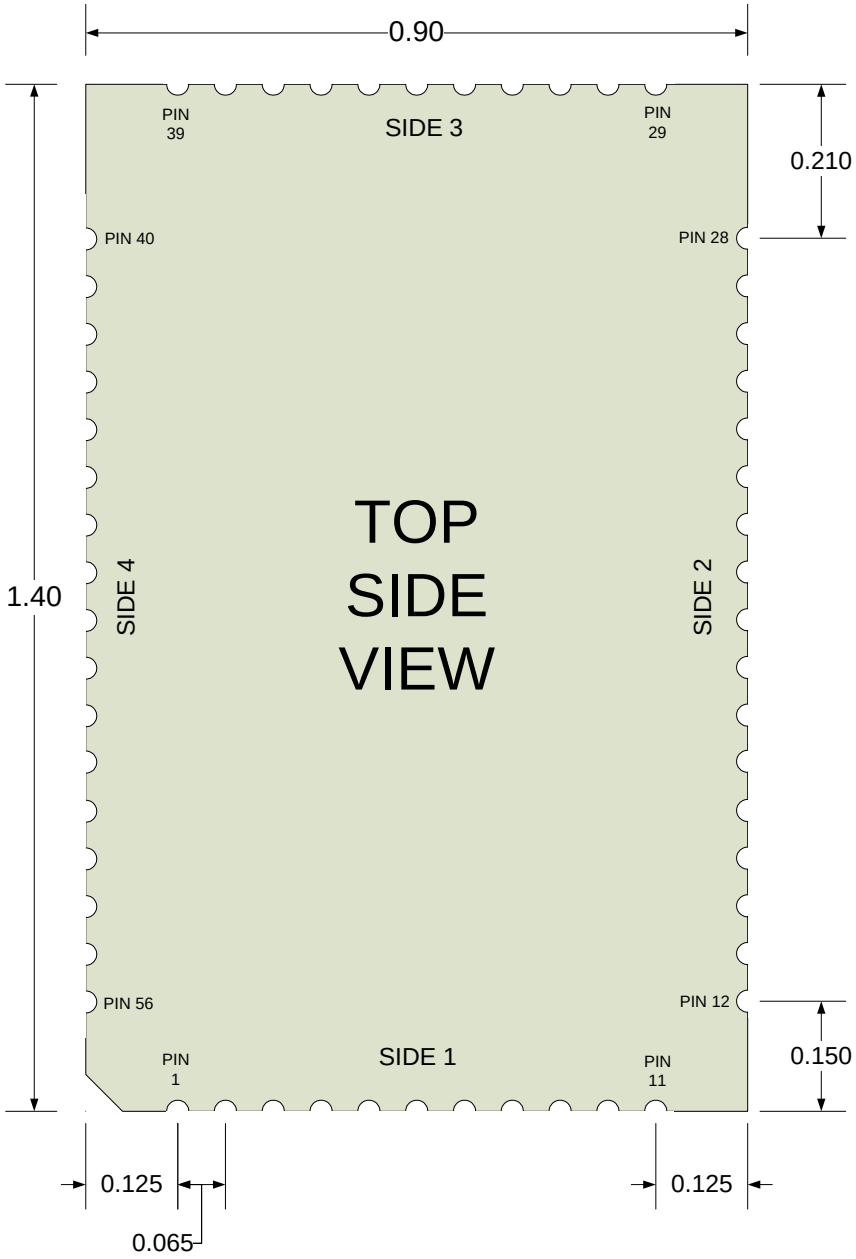
Radio Module Dimensions

This diagram shows the placement of the pins on the module as well as the overall dimensions. This module size is implemented in both a 802.15.4, and an 802.11 configuration.



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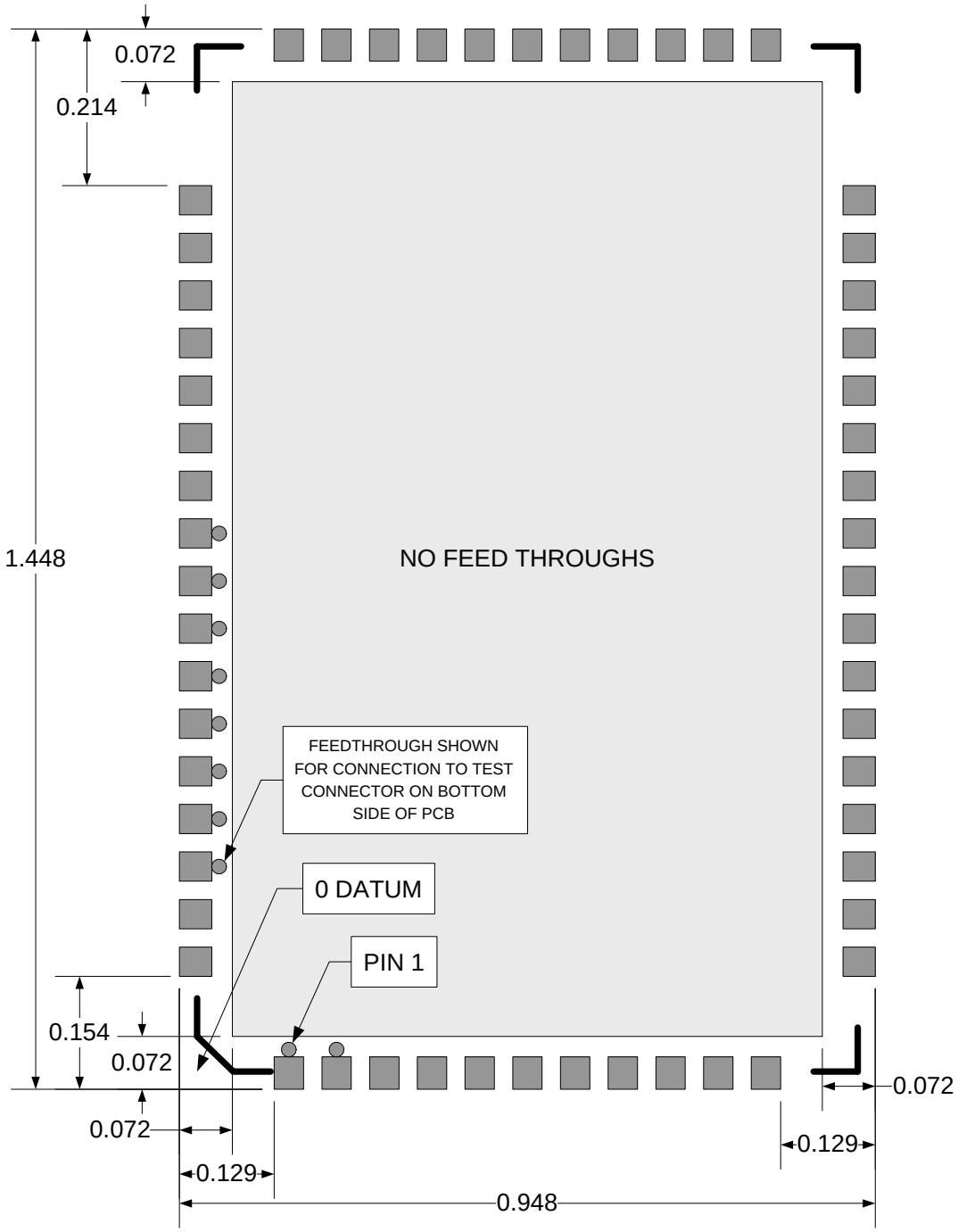
PCB Top Side Layout

This layout shows all of the pins for the larger module size. In most modules, not all pins will be used. It is recommended that unused pads not be implemented on the motherboard.



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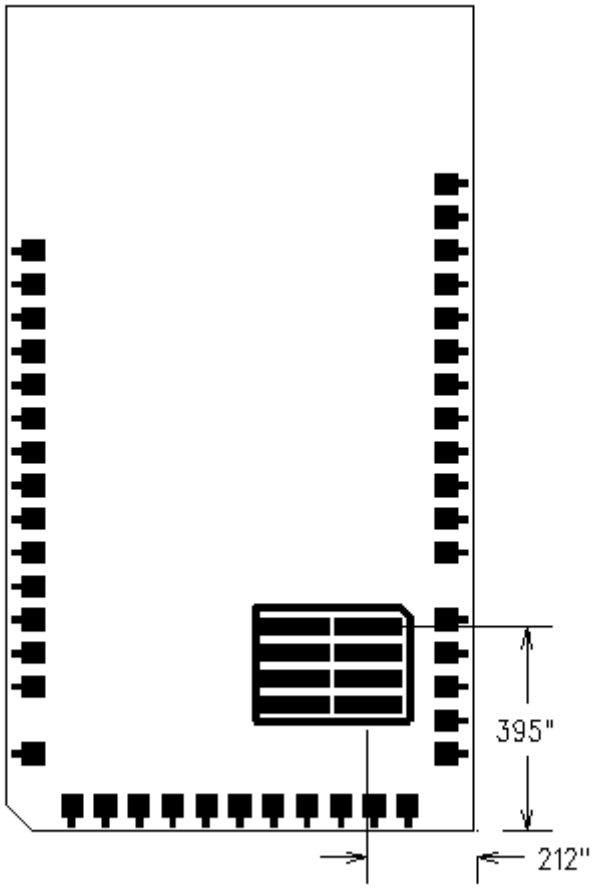
Programming Header

The bottom side of the board has a footprint for an 8-pin .050” pitch surface mount header. The header corresponds to G2 specifications and is used for programming and testing the G2 chip only. No access to the AT-tiny is provided by this header. Its location is shown below. Odd number pins are in right column.



Pin 1: GND
Pin 2: VBat
Pin 3: CPU_DEBUG_TX
Pin 4: RXD
Pin 5: FORCE_AWAKE
Pin 6: PWRONRST_L
Pin 7: CPU_DEBUG_RX
Pin 8: TXD