# 4 MTS400/MTS420

The MTS400CA/MTS420CA and MTS400CB/MTS420CB have the same content in this chapter. The MTS400CC/MTS420CC has some minor differences.

The MTS400 offers five basic environmental sensors with an additional GPS module option (MTS420). The features offered on these boards allows for a wide variety of applications ranging from a simple wireless weather station to a full network of environmental monitoring nodes. Applicable industries include agriculture, industrial, forestry, HVAC and more. These environmental sensor boards utilize the latest generation of energy efficient digital IC-based board-mount sensors. This feature provides extended battery life where a low maintenance, field deployed, sensor node is required.

The GPS module offered on the MTS420 (Figure 4-1) may be used for positional identification of Motes deployed in inaccessible environments and for location tracking of cargo, vehicles, vessels, and wildlife.

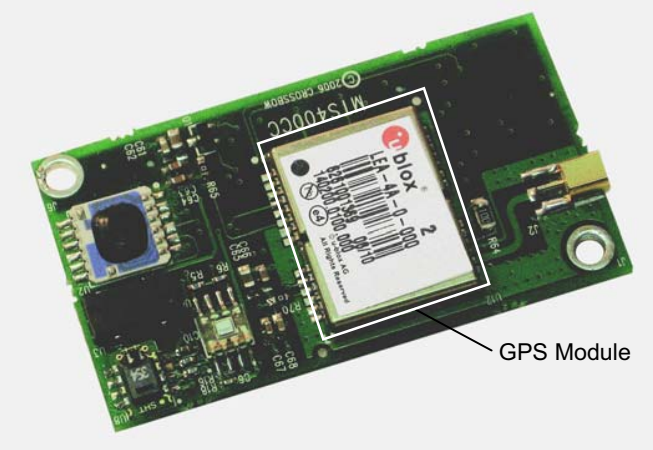


**Figure 4-1.** *Photo of MTS420CC. The MTS400 does not have the GPS module (highlighted by the box).*

**NOTE:** Motes are designed for power efficiency. Hence all the sensors are disconnected from power on the MTS400 and MTS420 sensor boards unless specifically turned on. See Section 4.6 for more information.

## 4.1 Humidity and Temperature Sensor

The Sensirion® (http://www.sensirion.com/) SHT11 is a single-chip humidity and temperature multi sensor module comprising a calibrated digital output. The chip has an internal 14-bit analog-to-digital converter and serial interface. SHT11s are individually calibrated.

**Table 4-1.** *Summary of the Sensirion® SHT11's Specifications*

| **Sensor Type** | Sensirion SHT11 | |
|---|---|---|
| **Channels** | Humidity | Temperature |
| **Range** | 0 to 100% | -40°C to 80°C |
| **Accuracy** | ± 3.5% RH (typical) | ± 2°C |
| **Operating Range** | 3.6 to 2.4 volts | |
| **Interface** | Digital interface | |

This sensor's power is enabled through a programmable switch. The control interface signals are also enabled through a programmable switch. An analog-to-digital converter in the sensor does the conversion from humidity and temperature to digital units.

## 4.2 Barometric Pressure and Temperature Sensor

The Intersema® (http://www.intersema.ch/) MS55ER is a SMD-hybrid device including a piezoresistive pressure sensor and an ADC interface IC. It provides a 16-bit data word from pressure and temperature measurements. A 3-wire interface is used for all communications.

This sensor's power is enabled through a programmable switch. The control interface signals are also enabled through a programmable switch. An analog-to-digital converter in the sensor does the conversion from pressure and temperature to digital units.

**Table 4-2.** *Summary of the Intersema® MS55ER's Specifications*

| **Sensor Type** | Intersema MS5534 |
|---|---|
| **Channels** | Pressure and Temperature |
| **Range** | Pressure: 300 to 110 mbar<br>Temperature: -10°C to 60°C |
| **Accuracy** | Pressure: ± 3.5%<br>Temperature: ± 2°C |
| **Operating Range** | 3.6 to 2.2 volts |
| **Interface** | Digital interface |

## 4.3 Light Sensor

The TLS2550 is a digital light sensor with a two-wire, SMBus serial interface. It is manufactured by TAOS, Inc (http://www.taosinc.com). It combines two photodiodes and a compounding analog-to-digital converter on a single CMOS integrated circuit to provide light measurements over an effective 12-bit dynamic range. Table 4-3 has a summary of the sensor's specifications.

**Table 4-3.** *Summary of TAOS TSL2550's Specifications*

| **Sensor Type** | Taos TSL2550 |
|---|---|
| **Channels** | Light |
| **Range** | 400 – 1000 nm |
| **Operating Range** | 3.6 to 2.7 volts |
| **Interface** | Digital interface |

This sensor's power is enabled through a programmable switch. The control interface signals are also enabled through a programmable switch. An analog-to-digital converter in the sensor does the conversion from light to digital units.

## 4.4 2-Axis Accelerometer

The accelerometer is a MEMS surface micro-machined 2-axis, ± 2 g device. It features very low current draw (< 1mA). The sensor can be used for tilt detection, movement, vibration, and/or seismic measurement. The sensor output's are connected to ADC channels on the Mote's ADC1 and ADC2 channels.

**Table 4-4.** *Summary of the ADXL202JE's Specifications*

| | |
|---|---|
| **Sensor Type** | Analog Devices ADXL202JE |
| **Channels** | X (ADC1), Y (ADC2) |
| **Range** | ±2 G (1 G = 9.81 m/s$^2$) |
| **Sensitivity** | 167 mV/G, ±17 % |
| **Resolution** | 2 mG (0.002 G) RMS |
| **Offset** | VBATTERY/2 ±0.4 V |
| **Operating Range** | 3.6 to 3.0 V |
| **Interface** | Analog interface |

**NOTE:** The ADXL202 sensitivity and offset have a wide initial tolerance. A simple calibration using earth's gravitational field can greatly enhance the accuracy of the ADXL202 sensor. By rotating the sensor into a +1 G and a –1 G position, the offset and sensitivity can be calculated to within 1 %.

## 4.5 GPS (MTS420 only)

The GPS module used is Leadtek GPS-9546 (http://www.leadtek.com/) in the case of MTS420CA/CB or uBlox LEA-4A (http://www.u-blox.com/ ) in the case of MTS420CC. The output from the GPS module is connected to a serial USART1 interface of the Mote. An active, external, antenna is supplied with the module. The GPS module supplies the antenna power.

**Table 4-5.** *Summary of the GPS Receiver Specifications.*

| | **MTS420CA/CB** | **MTS420CC** |
|---|---|---|
| **GPS Module** | Leadtek GPS-9546 | uBlox LEA-4A |
| **GPS Chipset** | SiRFstarIIe LP | ANTARIS 4 |
| **Channels** | 12 | 16 |
| **Meters** | 10 m, 2D | 3 m CEP |
| **Start Time (sec)** | 45 Cold; 38 Warm; 8 Hot | 34 Cold; 33 Warm; 3.5 Hot |
| **Reacquisition Time** | 0.1 sec (typical, w/o dense foliage) | < 1 sec |
| **Protocol** | NMEA-0183 and SIRF binary protocol | NMEA-0183 |
| **Current** | 60 mA at 3.3 V | 35 mA at 3.3V |
| **Interface** | Serial UART interface | |
| **Antenna** | External active antenna, power supplied by GPS module | |

**NOTE:** The MTS420CA/CB GPS module's DC-DC booster can interfere with radio communication. If the GPS module must be continually powered and monitored during radio communication, then 3.3-3.6V lithium batteries are recommended to power the Mote. Normal alkaline batteries are **not** recommended unless the GPS module is powered down during radio communication. The MTS420CC doesn't suffer from this limitation.

## 4.6 Turning Sensors On and Off

Power for all of the sensors on the MTS400/420 sensor board is controlled through an analog power switch at location U7. It can be programmed enable and disable power to individual sensors. The default condition for the sensors is off. This design helps minimize power draw by the sensor board.

## 4.7 Schematics of the MTS400 and MTS420

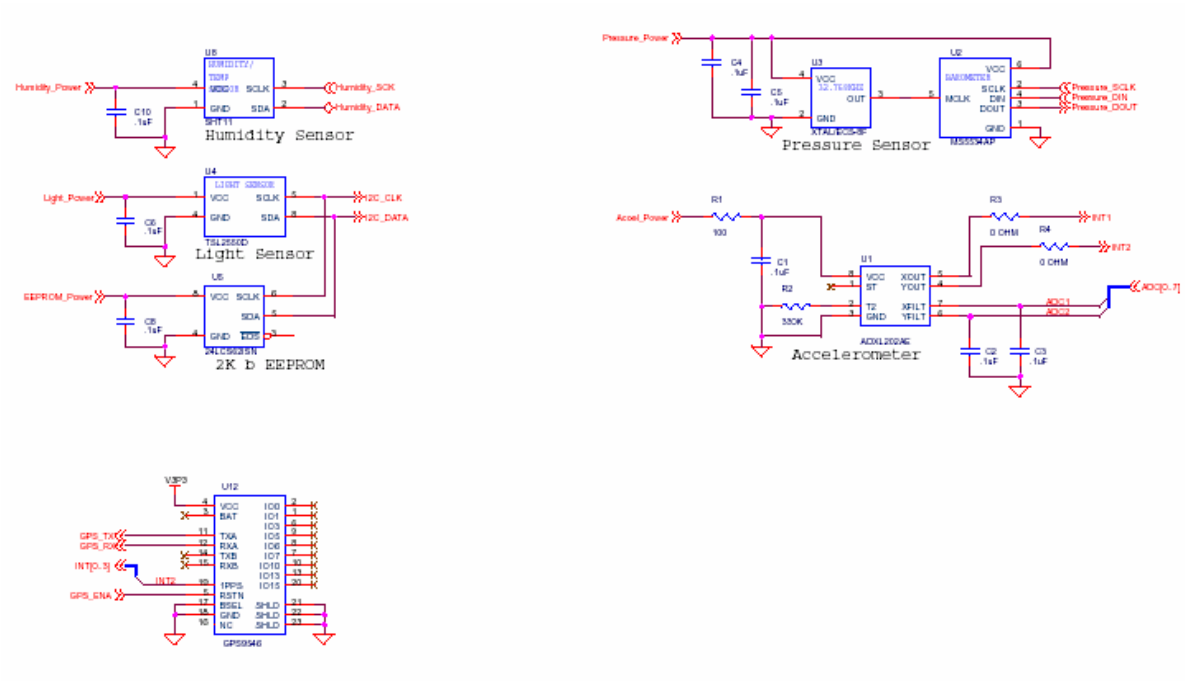


**Figure 4-2.** *MTS400 Sensors Schematic.*

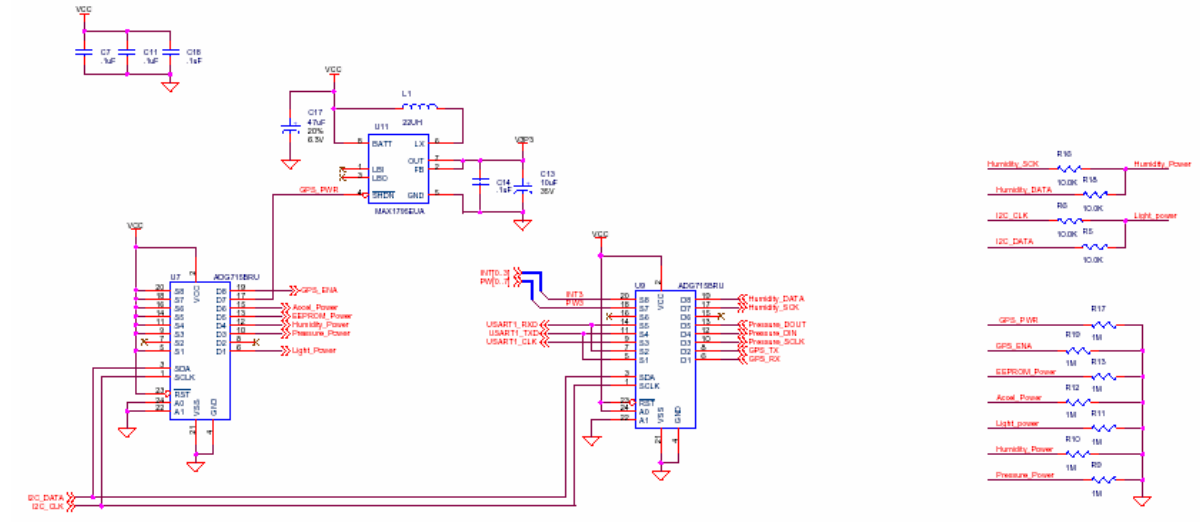

**Figure 4-3.** *MTS400 Power and Signal Control Schematic.*