KOBA BY KOBAKANT
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KOBAKANT
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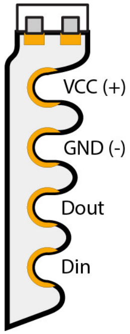

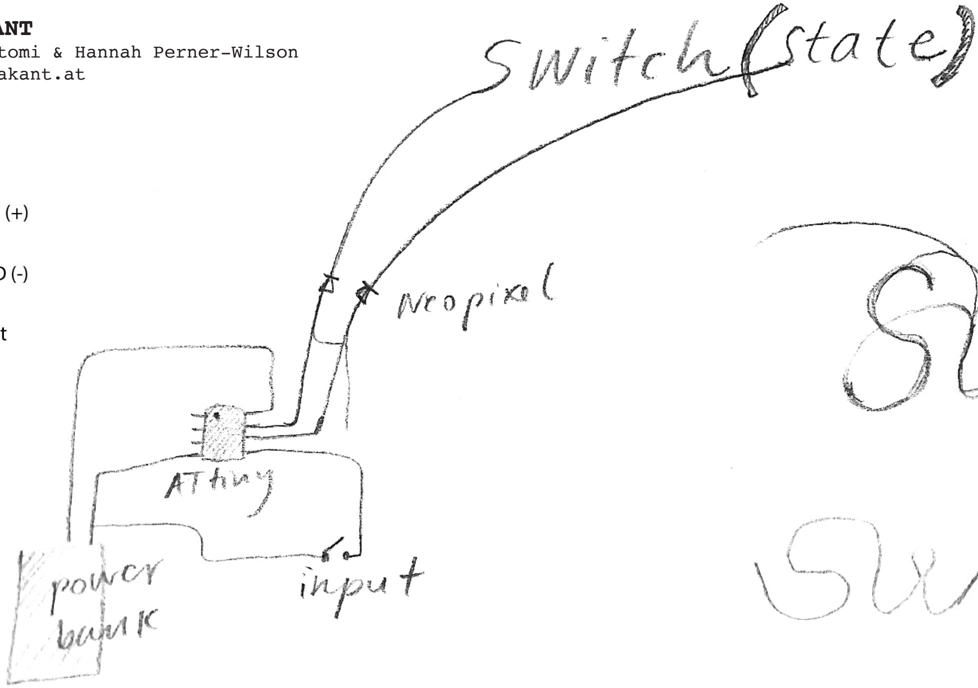

Tailoring with Electronic Textiles:

POETRY IN MOTION

January 10-12 2019
hosted jointly by Interface Cultures and Fashion and Technology departments at the Art University Linz, Austria

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sw switch(sta

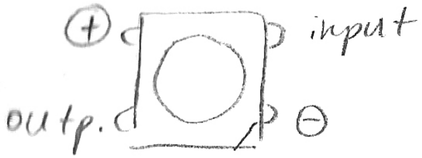
switch(state)

switch state

#include
inclu

#include

float



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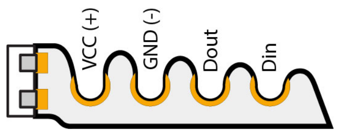


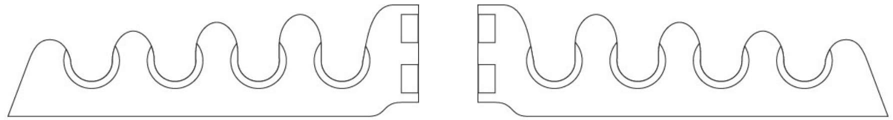
trust

This booklet belongs to: ________________________________

SCHEDULE

Thr	Fri	Sat
10-12 (2h) Introduction lecture	10-13 (3h) Arduino continued Analog sensor value → fade LED map, constrain Digital sensor → on/off Digital sensor → toggle/state Coffee break Install fastLED library Code examples	10-13 (3h) Commission working time
Lunch 12-13	Lunch 13-14	Lunch 13-14 (we prepare)
13-18 (5h) Meet the Materials SWATCH: traces and connections Textile Sensors SWATCH: textile sensor Intro: voltage divider, multimeter Worksheet: resistance, delta, voltage Intro: Arduino Programming Intro: “Poetry in Motion” Commission 17:00 Commissioners come	14-18 (4h) Lulu Intro SWATCH: Lulu Chain Lulu swatches in each group Intro: e-textile project process Interaction design exercise Commission working time	14-18 (4h) Commission working time 16:00 finish Fill out Lulu questionnaire 17:00 Commissioners come

How would you design the pin-out markings on the Lulu board?



Do you think you will use the Lulu in future projects?
yes – no – maybe

If YES, what do you want to build?

If NO, why not?

How would you want to buy a Lulu in future?
local shop – online – order PCB and assembly yourself –
other: ________________

Do you prefer to buy the Lulu independently or in a kit with other materials?
independantly – kit

How much would be willing to pay for a single Lulu?
__________ Euro

How much would be willing to pay for a kit containing:
2 Lulus, shrink-tube, 2m optic-fiber, 5m conductive thread?
__________ Euro

What materials and tools would you need to work with the Lulu that you don’t already have?

Anything else?

After completing this quesstionaire, please take a photo and email it to: lulu@etextile.org

Lulu Questionnaire

What experience do you already have working with...

…electronics: none – some – expert
…programming: none – some – expert
…textiles: none – some – expert
…e-textiles: none – some – expert

Please explain what the Lulu is in your own words:

How would you rate your experience of working with the Lulu?
easy - good learning curve - hard learning curve - difficult

What do you know now that you wish you had known in the beginning of this course?

What tip would you give somebody who is new to Lulu?

What did you like best about working with the Lulu?

What was most difficult about using the Karl-Grimm conductive thread to sew the Lulu circuitry?

What did you do with the ends of your conductive thread?
tie knot - solder - other:______________________

How was it to work with the optic fiber?
shrink-tube process: easy - medium - hard
couching technique: easy - medium - hard

When you had questions about the Lulu and the other materials, where did you find answers?
teacher – other students – online – other:__________________

Poetry in Motion

Written language is powerful tool for private communication as well as public propaganda. How would you feel about displaying words that hold meaning on your body?

In this workshop you will receive a commission for a “poetry in motion” jacket from somebody. They will provide you with a poem that holds meaning to them, and you will translate this into a garment.

KOBA Schneiderei für ELektronische Textilien

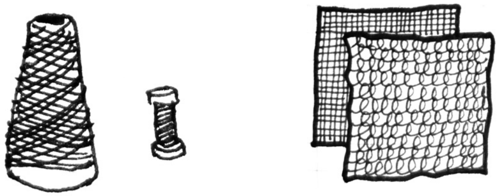
www.kobakant.at/KOBA

For the last 6 months KOBAKANT have been running KOBA, a tailorshop for electronic textiles and wearable technology in Berlin, Germany. This workshop is our chance to share some of our experiance at being e-textile tailors with you. We hope to challenge you to learn new techniques, inspisre you to engage with this expressive medium, and also enjoy creating something for somebody else.

CONTENTS

Meet the Materials

Not all conductive materials are equal. And we know very little about the origin of the materials we are working with.
Where do the raw materials come from?
How are they manufactured?
Can we recycle them?



Most conductive fabrics, threads and yarns are a blend of a conductor (metal, carbon or an inherantly conductive polymer) and non-conductive synthetic or natural fiber. This blending is done at the level of plating, coating, doping and spinning, as well as weaving and knitting. Intertwining materials at this level makes it hard to sperate them again. Unfortuantely there is near to no information about how to recycle these materials, how to prolong their life-time or even how to properly dispose of them.

When working with these materials you should:

- **take care** to produce as little waste as little.

- **consider** design solutions that use less material.

- **re-use** your own leftovers.

- **design for longevity**, make things that will last and that can be repaired when broken!

- **be curious**, find out as much information as possible about the materials you are using & wearing.

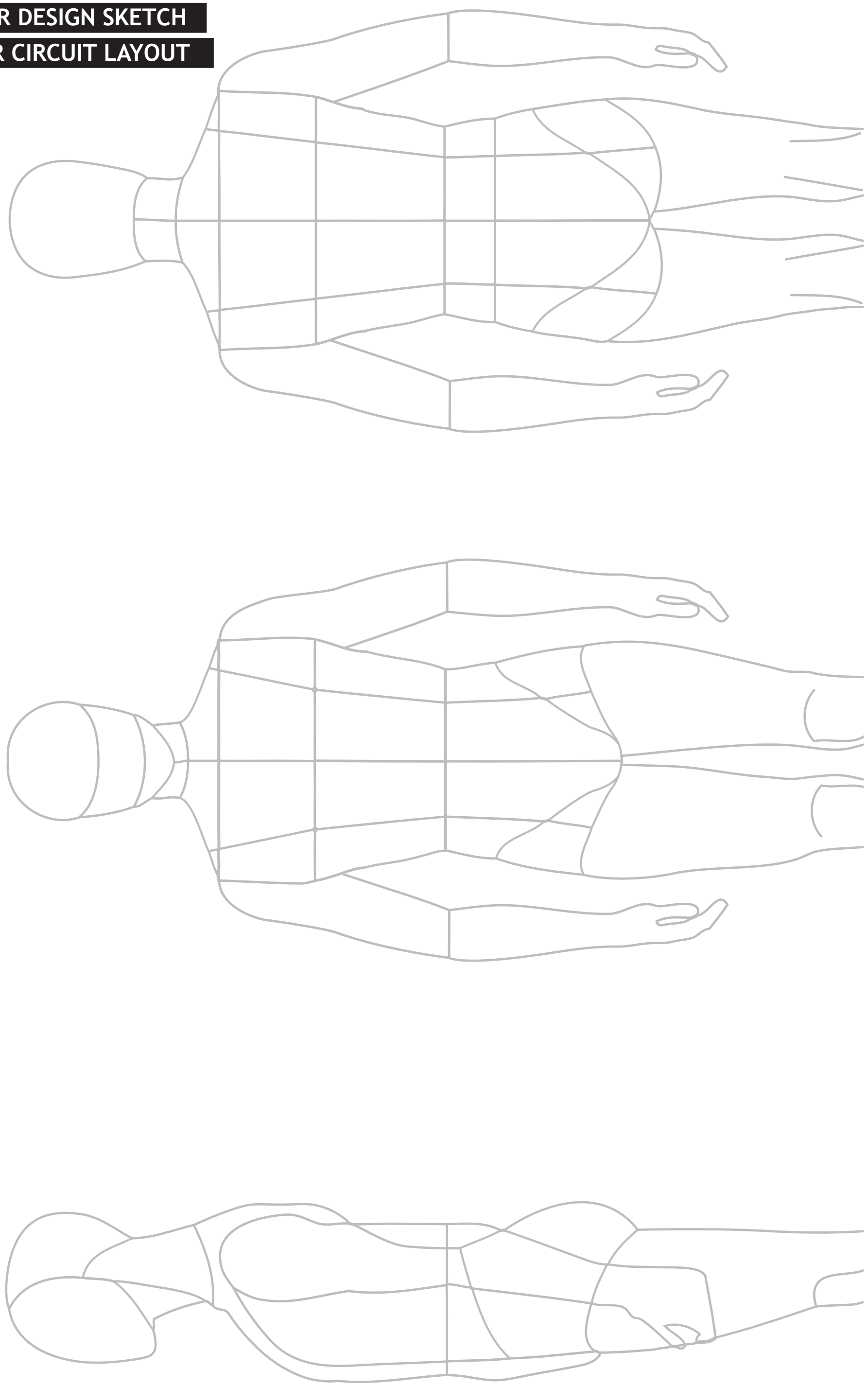
- **demand information**, contact suppliers as well as your local waste/recycling facilities and ask them to provide you with information about how to recyle them.

YOUR CIRCUIT DIAGRAM

YOUR PSEUDO-CODE

YOUR DESIGN SKETCH

YOUR CIRCUIT LAYOUT



Conductive Fabrics, Threads and Fibers

conductive, resistive, piezoresistive

Copper Conductive Fabric
Corrosion proof copper-silver plated polyamide ripstop fabric

Producer: Statex

0.03 ohm/sq

note:

20k ohm/sq

RIPSTOP SILVER FABRIC
Silver plated nylon

Vendor: lessEMF

0.25ohm/sq

note:

Silver Stretch Conductive Fabric
Silver plated knitted fabric, 78% Polyamide + 22% Elastomer plated with 99% pure silver

Producer: Statex

1 ohm/sq

note:

High Flex 3981 silver 14/000
Fine silver plated copper fiber plied with synthetic fiber core. Solderable
Producer: Karl Grimm

5cm

ohm/cm

note:

Elitex
235/34 Polyamid plated with silver
Producer: Imbut GmbH

5cm

ohm/cm

note:

Conductive Yarn
Nm10/3 conductive yarn, 80% polyester 20% stainless steel, light grey
Producer: plug and wear

5cm

ohm/cm

note:

Velostat
Carbon impregnated black polyethylene film.

producer: 3M

500 Ohms/cm

note:

Bemis heat bond
textile iron-on glue. Not a conductive material

Producer: Bemis

note:

E-TEXTILE DESIGN PROCESS

CONSTRAINTS

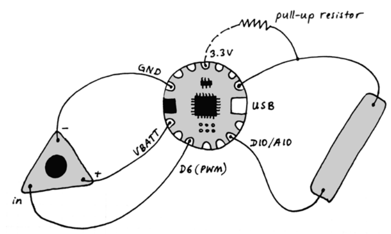
- poem
- integration into existing garment
- max 2 sensors to detect movement
- max 2 addressable LEDs
- max 2m of sideglow optic fiber
- 1 Flora
- 1 USB powerbank
- 1 day

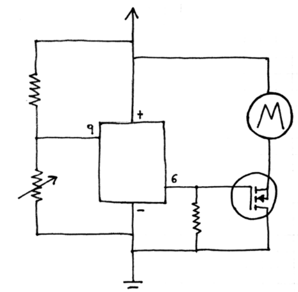
ARTISTIC INTERPRETATION

- what is the core statement of your commissioner's poem
- what gesture will trigger what lighting effect?

CIRCUIT DIAGRAM

Draw a schematic diagram of your circuit that indicates what connects with what. You can do this graphically or abstractly using component symbols.

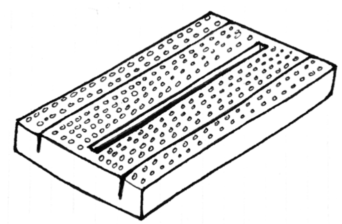




PSEUDO-CODE

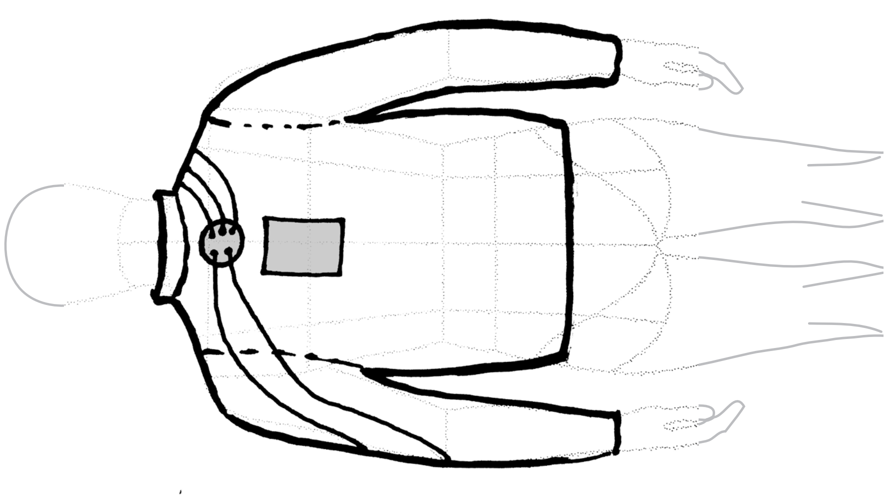
Write in human-language what opperations your program will do?

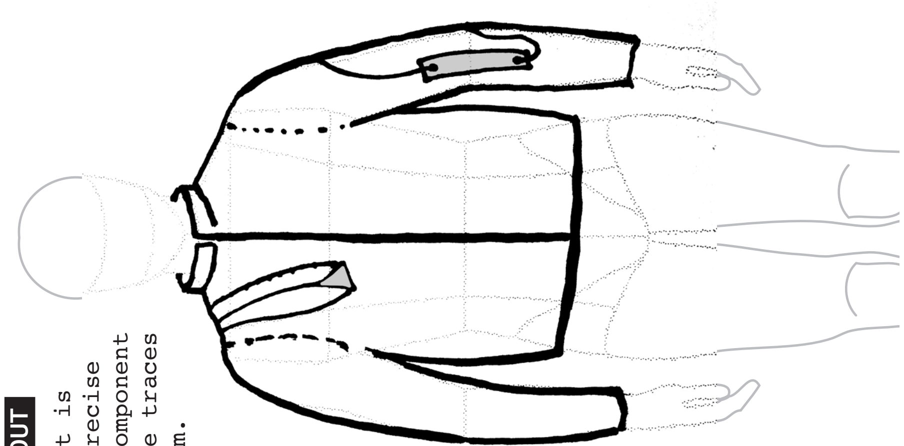
example:
"if sensor value goes bellow a certain threshold, then LED should fade from yellow to red"



CIRCUIT PROTOTYPING

Before finalizing your circuit test it using a breadboard and crocodile clips.

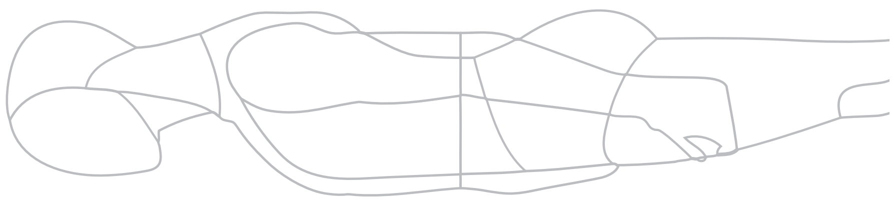




DESIGN SKETCH

CIRCUIT LAYOUT

Once your circuit is tested, make a precise drawing of the component placement and the traces that connect them.



SWATCH

Conductive Traces

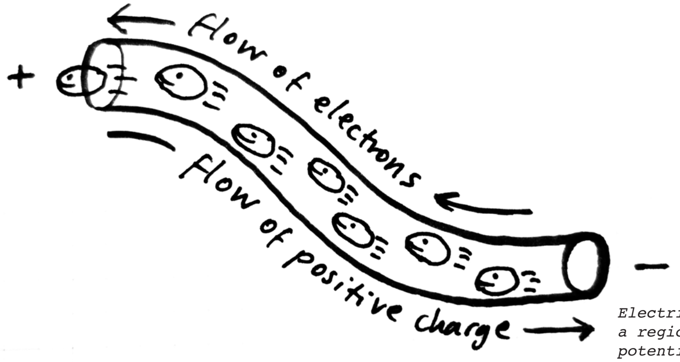
fused conductive fabrics and sewn conductive threads

fused conductive fabric

hand-sewn conductive thread

machine-sewn conductive thread

ELECTRICITY

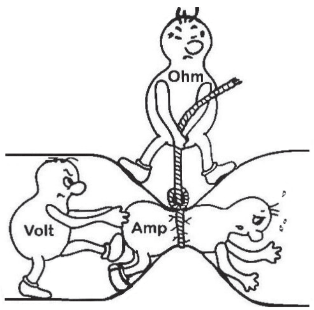


Electrical current flows from a region of high charge or potential to a region of low potential.

Voltage (V) - is electrical pressure or force. Sometimes referred to as potential. Voltage drop is the difference in voltage between the two ends of a conductor through which current is flowing.

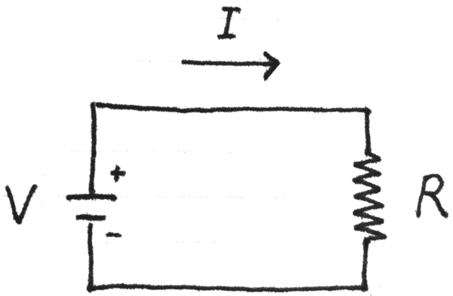
Current (I) - is the quantity of electronics passing a given point. The unit of current is Ampere.
1 Amp = 6,280,000,000,000,000,000 electronics passing a point in one second.

Resistance (R) - conductors are not perfect, they resist the flow of current to some degree. the unit of resistance is the Ohm (Ω).



WATER ANALOGY

If we compare electricity to water flowing through a pipe, then:
Voltage is the water pressure,
Current is the stream of flow of water,
Resistance is the valve.



OHM'S LAW

$$V = I \times R$$

A potential difference of 1V will force a current of 1A through a resistance of 1Ω

Lulu Daisy Bumblebee

programming light into textile

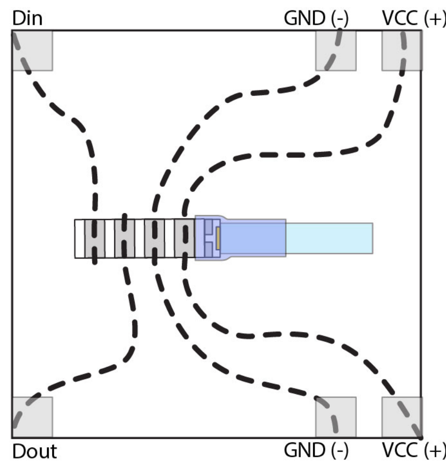
Lulu is a hardware solution that interfaces between an LED light source, an optic fiber strand or bundle, and sewable soft circuit connections.

Materials:
Conductive thread
Conductive fabric with fusible
Lulu Daisy Bumblebee
Shrink-tube 6mm with hot-melt-adhesive
Optic-fiber 2mm sideglow

Tools: sewing needle, scissors, hot-air-gun

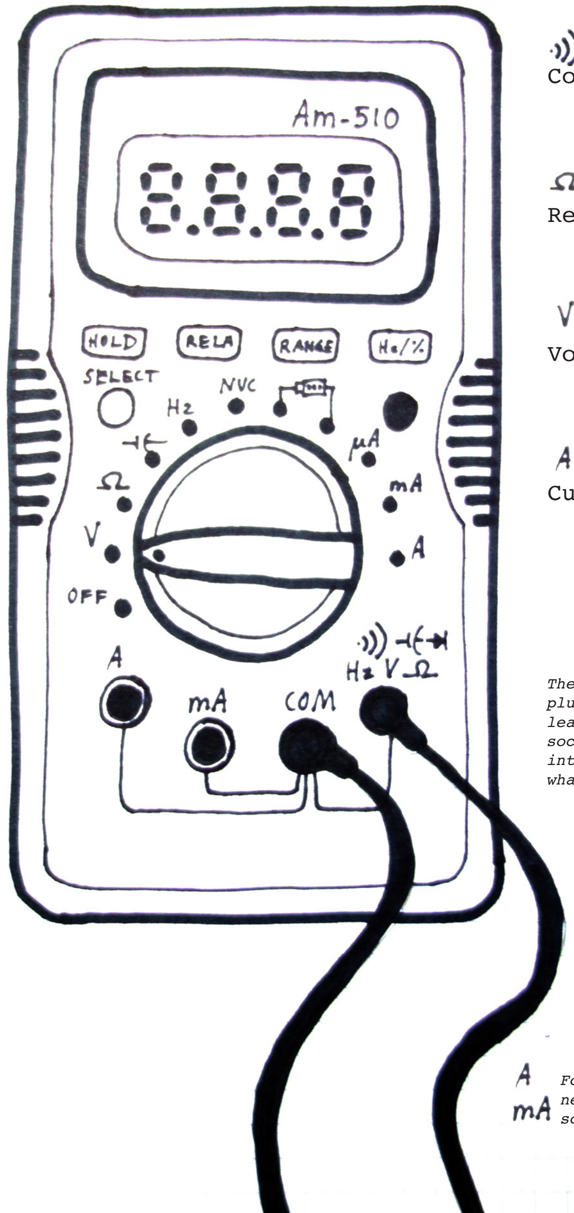
Techniques: sewing, cutting, shrinking tube

Lulu:
>> https://github.com/eTextile/Lulu



YOUR FRIEND - THE MULTIMETER

The multimeter is one of the most important electronic textile instruments. We will use it it for measuring electrical continuity (beep), resistance (Ω), voltage (V DC), and current (Ampere).



Continuity

Ω
Resistance

V
Voltage

A
Current

The leads of the multimeter's probes plug into these sockets. The black lead can generally stay in the COM socket, while the red lead will plug into a different socket depending on what you are measuring.

Hz V Ω

For measuring continuity, resistance and voltage, the red lead needs to be in the socket with these symbols.

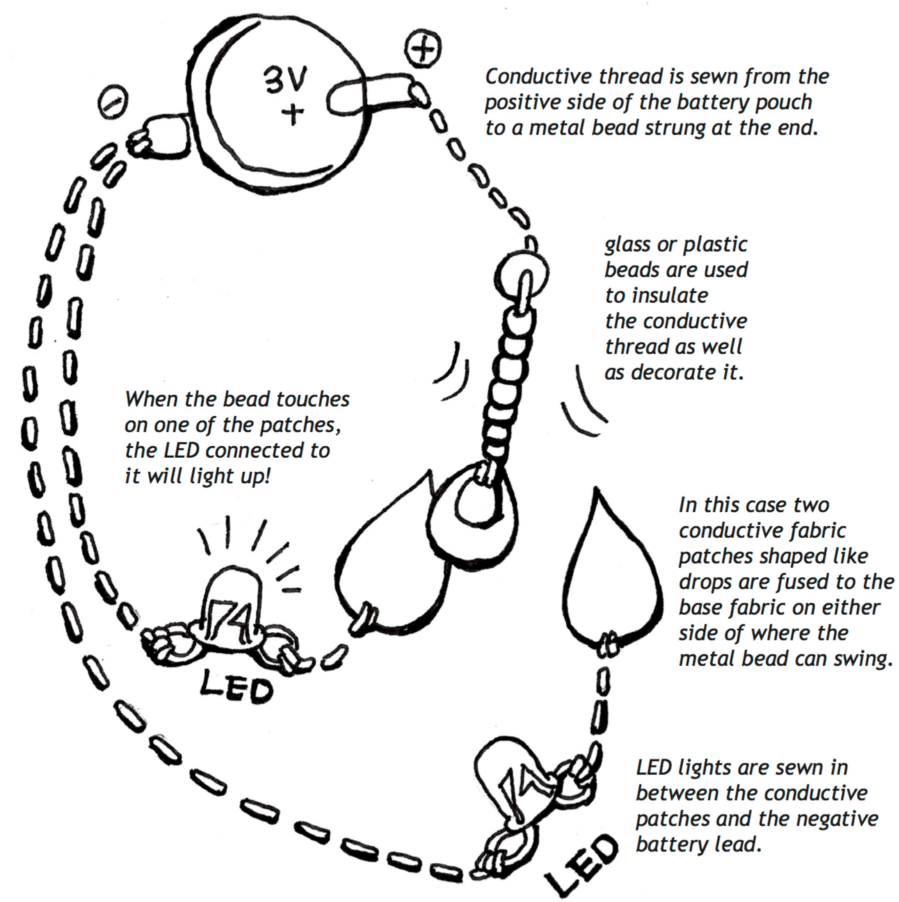
A
mA

For measuring current, the red lead needs to be plugged into one of the sockets with an A for Ampere.

Beaded Tilt Switch

A super simple tilt switch made from a metal bead strung on the end of condcutive thread, and a patch of conductive fabric nearby.

This sensor is made by stringing a metal bead to the end of a piece of conductive thread. A patch of conductive fabric is fused to the base fabric so that when the metal bead swings to a certain point it makes contact with the patch, closing the switch.



Connect Optic-Fiber with Lulu

```
Before sewing your optic-fiber into your project connect the
Lulu to the end(s) of the fiber using shrink-tube that has
hot-melt-adhesive inside.
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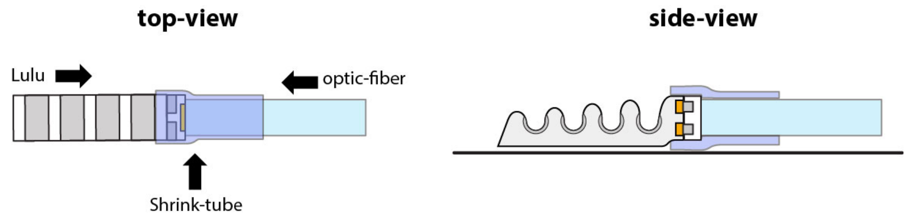

Sew Circuit

```
You can sew the VCC(+) and GND(-) connections with one long
piece of conductive thread. The Data-in contact should con-
nect to the Data-out contact as shown in this illustration:
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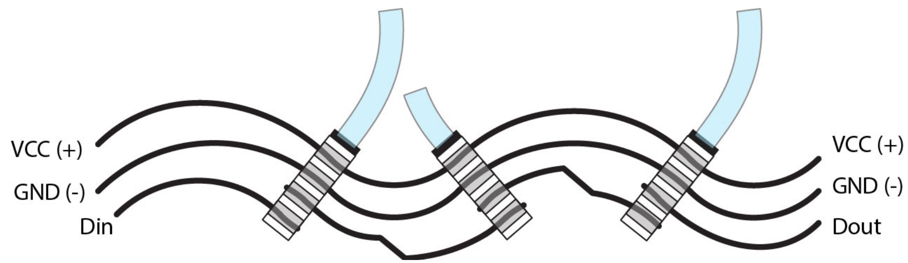


Lulu Daisy - Programming light into textile

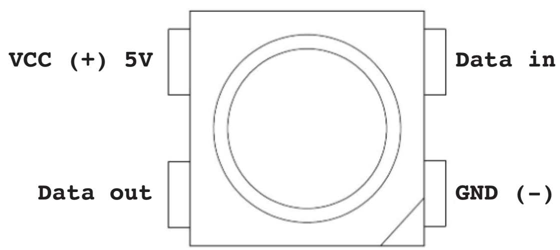
Lulu is a hardware solution that interfaces between an LED light source, an optic fiber strand or bundle, and sewable soft circuit connections.

Lulu is providing a simple, reliable toolset for people who want to use side glow optical fibers in their eTextile and wearable projects. Use of light in textile and fashion design is becoming more and more common and many schools started to teach this subject as a part of their textile design curriculum. Optic fibers could be embedded in textiles as embroidery, in weaving, knitting and knotting process and many textile designs have been realized in recent years.

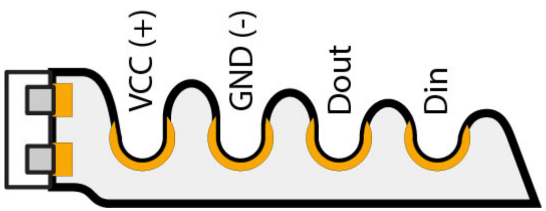
This is the first version of the Lulu Daisy Bumblebee_18.01 and you are our beta-testers:-)

>> https://github.com/eTextile/Lulu

WS2018 MINI addressable LED



Lulu Daisy Bumblebee_18.01



SWATCH

Beaded Tilt Sensor

digital sensor

Contact Switch detects if two contact points are touching or not. By extending one of the contact points with conductive thread and metal bead with weight, you can create a sensor that detects tilting direction. The metal bead swings with gravity and touches with open contact as it gets tilted.

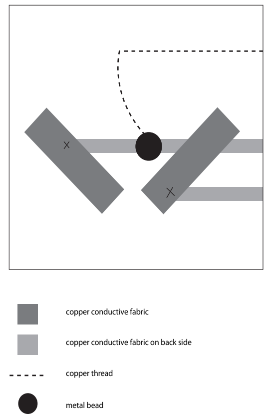
Materials: cotton fabric, copper thread (Karl-Grimm), copper conductive fabric, fusible interfacing, metal bead, galss/plastic bead

Tools: scissors, iron, sewing needle

Techniques: fusing, sewing

Tilt Sensor:

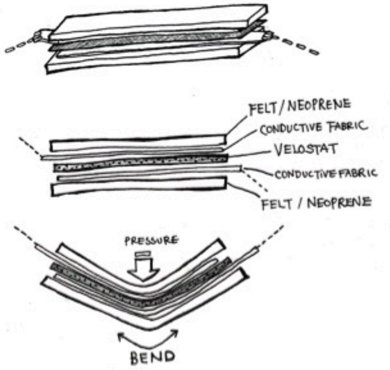
>> http://www.kobakant.at/DIY/?p=201

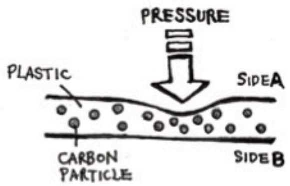


Neoprene Bend Sensor

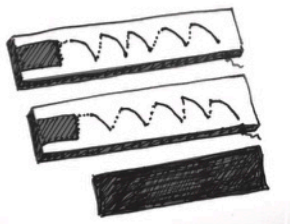
This sensor is constructed by layering conductive and piezoresistive materials. Velostat is a piezoresistive plastic film that reacts to pressure with a decrease in electrical resistance. The sensitivity of this sensor can be adjusted by controling how large the conductive areas on either side of the Velostat are.

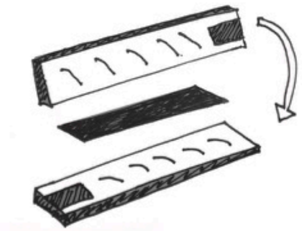
To make a bend sensor with a good range the conductive area should be minimized to just a few points of overlap. To achieve this the contacts on either side of the Velostat are stitched into neoprene as diagonal lines so that when they are sandwitched together they cross and only overlap in one point.



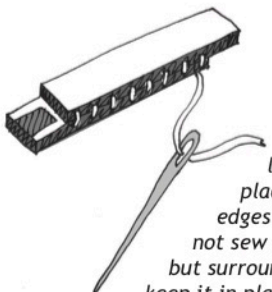


Cut two same size strips of neoprene. Thread the needle with conductive thread and tie a knot in one end. Stitch into the neoprene, exposing the thread in diagonal stitches as shown in the illustrations. Finish sewing the conductive thread by connecting it to a patch of conductive fabric at one end of the neoprene strip. This will make contacting the sensor easier.





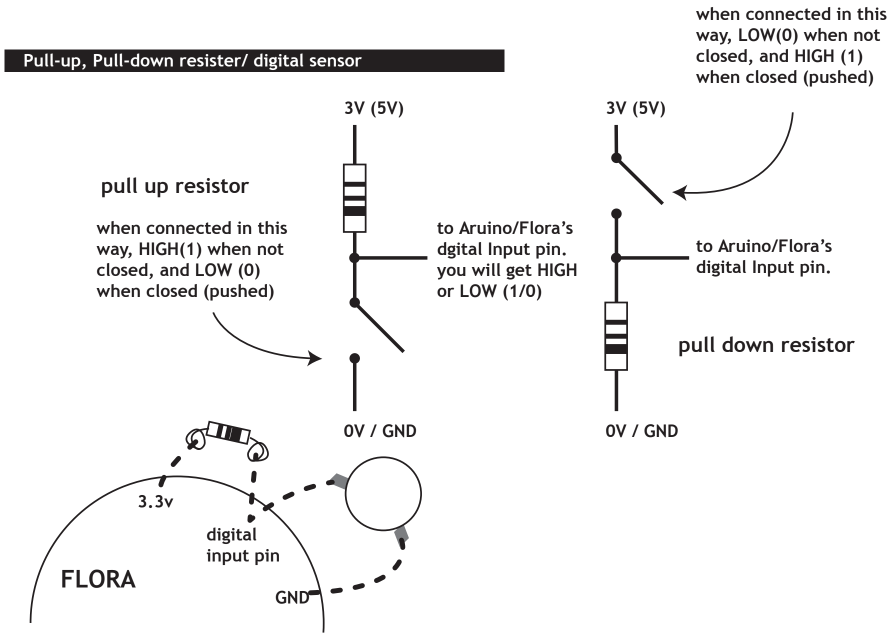
Layer a piece of Velostat in between the two pieces of neoprene, with the conductive stitches facing each other. The conductive fabric tabs should be on opposite ends. Make sure the conductive thread and the conductive fabric on either side never touch directly, only through the Velostat.



Thread the needle with regular sewing thread. Holding the layered materials in place, stitch around the edges of the neoprene. Do not sew through the Velostat, but surround it with stitches to keep it in place.

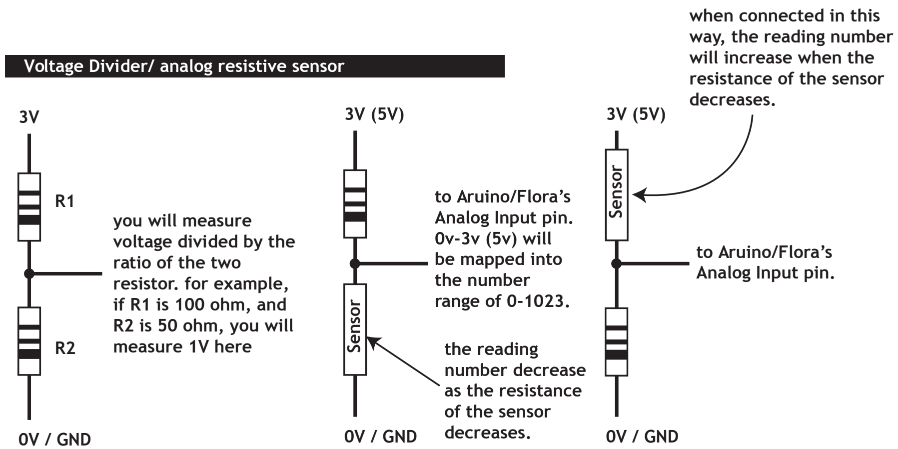
To test your finished sensor, connect either end to a multimeter set to measure resistance (Ohm). As you bend or pressure the layers of the sensor together, the resistance should decrease. Depending on the construction of your sensor, the values should range from 2K Ohm to 200 Ohm.

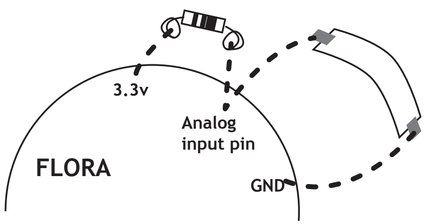
Pull-up, Pull-down resister/ digital sensor



Reading Sensors with Arduino

Voltage Divider/ analog resistive sensor



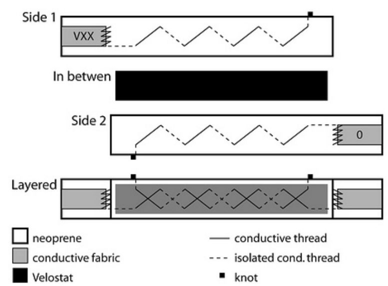


Neoprene Bend Sensor

analog sensor

This bend sensor actually reacts (decreases in resistance) to pressure, not specifically to bend. But because it is sandwiched between two layers of neoprene (a thick, sturdy material), pressure is exerted while bending, thus allowing one to measure bend (angle) via pressure.

You can make this sensor with any piezoresistive material, such as velostat, eeonyx non-woven or eeonyx stretch as middle material.



Materials: neoprene, conductive thread, piezoresistive material (velostat, eeonyx non-woven or eeonyx stretch), conductive fabric (silver stretch), fusible interfacing

Tools: scissors, sewing needle, iron

Techniques: cutting, fusing, layering, sewing

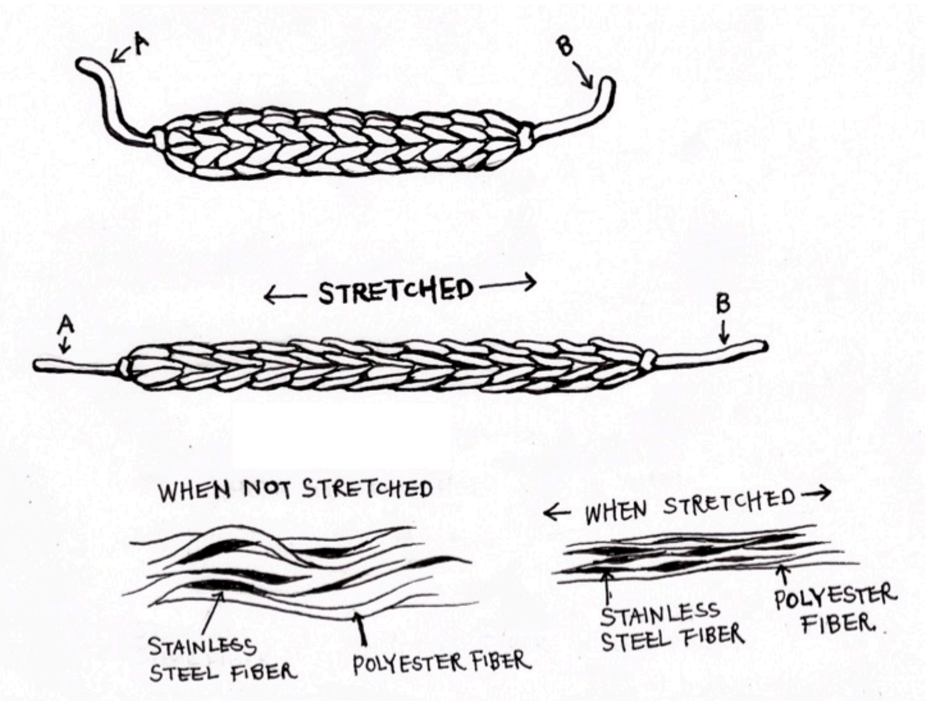
Neoprene Bend Sensor:

>> http://www.kobakant.at/DIY/?p=20

Knit Stretch Sensor

Stainless steel yarn is perfect for knitting or crochetting stretch sensors. The yarn is spun from a stainless stell and polyester yarn blend, making it conductive, but with a very high electrical resistance. When in a relaxed state the individual conductive fibers are not touching much, but when compressed through pressure or stretch, the steel fibers in the yarn make better contact and it becomes more conductive the more it is compressed. We can use this property of the yarn to sense stretch or pressure.

A single strand of yarn can already be used as a stretch or pressure sensor. But you can knit or crochet the yarn into any shape you like to make it more stretchy or squishy and giving you some feedback when manipulting the material.



I/O	DIGITAL	ANALOG
READ	**digitalRead(pin);** *returns: HIGH or LOW*	**analogRead(pin);** *returns: 10bit analog reading between 0 - 1023 (ADC resolution)*
WRITE	**digitalWrite(pin, HIGH or LOW);** *writes: HIGH (3V, 5V) or LOW (0V or GND)*	**analogWrite(pin, [0-255]);** *writes: 8bit PWM duty cycle between 0(always off) - 255(always on)*

SERIAL COMMUNICATION

Serial.begin(speed);
Sets the data rate for serial data transmission.
speed: in bits per second (baud)

Serial.print(val);
Prints data to the serial port as human-readable ASCII text.
val: the value to print - any data type

MATH

% "Modulo"
Remainder operation calculates the remainder when one integer is divided by another.

```
int x = 0;
x = 7 % 5;    // x now contains 2
x = 9 % 5;    // x now contains 4
x = 5 % 5;    // x now contains 0
x = 4 % 5;    // x now contains 4
x = -4 % 5;   // x now contains -4
x = 4 % -5;   // x now contains 4
```

map(value, fromLow, fromHigh, toLow, toHigh);
Re-maps a number from one range to another.
value: the number to map
fromLow, fromHigh: the lower and upper bounds of the value's current range
toLow, toHIGH: the lower and upper bounds of the value's target range
returns: the mapped value

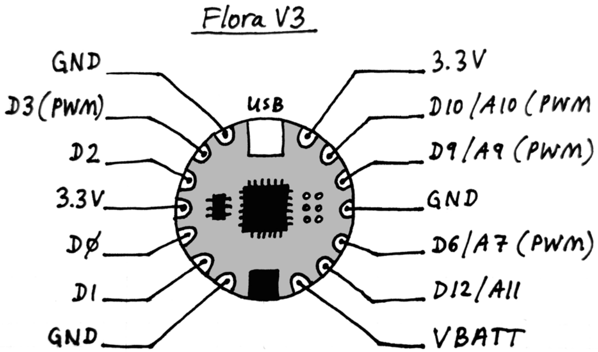
constrain(x, a, b);
Constrains a number to be within a range.
x: the number to constrain / a: the lower end of the range / b: the upper end of the range
returns: the constrained value

CONTROL STATEMENT

if (condition){ ... }
Executes the proceeding statement or set of statements if the condition is 'true'.
condition: true or false

for (initialization; condition; increment) { . . . }
Repeats a block of statements enclosed in curly braces as long as the condition is true. When the condition becomes false, the loop ends.

ARDUINO: MICROCONTROLLER PROGRAMMING



DOWNLOAD & INSTALL

Dowload the latest Arduino IDE version:
https://www.arduino.cc/en/Main/Software

Install the Flora:
https://learn.adafruit.com/adafruit-arduino-ide-setup/arduino-1-dot-6-x-ide

Download fastLED library:
http://fastled.io/

Workshop code examples:
https://github.com/KOBAKANT/workshop_material

Arduino CODE/SYNTAX

STRUCTURE

void setup() { . . . }
The setup function is called when a sketch starts. It will only run once after each powerup or reset of the Arduino board.

void loop() { . . . }
loops consecutively, allowing your program to change and respond.

VARIABLES

byte	0 to 255	1byte
int	-32,768 to 32,767	1byte
float	3.4028235E+38 and as low as -3.4028235E+38	4bytes
char	'A' or "ABC" a character value	1byte
bool	true or false	1byte

SWATCH

Knit/Crochet Stretch/Squeeze Sensor

analog sensor

Conductive yarn knit into tubular knit with 4 needle knitting mill. It lowers its resistance across the two end as it gets stretched.

Materials:
Plug and wear Conductive yarn (polyester 80% Stainless steel 20%), non-conductive yarn

Tools: knitting mill, crochet hook, scissors

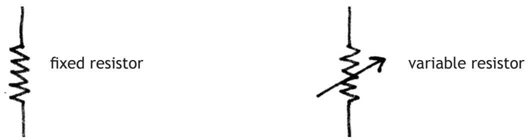
Techniques: knitting with 4 needle knitting mill

Circular knit stretch sensors:
>> http://www.kobakant.at/DIY/?p=2108

TEXTILE SENSORS

VARIABLE RESISTORS

The sensors we will construct in this workshop all work as variable resistors, meaning their electrical resistance changes under the circumstances of what they can sense.

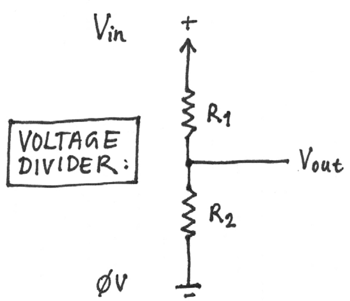


VOLTAGE DIVIDER

A voltage divider allows us to convert resistance into voltage. Connect two resistances in series, apply a voltage across them and measure the voltage at the point inbetween them - V(out).

Using Ohm’s law you can calculate how much voltage will be at V(out).
If one of these resistors were to vary their resistance, V(out) would also vary.

Because the ADC (Analog to Digital Converter) of the Arduino microcontroller reads voltage (not resistance), you will need to create a voltage divider for every sensor that you want to read.



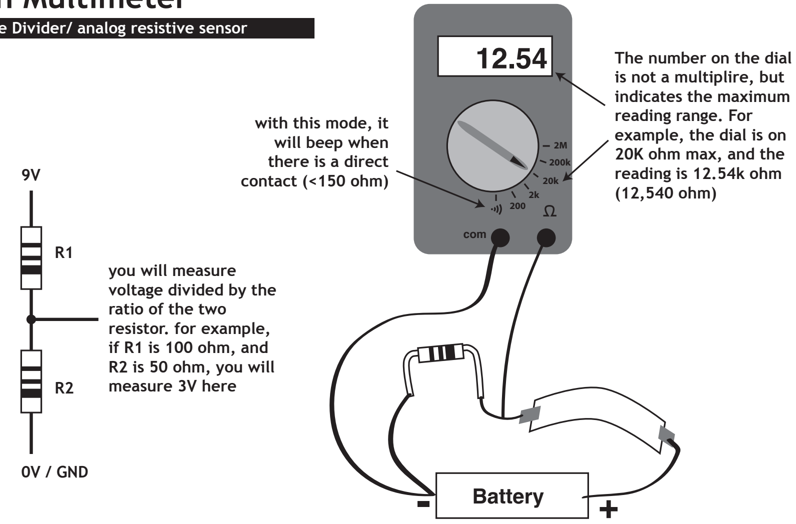
$\boxed{\text{Ohm's Law: } V = I \times R}$

$$V_{in} = I \times (R_1 + R_2)$$

$$V_{out} = V_{in} \cdot \left(\frac{R_2}{R_1 + R_2} \right)$$

Reading Analog Sensors with Multimeter

Voltage Divider/ analog resistive sensor



Voltage Divider Worksheet

Enter your sensor's resistance range, select your voltage divider, measure the voltage:

	sensor's resistance range		*voltage divider*	*sensor's voltage range*	
SENSOR	MIN Ω	MAX Ω	MEAN Ω	MIN V	MAX V