

TANGIBLE MEDIA & PHYSICAL COMPUTING

SENSORIAL SENSORS



AGENDA

SENSORIAL SENSORS



SENSORIAL SENSORS

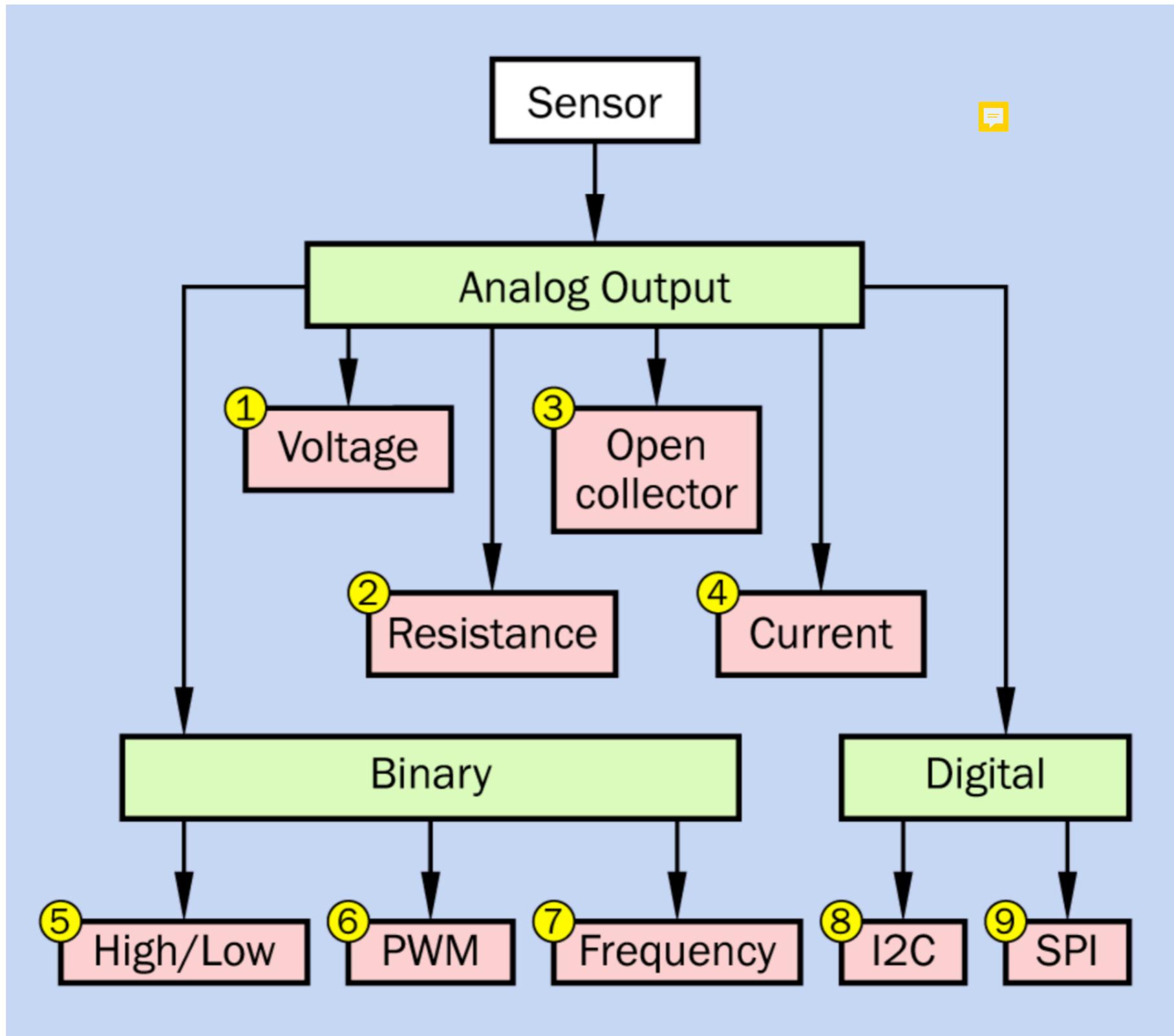
LOCATION. PRESENCE. PROXIMITY. ORIENTATION.
OSCILLATION. FORCE. LOAD. HUMAN INPUT. LIQUID AND
GAS PROPERTIES. LIGHT. HEAT. SOUND. ELECTRICITY

SENSORIAL SENSORS

EVERY SENSOR INITIALLY CREATES AN **ANALOG OUTPUT**, WHICH IS SOMETIMES CONNECTED DIRECTLY TO AN OUTPUT PIN OR THE SENSOR MAY PROCESS THE RESPONSE INTERNALLY IN ORDER TO CREATE A BINARY OR DIGITAL OUTPUT.

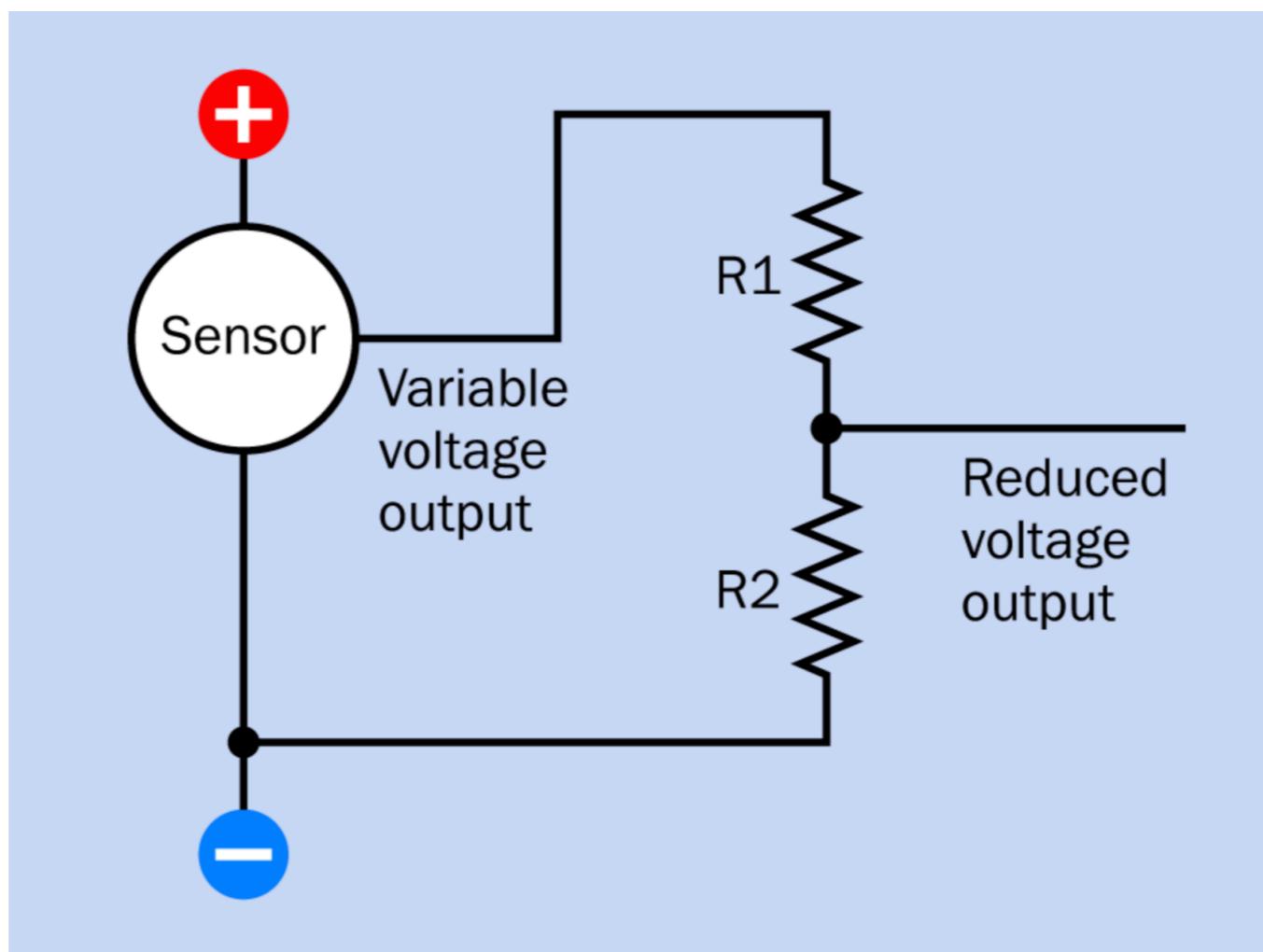


SENSORIAL SENSORS: DOMAINS



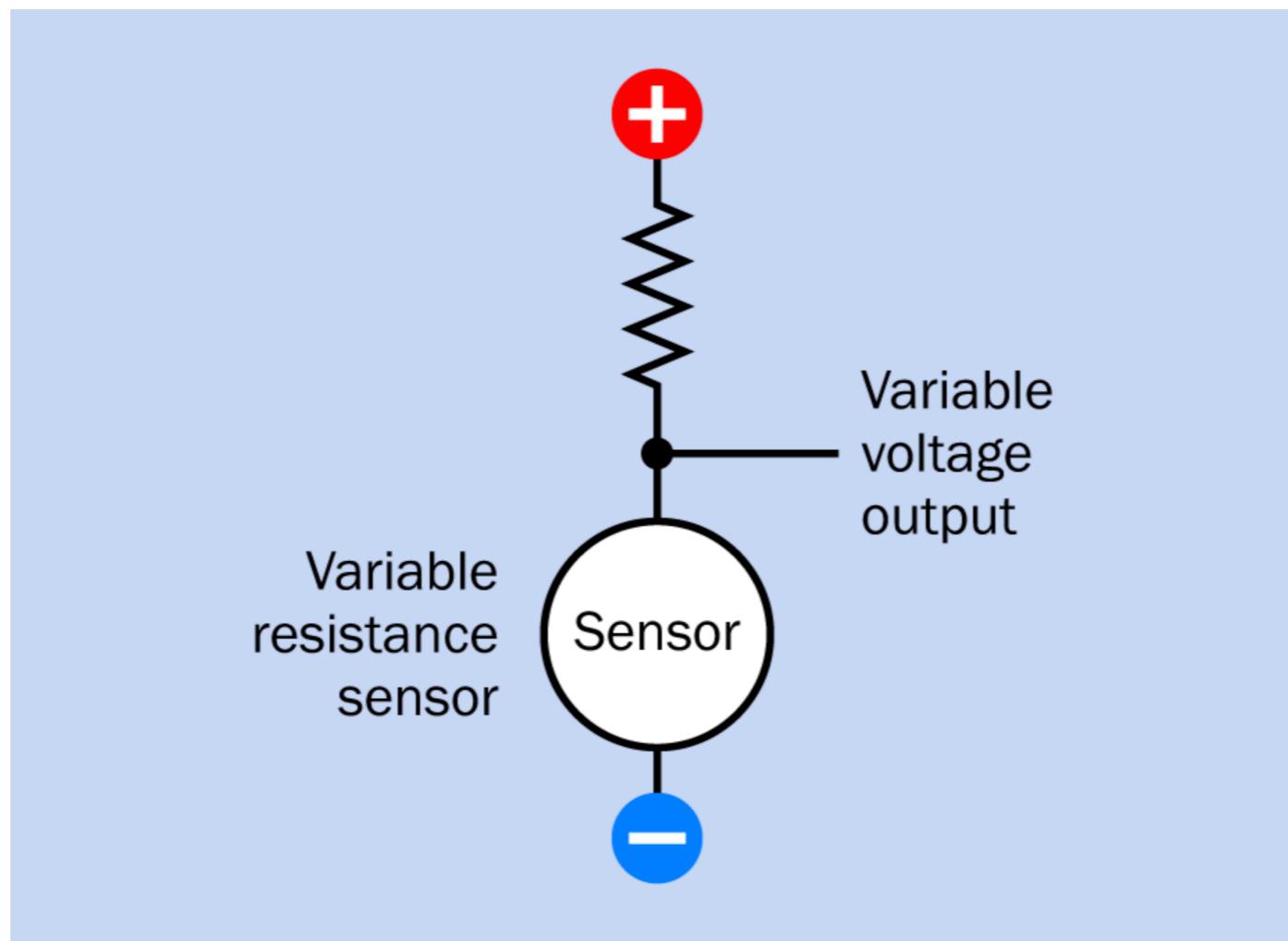
SENSORIAL SENSORS: ANALOG

ANALOG: VOLTAGE. AN ANALOG VOLTAGE OUTPUT CAN BE CONNECTED DIRECTLY TO AN ANALOG INPUT, SO LONG AS THE RANGE IS COMPATIBLE AND THE SENSOR CAN PROVIDE SUFFICIENT CURRENT.



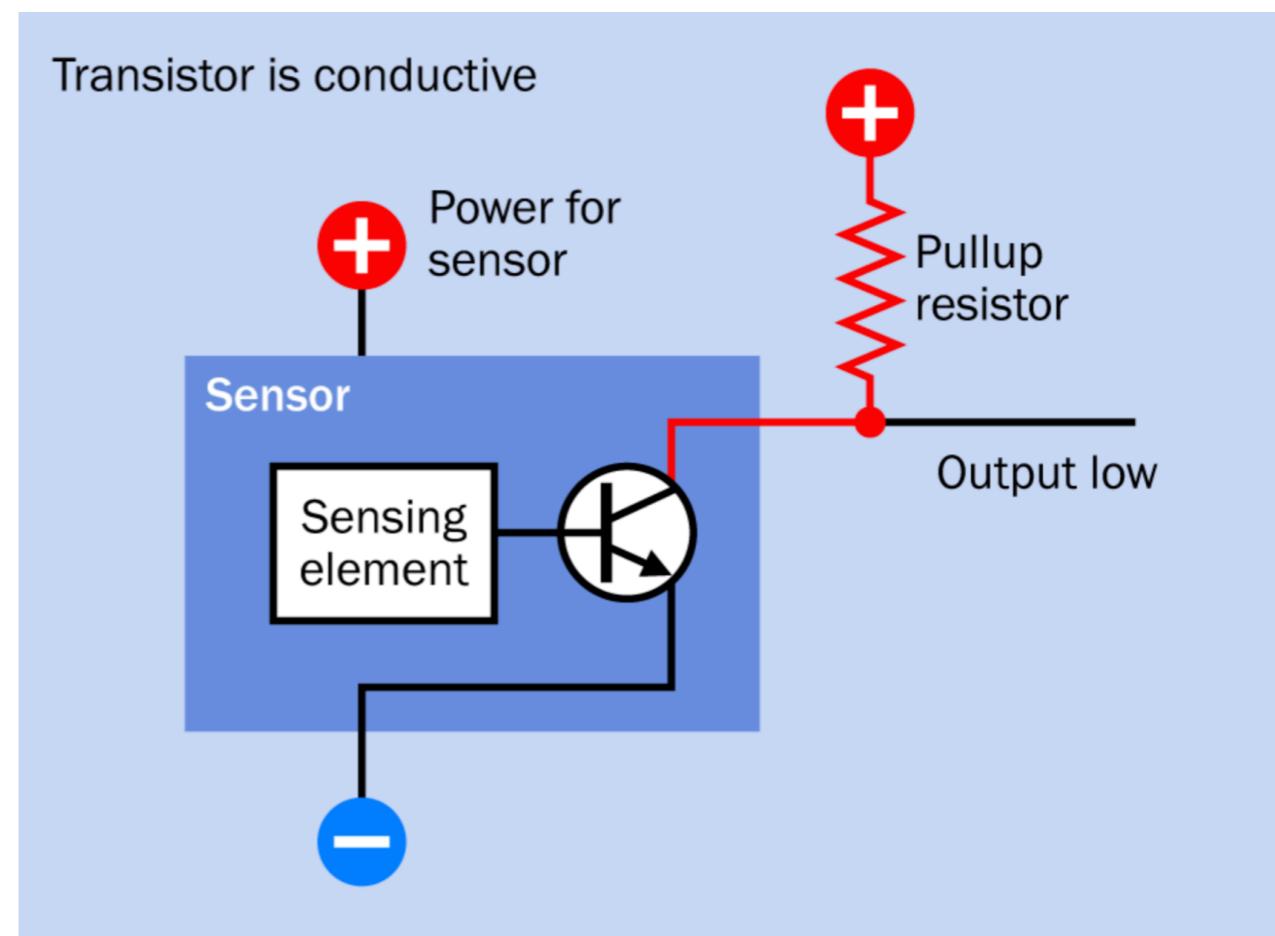
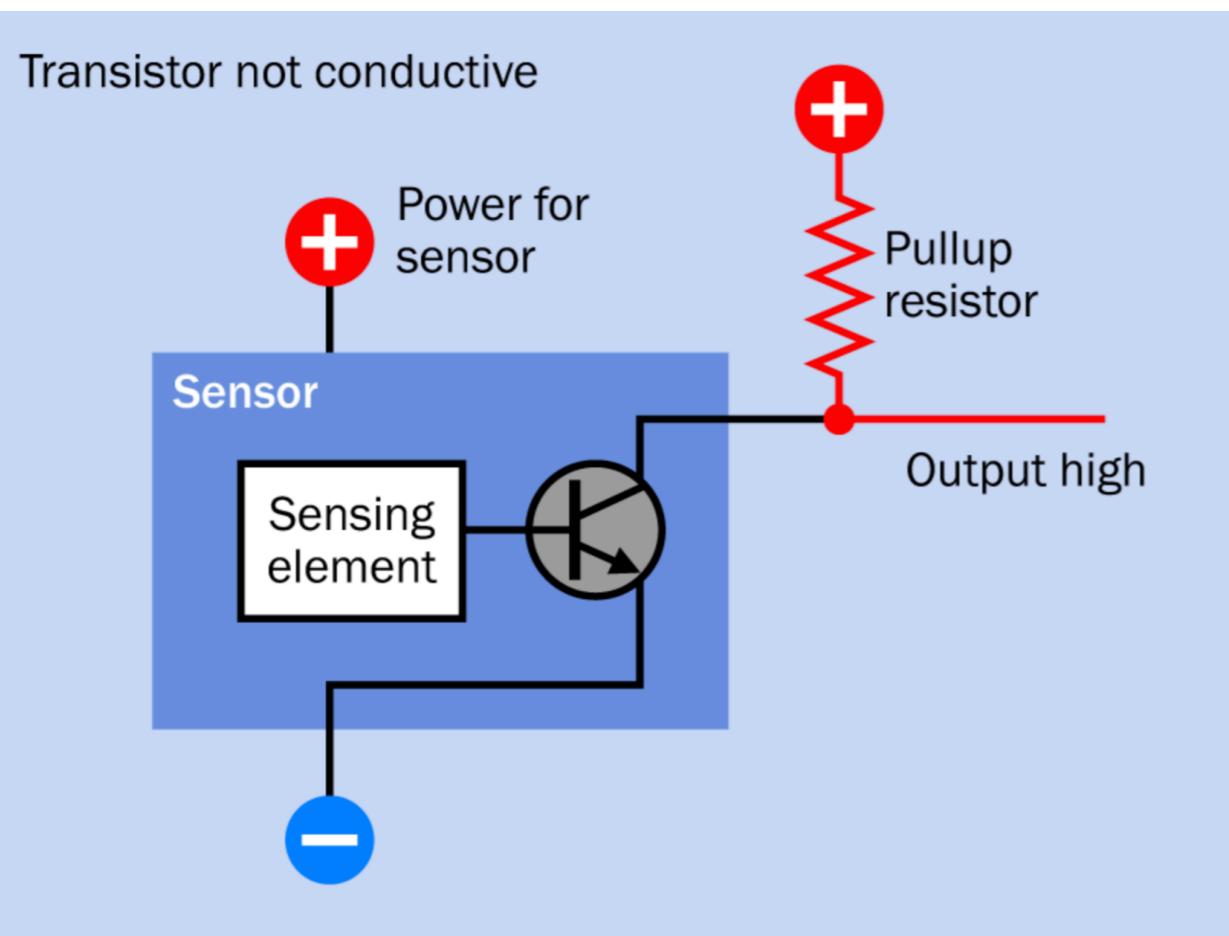
SENSORIAL SENSORS: ANALOG

ANALOG: RESISTANCE. A SENSOR THAT CHANGES ITS RESISTANCE AS IT RESPONDS TO ITS ENVIRONMENT CAN BE PLACED IN A **VOLTAGE DIVIDER** TO PROVIDE AN ANALOG VOLTAGE OUTPUT.



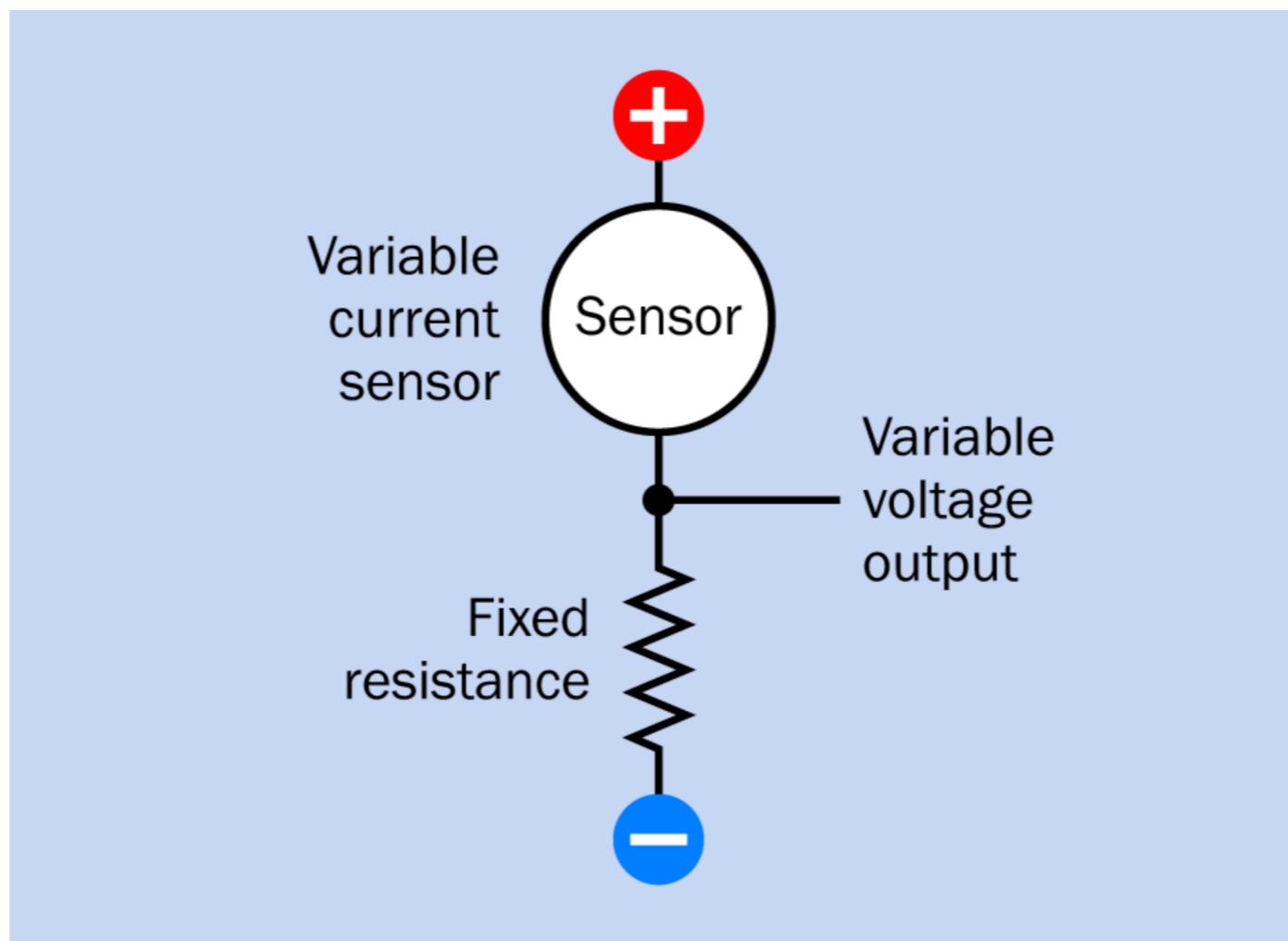
SENSORIAL SENSORS: ANALOG

ANALOG: OPEN-COLLECTOR. MANY SENSORS INCLUDE A BIPOLAR TRANSISTOR THAT HAS AN **OPEN-COLLECTOR** OUTPUT. THE TRANSISTOR MAY OR MAY NOT BE INCORPORATED IN AN INTERNAL OP-AMP.



SENSORIAL SENSORS: ANALOG

ANALOG: CURRENT. FEW SENSORS PROVIDE AN OUTPUT CONSISTING OF VARIATIONS IN CURRENT. THE OUTPUT CURRENT CAN BE CONVERTED TO A VOLTAGE OUTPUT SIMPLY BY PLACING A **FIXED RESISTOR** IN SERIES.



SENSORIAL SENSORS: BINARY

BINARY: HIGH / LOW. A SENSOR THAT PROVIDES A BINARY OUTPUT (THAT IS, AN OUTPUT THAT IS EITHER LOGIC-HIGH OR LOGIC-LOW) CAN BE CONNECTED DIRECTLY WITH A MICROCONTROLLER. IF THE VOLTAGE RANGE IS COMPATIBLE.

CODE IN THE MICROCONTROLLER CAN THEN TEST THE PIN TO ESTABLISH ITS STATE.

SENSORIAL SENSORS: BINARY

BINARY: PWM (PULSE WIDTH MODULATION). A SENSOR EMITS A STREAM OF SQUARE-WAVE PULSES WITH A FIXED FREQUENCY, BUT THE WIDTH OF EACH PULSE VARIES WITH THE STIMULUS TO WHICH THE SENSOR IS RESPONDING.

THE WIDTH OF EACH HIGH PULSE, RELATIVE TO THE WAVELENGTH BETWEEN THE START OF ONE PULSE AND THE START OF THE NEXT, IS CALLED THE **DUTY CYCLE**.

SENSORIAL SENSORS: BINARY

BINARY: FREQUENCY (HZ). A SENSOR EMITS A STREAM OF PULSES WITH A FIXED FREQUENCY. SO LONG AS THE FREQUENCY IS A SQUARE WAVE WITH A KNOWN DUTY CYCLE, THE PULSEIN() FUNCTION ON THE ARDUINO MAY BE USED.

SENSORIAL SENSORS: DIGITAL

IN DIGITAL ELECTRONICS, A **BUS** IS A COMMUNAL PATHWAY FOR SHARING DATA AMONG COMPONENTS OR DEVICES.

SENSORIAL SENSORS: DIGITAL

DIGITAL: I²C. I²C INTEGRATED CIRCUIT BUS. SOMETIMES WRITTEN AS I²C, AND OFTEN REFERRED TO VERBALLY AS “I- SQUARED-C.” A COMMUNICATIONS PROTOCOL THAT IS OFTEN USED BETWEEN A MICROCONTROLLER AND OTHER COMPONENTS ON A CIRCUIT BOARD.

SENSORIAL SENSORS: DIGITAL

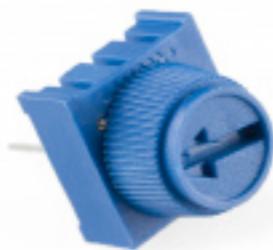
DIGITAL: SPI. SPI IS AN ACRONYM FOR SERIAL PERIPHERALS INTERFACE, A COMMUNICATION STANDARD THAT SERVES A SIMILAR FUNCTION TO THE I2C.

THE SPI STANDARD IS SLIGHTLY MORE SOPHISTICATED, ENABLING DUPLEX COMMUNICATION AND HIGHER DATA TRANSFER SPEEDS.

SENSORIAL SENSORS: VOLTAGE DIVIDERS

A VOLTAGE DIVIDER IS A SIMPLE CIRCUIT WHICH TURNS A LARGE VOLTAGE INTO A SMALLER ONE. USING JUST TWO SERIES RESISTORS AND AN INPUT VOLTAGE, WE CAN CREATE AN OUTPUT VOLTAGE THAT IS A FRACTION OF THE INPUT.

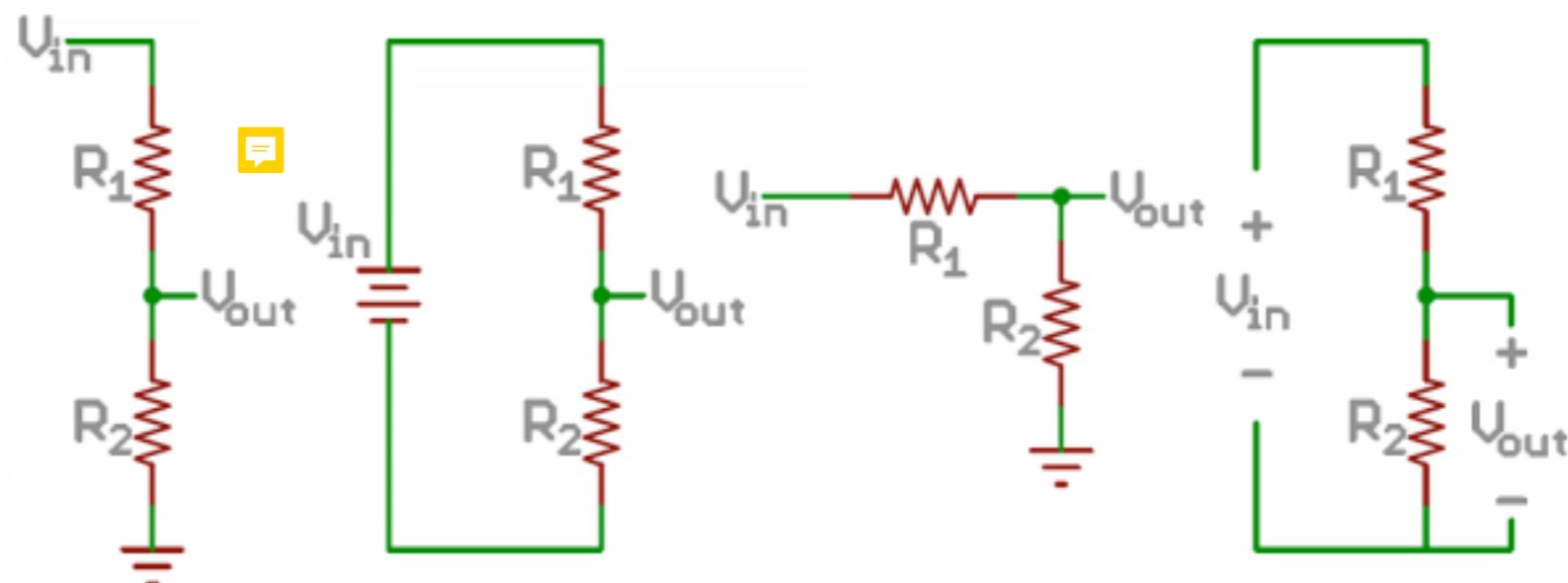
VOLTAGE DIVIDERS ARE ONE OF THE MOST FUNDAMENTAL CIRCUITS IN ELECTRONICS.



SENSORIAL SENSORS: VOLTAGE DIVIDERS

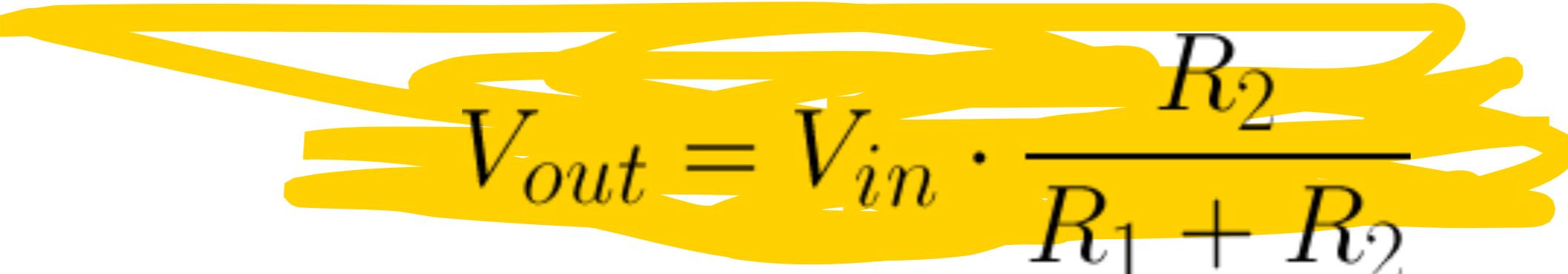
THERE ARE TWO IMPORTANT PARTS TO THE VOLTAGE DIVIDER: THE CIRCUIT AND THE EQUATION.

A VOLTAGE DIVIDER INVOLVES APPLYING A VOLTAGE SOURCE ACROSS A SERIES OF TWO RESISTORS. YOU MAY SEE IT DRAWN A FEW DIFFERENT WAYS, BUT THEY SHOULD ALWAYS ESSENTIALLY BE THE SAME CIRCUIT.



SENSORIAL SENSORS: VOLTAGE DIVIDERS

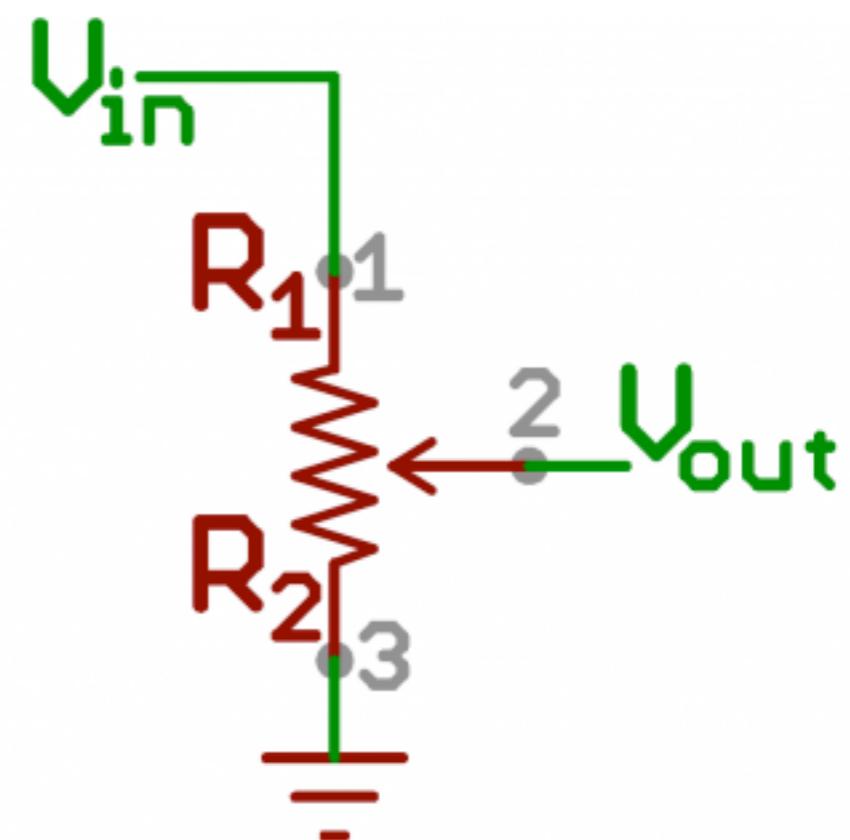
THE VOLTAGE DIVIDER EQUATION ASSUMES THAT YOU KNOW THREE VALUES FOR CIRCUIT: THE INPUT VOLTAGE (V_{in}), AND BOTH RESISTOR VALUES (R_1 AND R_2). GIVEN THÓSE VALUES, WE CAN USE THIS EQUATION TO FIND THE OUTPUT VOLTAGE (V_{out}):


$$V_{out} = V_{in} \cdot \frac{R_2}{R_1 + R_2}$$

THIS EQUATION STATES THAT THE OUTPUT VOLTAGE IS DIRECTLY PROPORTIONAL TO THE INPUT VOLTAGE AND THE RATIO OF R_1 AND R_2 .

SENSORIAL SENSORS: VOLTAGE DIVIDERS

VOLTAGE DIVIDERS HAVE TONS OF APPLICATIONS, THEY ARE AMONG THE MOST COMMON OF CIRCUITS IN ELECTRONICS.



SENSORIAL SENSORS: VOLTAGE DIVIDERS

MANY SENSORS IN THE REAL WORLD ARE SIMPLE RESISTIVE DEVICES. A PHOTOCELL IS A VARIABLE RESISTOR, WHICH PRODUCES A RESISTANCE PROPORTIONAL TO THE AMOUNT OF LIGHT IT SENSES.

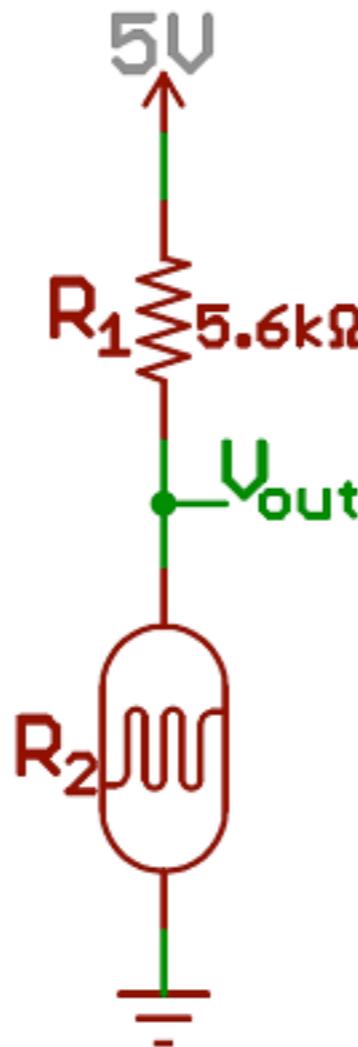
OTHER DEVICES LIKE FLEX SENSORS, FORCE-SENSITIVE RESISTORS, AND THERMISTORS, ARE ALSO VARIABLE RESISTORS.

SENSORIAL SENSORS: VOLTAGE DIVIDERS

IT TURNS OUT VOLTAGE IS REALLY EASY FOR MICROCONTROLLERS TO MEASURE (ADC). BUT RESISTANCE, NOT SO MUCH.

BUT, BY ADDING ANOTHER RESISTOR TO THE RESISTIVE SENSORS, WE CAN CREATE A VOLTAGE DIVIDER. ONCE THE OUTPUT OF THE VOLTAGE DIVIDER IS KNOWN, WE CAN GO BACK AND CALCULATE THE RESISTANCE OF THE SENSOR.

SENSORIAL SENSORS: VOLTAGE DIVIDERS



Light Level	R_2 (Sensor)	R_1 (Fixed)	Ratio $R_2/(R_1+R_2)$	V_{out}
Light	1kΩ	5.6kΩ	0.15	0.76 V
Dim	7kΩ	5.6kΩ	0.56	2.78 V
Dark	10kΩ	5.6kΩ	0.67	3.21 V

SENSORIAL SENSORS: REFERENCE

ENCYCLOPEDIA OF ELECTRONIC COMPONENTS VOLUME 3.

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SENSORIAL SENSORS

