* Battery is recharged using the RFID reader’s field (No wires to plug in, no batteries to change)
* Customizable data read times from 1 minute to 1 hour
* Stores maximum, minimum, and average values in user memory
* Read times and dates are available along with sensor data

**APPLICATIONS**

* Wireless Sensors
  + Industrial Monitoring
  + Smart Grid
  + Building automation
* Asset tracking
* E-Textiles
* Consumer Electronics
  + Headphones
  + Keyboards
  + Mice
  + Fitness brands
* Smart wearables

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**DESCRIPTION**

The PCT200 SuperTag is a high-functioning, datalogging RFID tag capable of measuring temperature, humidity, and light level with high accuracy. It contains a wirelessly rechargeable battery to enable long lasting data logging capabilities while outside of the RFID reader’s field. Its customizable data reading capabilities can be easily set through a user friendly interface. The tag harnesses the capability of the Powercast Powerharvester® Chipset to recharge the on-board battery while the data is being downloaded. The sensor measurements can be read back out of the tag’s memory using any standard UHF RFID reader. Powercast’s technology enables a completely maintenance-free sensing and tracking solution for UHF RFID applications.

**FEATURES**

* EPC Class 1 Gen 2 compliant
* ISO/IEC 18000-6C compliant
* 10 meter read range
* High sensor accuracy
* “Find Tag” – locate one specific tag by illuminating an on-board LED
* Wide RF operating range: -17dBm to +20 dBm
* Frequency range: 860MHz – 960MHz
* Compact hard case packaging
* RoHS Compliant
* High RF to DC conversion efficiency – up to 75%
* -40 to +85C operational temperature range
* Up to 1 month of battery life without recharging

***Powercast products and technology are covered by one or more patents with other patents pending. All patent and trademark information can be found at*** [***http://www.powercastco.com/IP/***](http://www.powercastco.com/IP/)***.***

**­**

**SPECIFICATIONS**

**TA = 25°C, RFIN = 915MHz, unless otherwise noted**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Min** | **Typ** | **Max** | **Unit** |
| RF Characteristics Input Power Frequency | -17  860 | 915 | +20  960 | dBmMHz MHz |
| Read Distance | 0 | 5 | 10 | m |
| Sensor Read Time | 15.3 | 3600 | 86,400 | s |
| Temperature | -20  - | -  ±2% | 60  - | °C  - |
| Range |
| Accuracy | - | - |  |
| Light  Range  Accuracy | 0  - | 0  ±10% | 1000  - | Lux |
| Humidity  Range  Accuracy  11% to 89%  0% to 10% or 90% to 100% | 0  - | -  ±4%  ±8% | 100  - | %RH |
| Battery Life | 5 | 14 | 28 | Days |
| Recharge Time (at 1m) | 10 | 16 | 24 | Hours |

\*Device runtime will decrease as temperature decreases

Exceeding the absolute maximum ratings may cause permanent damage to the device.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Rating** | **Unit** |
| RF Input Power | 23 | dBm |
| RFIN to GND | 0 | V |
| DCOUT to GND | 5.25 | V |
| DCOUT Current | 100 | mA |
| Operating Temperature Range | -40 to +85 | °C |
| Storage Temperature Range | -50 to +145 1145145 | °C |

**ABSOLUTE MAXIMUM RATINGS**

**TA = 25°C, unless otherwise noted.**

**A diagram of a computer

Description automatically generated**

**FUNCTIONAL BLOCK DIAGRAM**

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To prevent permanent battery damage, it is recommended to recharge the battery every 2 months when not in use

**SENSOR READS**

The PCT200 has the option to sense temperature, light, and humidity or any combination of the three. There is also a find tag only version. The rate at which sensor reads are taken is adjustable by the user and can range from 15s to one day (24 hours) in 15s increments. See **WAKEUP DURATION** for instructions on how to set the check in time.

**SENSOR TIMES**

The tag stores an approximate corresponding time associated with each maximum and minimum sensor read. To get the sensor times, add one to the value read from the tag and multiply it by 15.3 s and add it to the start time.

**SENSOR DATA**

The PCT200 will store:

* The 5 maximum and 5 minimum values and their respective read times for each sensor
* The current sensor read values
* The averages of all the sensor read values

The averages and current values are updated twice per day or on demand by setting the correct flag. The memory location for each sensor read is listed in Table 1. The data is stored as a hexadecimal value between 0 and 1023. See section entitled Conversion Formulas for information on how to convert these values to their corresponding sensor values.

**FUNCTIONAL DESCRIPTION**

**OVERVIEW**

The tag operates by waking up approximately every 15s and checking user programmable flags in memory. These flags determine the tags’ behavior. Depending on how the flags are configured, the tag will do one or more of the following:

1. Go back to sleep
2. Erase the memory
3. Perform the locate operation
4. Update maximum and minimum sensor reads
5. Update the logged averages and current sensor reads

Sensor reads are taken at user defined intervals from 15s to one day (24 hours) and are settable via the “wakeUpDuration” word. The sensor values are stored in the RFID chip’s memory so that the values can be read out even if the tag loses power.

**POWER**

The PCT200 tag is powered from an onboard rechargeable battery. The battery life ranges from 5 days to 28 days depending upon how often the tag is set to check in, which is adjustable by the user. The tag utilizes Powercast’s harvesting technology to harvest the RF energy produced by an RFID reader and efficiently convert it into usable DC Power to recharge the battery. Therefore, anytime that the tag is in the RF field, the battery is being recharged. Recharge time typically take between 8 and 12 hours depending on the current state of the battery and how close to the reader that tag is. The LED will quickly blink two times when the battery is full.

# DATA RETRIEVAL

The tags are compatible with EPC Gen2 commands. Data should be read in 16 bit words. The user data is stored in the user memory locations (memory bank 3) starting at byte 00h. The data values will range from 0 to 1023.

**Table 1: Sensor Memory Locations**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **WORD** | **MEMORY ADDRESS** | **CONTENT** | **DATA SOURCE** | **DATA SINK** | **ERASED ON CLEAR** | **CRC** |
| 0 | 00h | Product ID | PCT200 | User | No | No |
| 1 | 02h | Product  Configuration | PCT200 | User | No | No |
| 2 | 04h | Flags | User | PCT200 | No | No |
| 3 | 06h | Wake Up Duration | User | PCT200 | No | No |
| 4 | 08h | RESERVED | - | - | - | - |
| 5 | 0Ah | Start Time | User | User | No\* | No |
| 6 | 0Ch | Start Time | User | User | No\* | No |
| 7 | 0Eh | Battery Voltage | PCT200 | User | Yes | No |
| 8 | 10h | Maximum ADC Read  of Temperature 1 | PCT200 | User | Yes | Yes |
| 9 | 12h | # of wakes since start | PCT200 | User | Yes | Yes |
| 10 | 14h | Maximum ADC Read  of Temperature 2 | PCT200 | User | Yes | Yes |
| 11 | 16h | # of wakes since start | PCT200 | User | Yes | Yes |
| 12 | 18h | Maximum ADC Read  of Temperature 3 | PCT200 | User | Yes | Yes |
| 13 | 1Ah | # of wakes since start | PCT200 | User | Yes | Yes |
| 14 | 1Ch | Maximum ADC Read of Temperature 4 | PCT200 | User | Yes | Yes |
| 15 | 1Eh | # of wakes since start | PCT200 | User | Yes | Yes |

**LOCATE TAG**

The PCT200 is equipped with a locate tag feature. This helps to find a tag in the field when there are multiple tags. It causes the LED on the tag to blink so that the user can find it

**MEMORY CLEAR**

The sensor data can be reset using the flags on the tag. This enables the tag to be used multiple times for different applications. This will cause all the logged sensor data to be permanently deleted. The start time must always be written to the tag after every memory clear.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 16 | 20h | Maximum ADC Read of Temperature 5 | PCT200 | User | Yes | Yes |
| 17 | 22h | # of wakes since start | PCT200 | User | Yes | Yes |
| 18 | 24h | Minimum ADC Read of Temperature 1 | PCT200 | User | Yes | Yes |
| 19 | 26h | # of wakes since start | PCT200 | User | Yes | Yes |
| 20 | 28h | Minimum ADC Read  of Temperature 2 | PCT200 | User | Yes | Yes |
| 21 | 2Ah | # of wakes since start | PCT200 | User | Yes | Yes |
| 22 | 2Ch | Minimum ADC Read  of Temperature 3 | PCT200 | User | Yes | Yes |
| 23 | 2Eh | # of wakes since start | PCT200 | User | Yes | Yes |
| 24 | 30h | Minimum ADC Read  of Temperature 4 | PCT200 | User | Yes | Yes |
| 25 | 32h | # of wakes since start | PCT200 | User | Yes | Yes |
| 26 | 34h | Minimum ADC Read  of Temperature 5 | PCT200 | User | Yes | Yes |
| 27 | 36h | # of wakes since start | PCT200 | User | Yes | Yes |
| 28 | 38h | Maximum ADC Read  of Humidity 1 | PCT200 | User | Yes | Yes |
| 29 | 3Ah | # of wakes since start | PCT200 | User | Yes | Yes |
| 30 | 3Ch | Maximum ADC Read  of Humidity 2 | PCT200 | User | Yes | Yes |
| 31 | 3Eh | # of wakes since start | PCT200 | User | Yes | Yes |
| 32 | 40h | Maximum ADC Read  of Humidity 3 | PCT200 | User | Yes | Yes |
| 33 | 42h | # of wakes since start | PCT200 | User | Yes | Yes |
| 34 | 44h | Maximum ADC Read  of Humidity 4 | PCT200 | User | Yes | Yes |
| 35 | 46h | # of wakes since start | PCT200 | User | Yes | Yes |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 36 | 48h | Maximum ADC Read of Humidity 5 | PCT200 | User | Yes | Yes |
| 37 | 4Ah | # of wakes since start | PCT200 | User | Yes | Yes |
| 38 | 4Ch | Minimum ADC Read  of Humidity 1 | PCT200 | User | Yes | Yes |
| 39 | 4Eh | # of wakes since start | PCT200 | User | Yes | Yes |
| 40 | 50h | Minimum ADC Read of Humidity 2 | PCT200 | User | Yes | Yes |
| 41 | 52h | # of wakes since start | PCT200 | User | Yes | Yes |
| 42 | 54h | Minimum ADC Read  of Humidity 3 | PCT200 | User | Yes | Yes |
| 43 | 56h | # of wakes since start | PCT200 | User | Yes | Yes |
| 44 | 58h | Minimum ADC Read  of Humidity 4 | PCT200 | User | Yes | Yes |
| 45 | 5Ah | # of wakes since start | PCT200 | User | Yes | Yes |
| 46 | 5Ch | Minimum ADC Read  of Humidity 5 | PCT200 | User | Yes | Yes |
| 47 | 5Eh | # of wakes since start | PCT200 | User | Yes | Yes |
| 48 | 60h | Maximum ADC Read  of Light 1 | PCT200 | User | Yes | Yes |
| 49 | 62h | # of wakes since start | PCT200 | User | Yes | Yes |
| 50 | 64h | Maximum ADC Read of Light 2 | PCT200 | User | Yes | Yes |
| 51 | 66h | # of wakes since start | PCT200 | User | Yes | Yes |
| 52 | 68h | Maximum ADC Read of Light 3 | PCT200 | User | Yes | Yes |
| 53 | 6Ah | # of wakes since start | PCT200 | User | Yes | Yes |
| 54 | 6Ch | Maximum ADC Read  of Light 4 | PCT200 | User | Yes | Yes |
| 55 | 6Eh | # of wakes since start | PCT200 | User | Yes | Yes |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 56 | 70h | Maximum ADC Read  of Light 5 | PCT200 | User | Yes | Yes |
| 57 | 72h | # of wakes since start | PCT200 | User | Yes | Yes |
| 58 | 74h | Minimum ADC Read  of Light 1 | PCT200 | User | Yes | Yes |
| 59 | 76h | # of wakes since start | PCT200 | User | Yes | Yes |
| 60 | 78h | Minimum ADC Read  of Light 2 | PCT200 | User | Yes | Yes |
| 61 | 7Ah | # of wakes since start | PCT200 | User | Yes | Yes |
| 62 | 7Ch | Minimum ADC Read  of Light 3 | PCT200 | User | Yes | Yes |
| 63 | 7Eh | # of wakes since start | PCT200 | User | Yes | Yes |
| 64 | 80h | Minimum ADC Read  of Light 4 | PCT200 | User | Yes | Yes |
| 65 | 82h | # of wakes since start | PCT200 | User | Yes | Yes |
| 66 | 84h | Minimum ADC Read  of Light 5 | PCT200 | User | Yes | Yes |
| 67 | 86h | # of wakes since start | PCT200 | User | Yes | Yes |
| 68 | 88h | Current Temperature | PCT200 | User | Yes | Yes |
| 69 | 8Ah | Current Humidity | PCT200 | User | Yes | Yes |
| 70 | 8Ch | Current Light | PCT200 | User | Yes | Yes |
| 71 | 8Eh | RESERVED | - | - | Yes | Yes  (0000h) |
| 72-73 | 90h | Average  Temperature | PCT200 | User | Yes | Yes |
| 74-75 | 94h | Average Humidity | PCT200 | User | Yes | Yes |
| 76-77 | 98h | Average Light | PCT200 | User | Yes | Yes |
| 78 | 9Ch | # of wake ups | PCT200 | User | Yes | Yes |
| 79 | 9Eh | CRC | PCT200 | User | Yes | - |

**ERASE MEMORY**

When set to 1, the tag will erase all values from word 7 onward, including the count that relates the sensor reads to the start time. Because of this, the start time must be written to the tag every time the memory is cleared. After the memory is cleared the Erase Memory flag will automatically be set back to 0 and the LED will blink twice. The tag will then continue checking the rest of the flag bits and will resume whatever mode it was in prior to locate.

**LOCATE**

The locate feature is activated by setting the locate bit high. The LED will blink for 10s. Afterward, the locate bit is automatically set back to 0. The tag will then continue checking the rest of the flag bits and will resume whatever mode it was in prior to locate.

**UPDATE AVERAGES**

The averages are automatically sent to the RFID chip for reading twice per day, regardless of what the Update Averages flag is set to. The user can also request that the averages be updated on demand by setting the Update Averages flag to high. This is done to preserve battery life and limit the number of writes to the RFID chip memory. Afterward, the Update Averages flag is automatically cleared. The tag will then continue checking the rest of the flag bits and will resume whatever mode it was in prior to locate.

**PRODUCT ID AND CONFIGURATION**

The product ID code for the PCT200 is 200 (C8h). For the PCT100 tag, it will be 100 (64h). The product configuration is dependent upon which sensors are populated. It is a binary code where 1 represents the sensor being populated and 0 represents the sensor being absent.

**Table 2: Product Configuration**

|  |  |  |
| --- | --- | --- |
| Bit 2 | Bit 1 | Bit 0 |
| Temperature | Light | Humidity |

For Example, if temperature and humidity are populated and light is not, the product ID would be 101b or 5h.

**FLAGS**

The flags are used to control operation of the tag.

|  |  |  |
| --- | --- | --- |
| **Bit** | **Description** | **Values** |
| 0 | Start/Stop | 0-Stop 1-Start |
| 1 | Erase Memory | 1-Clear |
| 2 | Locate | 1-Locate |
| 3 | Update Averages | 1-Update Averages |
| 4 | RESERVED |  |
| 5 | RESERVED |  |
| 6 | RESERVED |  |
| 7 | RESERVED |  |

**START/STOP**

The tag will remain in sleep mode until the run bit is set to 1. Once it is running, it will take all of the sensor readings, update the RFID chip, and go to sleep for the **wakeUpDuration**. It will wake up every 15s to check the flags. It will stay in this loop until the run bit is set to 0. When the run bit is set to 0, all the ADC reads can still be read out from the tag, but no new values will be populated.

**CURRENT SENSOR VALUES**

The current sensor values, like the averages, are written to the RFID chip twice per day. You can get the current values on demand by setting the corresponding flag bit high. The current ADC reads are converted using the same formulas as the normal sensor reads.

**AVERAGE VALUES**

The average values are stored on the RFID tag using an unsigned Q 10.22 format. The average values must be bitwise shifted to the right by 22 bits. The remaining value can be converted using the same formulas below.

**CYCLIC REDUNDANCY CHECK**

The averages, current values, and wake count (word addresses 88h to 9Dh inclusive) can be verified using the cyclic redundancy check ITU X.25 FCS. This checksum value is available in memory bank 3 (user memory) at word address 9Eh. It is represented in big-endian order with the most significant bit first.

For more information, see Section 2.2.7.4 in *ITU-T Rec. X.25 (10/96) Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by a dedicated circuit.*

**WAKE UP DURATION**

The wake up duration is user settable. It tells the tag how often to take the sensor reads. It will be 15.3s multiplied by the user set value. For example, if the **wakeUpDuration** field is set to 10, the tag will take sensor readings every 150.3s. The **wakeUpDuration** is checked every 15.3s by the tag.

**START TIME**

The start time is stored in words 5-6 on the tag. It uses 32-bit POSIX time, which is the number of seconds from EPOC. The time- zone is UTC+0. The count associated with each sensor read is multiplied by 15.3s and added to this start time to get a rough idea of when each sensor read was taken.

**SENSOR ADC READS**

The sensor read results are integers between 0 and 1023 and can be converted using the equations in the CONVERSION FORMULAS section below. If a sensor is not populated, the ADC value will be read as 1111 11XX XXXX XXXX in binary.

The word directly following a sensor ADC read is the count corresponding to that read. To determine when a sensor read was taken, add one to the count and multiply it by 15.3s. Then, add this value to the start time. If a sensor is not populated, the value will be read as 0000h.

**LIGHT**

Where X is the decimal value read from the Tag.

*Note: The Light equations for the PCT100 and PCT200 are different.*

**HUMIDITY**

Where X is the decimal value read from the tag.

Please see the PCT Conversions document.

**SENSOR TIME**

Where X is the value read from the tag in decimal and start is the start time stored in words 5 and 6.

*Note: All times are approximate.*

**BATTERY VOLTAGE**

The battery voltage will range from 3.6V to 4.2V. The formula to calculate is:

**CONVERSION FORMULAS**

The values for each sensor read will be integers between 0 and 1023 in decimal and stored on the RFID chip as hexadecimal values. The following are the formulas to convert these values into their respective sensor values.

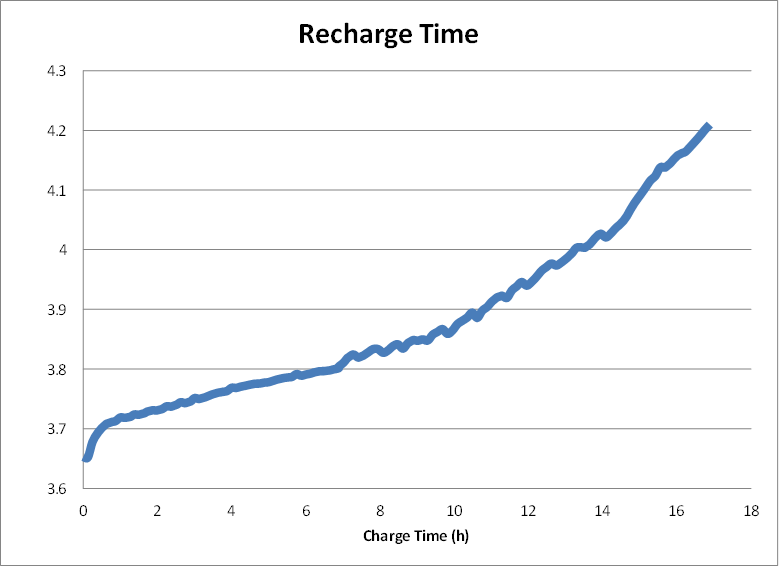
**TEMPERATURE**

For temperature, the formula will convert the values read into a resistance.

Where X is the decimal value read from the tag. The resistance value must then convert into temperature using the look up table in **Table 1**. If the resistance falls between two values, a linear approximation between the two closest values should be made.

|  |  |  |  |
| --- | --- | --- | --- |
| **Resistance**  **(kΩ)** | **Temperature**  **(⁰C)** | **Resistance**  **(kΩ)** | **Temperature**  **(⁰C)** |
| 195.652 | -40 | 4.917 | 45 |
| 148.171 | -35 | 4.161 | 50 |
| 113.347 | -30 | 5.535 | 55 |
| 87.559 | -25 | 3.014 | 60 |
| 68.237 | -20 | 2.586 | 65 |
| 53.65 | -15 | 2.228 | 70 |
| 42.506 | -10 | 1.925 | 75 |
| 33.892 | -5 | 1.669 | 80 |
| 27.219 | 0 | 1.452 | 85 |
| 22.021 | 5 | 1.268 | 90 |
| 17.926 | 10 | 1.11 | 95 |
| 14.674 | 15 | 0.974 | 100 |
| 12.081 | 20 | 0.858 | 105 |
| 10 | 25 | 0.758 | 110 |
| 8.315 | 30 | 0.672 | 115 |
| 6.948 | 35 | 0.596 | 120 |
| 5.834 | 40 | 0.531 | 125 |

**Table 1: Resistance to Temperature**



**BATTERY RECHARGING INFORMATION**

The battery was recharged using a standard RFID reader at a distance of 1m. Factors that affect the recharge time are tag orientation and distance from the reader. For optimal charge time, the tag should be oriented parallel to the RFID antenna.



A screen shot of a phone

Description automatically generated

**DIMENSIONS**

**P2110 MODULE SERIES**

PCT 2 00 - XYZ

|  |  |  |
| --- | --- | --- |
| **PCT**  Tag series | Version  **100** = Battery Free  **200** = Datalogging | XYZ (Sensors Desired) **T**= Temperature **H**=Humidity  **L** = Light  **F** = Find Tag Only |

|  |  |
| --- | --- |
| PCT100-T | Temperature |
| PCT100-L | Light |
| PCT100-H | Humidity |
| PCT100-TL | Temperature and Light |
| PCT100-TH | Temperature and Humidity |
| PCT100-LH | Light and Humidity |
| PCT100-TLH | Temperature, Light and Humidity |
| PCT100-F | Find Tag Only |
| PCT200-T | Temperature |
| PCT200-L | Light |
| PCT200-H | Humidity |
| PCT200-TL | Temperature and Light |
| PCT200-TH | Temperature and Humidity |
| PCT200-LH | Light and Humidity |
| PCT200-TLH | Temperature, Light and Humidity |
| PCT200-F | Find Tag Only |

All Dimensions in inches

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