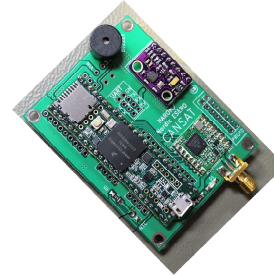




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# How to use the CanSat as a thermometer: Programming the Teensy step 2

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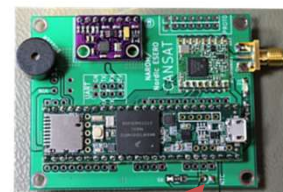
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## How to use CanSat as thermometer

We have

- Teensy 3.5 (Arduino programming)
- NTC Temperature sensor

The CanSat:



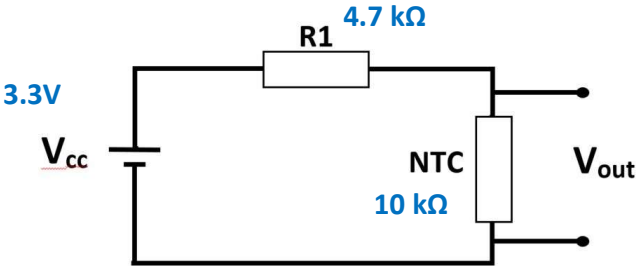
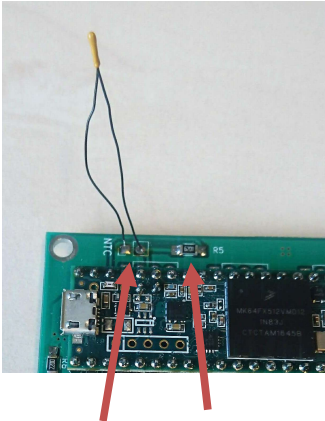
NTC Sensor:



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NTC Temperature sensor

We want to program the Teensy to tell us the ANALOGUE VOLTAGE  $V_{out}$

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We want to program the Teensy to tell us the ANALOGUE VOLTAGE  $V_{out}$

Arduino Language

- Structure
- Values: Variables and Constants
- Functions

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## Arduino language Structure:

```

void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}

```



## Arduino language Values:

Variables:    x        y        x1        x2            press        temp

Constants:    1        2.43        PI        k    start\_temp        counter

## Datatypes:

**int:**        integer (16-bit, max value  $\pm 2^{15}-1$ )

**char:**      character (integer 8-bit (1 byte), max  $\pm 2^7-1$ )

**long:**      integer (32-bit, max value  $\pm 2^{31}-1$ )

**unsigned long:** integer from 0 to  $2^{32}-1$  (only positive/zero)

**float:**     decimal number    (32-bit)



## Arduino language Values: Datatypes:

Examples:

```
int led = 13;
```

```
int LOOPTIME = 500;
```

```
unsigned long Distance;
```

```
float G = 9.81;
```

Small notices on **variable names**:

- A variable name must begin with a letter or \_
- Use understandable variable names...
- Don't use already reserved words (int, const, goto, ...)
- Remember: uppercase and lowercase letter sensitivity



## Arduino language Functions:

Examples of functions:

- delay()
- millis()
- sqrt()
- cos()
- random()
- analogRead()



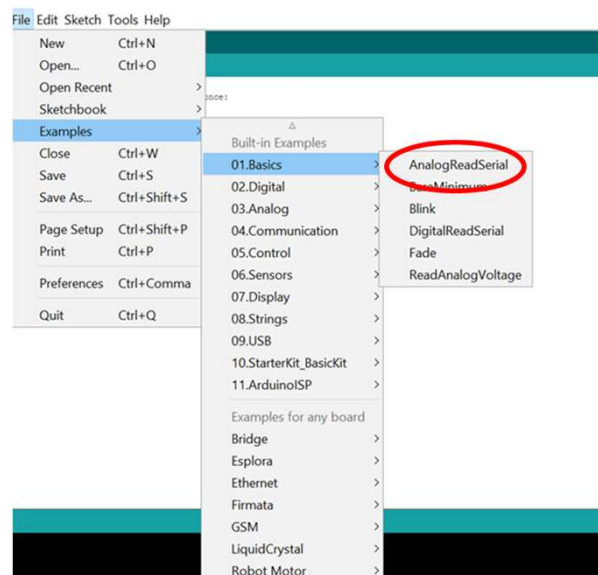
We want to program the Teensy to tell us the ANALOGUE VOLTAGE  $V_{out}$

We will use the function  
AnalogRead()



We now choose  
the example  
programme:

**AnalogReadSerial**





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## How to use CanSat as thermometer

```

/*
AnalogReadSerial

Reads an analog input on pin 0, prints the result to the Serial Monitor.
Graphical representation is available using Serial Plotter (Tools > Serial Plotter menu).
Attach the center pin of a potentiometer to pin A0, and the outside pins to +5V and ground.

This example code is in the public domain.

http://www.arduino.cc/en/Tutorial/AnalogReadSerial
*/

// the setup routine runs once when you press reset:
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
}

// the loop routine runs over and over again forever:
void loop() {
  // read the input on analog pin 0:
  int sensorValue = analogRead(A0);
  // print out the value you read:
  Serial.println(sensorValue);
  delay(1);    // delay in between reads for stability
}

```



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Reads an analog input on pin 0, prints the result to the Serial Monitor.
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}

```





## How to use CanSat as thermometer

```

void setup() {

  Serial.begin(9600);
}

void loop() {
  int sensorValue = analogRead(A0);
  Serial.println(sensorValue);
  delay(1);
}

```

The AnalogueReadSerial programme without comments/text.

We need to adjust it a little...



## How to use CanSat as thermometer

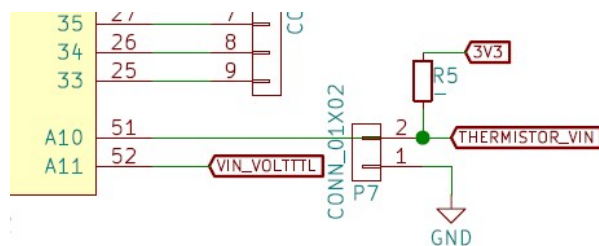
```

void setup() {

  Serial.begin(9600);
}

void loop() {
  int sensorValue = analogRead(A10);
  Serial.println(sensorValue);
  delay(1000);
}

```



- Delay time 1 sec (1000 msec)
- NTC analogue output voltage is on A10



## How to use CanSat as thermometer

Output from the AnalogReadSerial program:

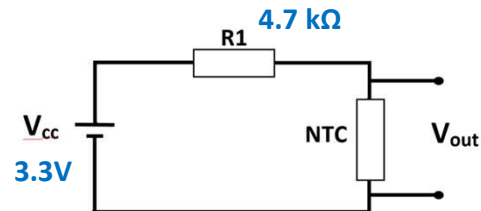
648  
640  
625  
612

·  
·  
·

The digital numbers (12 bit) must be converted to voltage:

The Voltage corresponding to 648 is  $\frac{648}{4095} \cdot 3.3V = 0.52V$

These voltages has to be calculated into temperature by data sheet and circuit diagram or by own calibration.



Teensy 3.5 uses 12 bit:

648 = 001010001000<sub>(2)</sub>

612 = 001001100100<sub>(2)</sub>

Max:  $2^{12}-1 = 4095$

0V ↔ 0

3.3V ↔ 4095



## How to use CanSat as thermometer

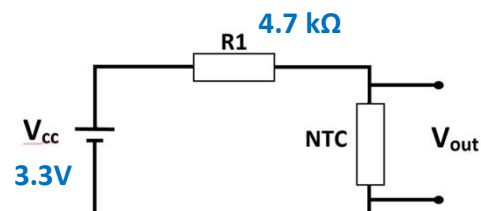
The Voltage corresponding to 648

is  $\frac{648}{4095} \cdot 3.3V = 0.52V$

corresponding to an NTC resistance  $R_{NTC}$  of:

$$R_{NTC} = \frac{V_{out}}{V_{cc} - V_{out}} \cdot R_1 = \frac{V_{out}}{3.3V - V_{out}} \cdot 4.7 \text{ k}\Omega$$

$$= \frac{0.52V}{3.3V - 0.52V} \cdot 4.7 \text{ k}\Omega = 0,88 \text{ k}\Omega$$



Can be calculated into temperature by data sheet or by own calibration

<https://www.narom.no/wp-content/uploads/2016/11/TempSensor-NTC.pdf>



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```

unsigned long time;

void setup() {
  Serial.begin(9600);
}

void loop() {
  time = millis();
  int sensorValue = analogRead(A0);

  Serial.print(" | Time[millisek]: ");

  Serial.print(time);
  Serial.print("Sensor_0 spenning: ");
  Serial.println(sensorValue);
  delay(1000);
}

```

Time Indication

Write Text

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