Sensor & Actuator Modules

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Modules

- Arduino compatible board & kit
- LEDs, switches and potentiometers
- Sensors – environmental & physical monitoring, motion sensing, user interface
- Special purpose – meter, clock and camera
- Wireless
- Actuators – servo & motor
Building Prototypes

- Ready-made modules can simplify your prototype construction.
- Published software *sketches* can serve as a guide or base from which you can write your own program.
- Modules connect with the microcontroller board via analog, digital or communication ports – SPA, I²C, serial UART and Wifi.
- The following companies supply various modules, sketches and/or example projects:
  - Adafruit
  - Arduino
  - Digi-Key
  - EngineersGarage.com
  - Seeed WIKI – Grove
  - Phidgets Precision
  - Microchip
  - Trossen Electronics–RobotGeek
  - Sharp
  - SparkFun
  - Many other components are available on Amazon and EBay.
Individual parts can be purchased locally at Axman surplus store on University Ave., or ordered from Digi-key.

Specialized Dupont connectors, crimps, wire and ribbon cable are available from me for module to microcontroller board interconnections.

The following slides are illustrative of some of the modules available.
RobotGeek “Workbench” Kits

- Modular style placement of microcontroller, shield and sensors.
- Surface area: 21 X 22 CM
- All Robot Geek products and kits conform to a standard 1 X 1 CM hole pattern grid.
RobotGeek Geekduino

- Compatible with the Arduino Duemilanove and uses the ATMega 328, the same chip as the Arduino Uno.
- Used with the RobotGeek kits.
RobotGeek Sensor Shield

- Fits atop the Arduino board.
- 3–Pin connectors to RobotGeek sensors and other sensors, actuators and output boards.
- 14 Digital I/O Channels
- 6 Analog Input Channels
- Power selector jumpers for PWM channels
- UART and I²C 4–pin connectors
- Vin, 5v, 3.3v and Ground power breakout
Sensor Cables

- These cables are .1" (2.54mm) pitch and are 300mm in length with color coded wires.
- Come in packages of 10.
- 3-pin compatible with RobotGeek Sensor cables.
RobotGeek Pushbutton

- Simple pushbutton with pull-up resistor.
- You will need to add components or software debounce.

Courtesy of Trussen Robotics
RobotGeek Joystick

- Optional mushroom or stick style controls.
- Potentiometer-based.
- Mounting hole pattern is 1 x 1 cm
- RobotGeek compatible.

Courtesy of Trussen Robotics
RobotGeek Slider

- Slide potentiometer for projects requiring a linear analog input.

Courtesy of Trussen Robotics
Potentiometer – a variable resistor with center tap.
RobotGeek Tilt Switch

- Uses a digital input and allows determination if the object it is mounted to is tilted.

Courtesy of Trussen Robotics
NeoPixel Lighted Rotary Switch

- RobotGeek Compatible mount.
- Single-wire-based LED pixels.
- Analog output of switch position.
- Uses Adafruit_NeoPixel.h library

Courtesy of Trussen Robotics
Floor Mat Switch

- Two strips of metal apart with thin squares of foam in-between them every .75 inches.
- The pairs of metal strips are spaced out 2.5 inches from each other for the length of the mat.
- When someone steps on the mat their weight presses the two metal strips together creating a closed contact.
- All the strips are connected down both sides of the mat creating one large switch.
- Can be trimmed into smaller units.

Courtesy of Trussen Robotics
Hall Effect Sensor Switch

- A Hall effect switch that turns on and off depending on the presence of a magnetic field.
- 400ns transition period for rise and fall
- Continuous-time hall effect sensor
- 20mm by 24mm

Courtesy of Trussen Robotics
RobotGeek Light Sensor

- Analog output will be proportional to the light intensity.
Light Sensor

- For use with the Phidgets 8/8/8 kit.
- Response Time Max: 2ms
- Peak Sensitivity Wavelength: 625 nm
- Light Level Min: 1 lux
- Light Level Max (5v): 1000 lux
- Light Current Ratio: 1.2
- Device Current Consumption: 5 mA
- Output Impedance: 1K ohms
- Bandwidth / Reaction Time: 50 Hz
- Minimum / Maximum Voltage: 2.4VDC to 5.5VDC
- Operating Temp Min: −40°
- Operating Temp Max: 85°

Courtesy of Trussen Robotics
Robot Geek Temperature Sensor

- RobotGeek compatible.
- Voltage Input: 2.7 V to 5.5 VDC
- 10 mV/°C scale factor
- ±2°C accuracy over temperature
- ±0.5°C linearity
- Operating Range: –40°C to +125°C

Courtesy of Trusssen Robotics
High Temperature Sensor

- Thermocouples are very sensitive, requiring a good amplifier with a cold-compensation reference.
- K type thermocouple for temperature detection, with a Thermistor
- The detectable range of this Sensor is −50°C to 600°C (−58°F to 1112°F), and the accuracy is rated at ±(2.0% + 2°C).
IR Reflective Sensor

- Made to connect to the Phidgets 8/8/8 Interface
- Based on the QRB1114 sensor.
- It can be used to determine the difference between black (low reflective conditions) and white (high reflective conditions).
Sharp IR Distance Sensor

- Detects distances from 4" to 30" (10cm–80cm).
- Sharp IR GP2Y0A21YK0F.
- Graph shows output voltage relative to distance.

Courtesy of Trussen Robotics
RobotGeek Voltage Divider

- Use with any sensor that has variable resistance.
- The “fixed” resistor is an adjustable potentiometer on the board.
- Sensors may plug into the top or connect by wire to the blue terminal block.

Courtesy of Trussen Robotics

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Adafruit 9-DOF Absolute Orientation Sensor BN0055

Courtesy of Adafruit
Adafruit BN0055 Features...

- Absolute Orientation (Euler Vector, 100Hz) Three axis orientation data based on a 360° sphere
- Absolute Orientation (Quaternions, 100Hz) Four point quaternion output for more accurate data manipulation
- Angular Velocity Vector (100Hz) Three axis of 'rotation speed' in rad/s
- Acceleration Vector (100Hz) Three axis of acceleration (gravity + linear motion) in m/s^2
- Magnetic Field Strength Vector (20Hz) Three axis of magnetic field sensing in micro Tesla (uT)
- Linear Acceleration Vector (100Hz) Three axis of linear acceleration data (acceleration minus gravity) in m/s^2
- Gravity Vector (100Hz) Three axis of gravitational acceleration (minus any movement) in m/s^2
- Temperature (1Hz) Ambient temperature in degrees celsius
Adafruit Long Flex Sensor

- Can detect flexing or bending in one direction.
- Basically resistors that change value based on how much they're flexed.
- If they're unflexed, the resistance is about $\sim 10\,\Omega$.
- When flexed all the way the resistance rises to $\sim 20\,\Omega$. 

Courtesy of Adafruit
Leap Features…

- Tracks hands, fingers, and pointable tools
- Sub-millimeter accuracy and near-zero latency
- 8 cubic feet of interactive 3D space
- 150° field of view extending above the device
- Compact device at 3" long
- Compatible with Mac, Windows, and Linux via USB
- SDKs in six programming languages
- New: Image API provides developers access to raw stereo image
Grove Modules

- Button contains a pull-down resistor.
- LED has a current limiting resistor.
- Buzzer can be driven either with a digital signal or analog PWM.
- Potentiometer is 10k ohm.
Groves Environmental Monitoring Modules

- Grove - Digital Light Sensor
- Grove - Light Sensor
- Grove - Temperature and Humidity Sensor
- Grove - Barometer Sensor
- Grove - Dust Sensor
- Grove - Gas Sensor
- Grove - Temperature Sensor
- Grove - Air Quality Sensor
- Grove - Temperature and Humidity Sensor Pro
- Grove - Gas Sensor (O2)
- Grove - HCHO Sensor
- Grove - Temp&Hum Sensor (SHT31)
- Grove - Grove - Barometer Sensor (BMP280)
- Grove - Grove - Barometer Sensor (BME280)

Courtesy of seeed WIKI – Grove
Groves Physical Monitoring Modules #1

Grove - Hall Sensor  
Grove - Infrared temperature sensor  
Grove - Ultrasonic Ranger  
Grove - Rotary Angle Sensor  
Grove - Serial Camera

Grove - Chest Strap Heart Rate Sensor  
Grove - Ear-clip Heart Rate Sensor  
Grove - Loudness Sensor  
Grove - UV Sensor  
Grove – Serial MP3 Player

Grove - 80cm Infrared Proximity Sensor  
Grove - Mini Camera  
Grove - PH Sensor  
Grove - GSR Sensor

 Courtesy of seeed WIKI – Grove
Grove Physical Monitoring Modules #2

Grove - Water Sensor  Grove - Magnetic Switch  Grove - Alcohol Sensor  Grove - RTC  Grove - Differential Amplifier

Grove - Electricity Sensor  Grove - Sound Sensor  Grove - IR Distance Interrupt  Grove - Tilt Switch  Grove - Encoder

Grove - I2C Color Sensor  Grove - Sound Recorder  Grove - Moisture Sensor  Grove - PIR Motion Sensor  Grove - Infrared Reflective Sensor

Courtesy of seeed WIKI – Grove
Grove Motion Sensor Modules

Grove - 3-Axis Digital Compass
Grove - 3-Axis Digital Accelerometer (±1.5g)
Grove - 3-Axis Digital Gyro
Grove - Collision Sensor
Grove - 3-Axis Analog Accelerometer

Grove - 3-Axis Digital Accelerometer (±16g)
Grove - 6-Axis Accelerometer and Compass V1.0
Grove - Single Axis Analog Gyro

Courtesy of seeed WIKI – Grove
Grove User Interface Modules #1

- Grove - Solid State Relay
- Grove - OLED Display 128x64
- Grove - Serial LCD
- Grove - LED Socket Kit
- Grove - Button
- Grove - Vibration Motor
- Grove - LED Bar
- Grove - Relay
- Grove - Protoshield
- Grove - Thumb Joystick
- Grove - Infrared Reflective Sensor
- Grove - LED Strip Driver
- Grove - 4-Digit Display
- Grove - OLED Display 96x96
- Grove - I2C Motor Driver

Courtesy of seeed WIKI – Grove
Grove User Interface Modules #2

- Grove - Slide Potentiometer
- Grove - Chainable RGB LED
- Grove - PS/2 Adapter
- Grove - BlinkM
- Grove - I2C Hub
- Grove - I2C Touch Sensor
- Grove - Screw Terminal
- Grove - Buzzer
- Grove - Servo
- Grove - Circular LED
- Grove - Touch Sensor
- Grove - Switch(P)
- Grove - Variable Color LED
- Grove - Piezo Vibration Sensor
- Grove - Dry-Reed Relay

Courtesy of seeed WIKI – Grove
Grove User Interface Modules #3

- Grove - SPDT Relay (30A)
- Grove - 2-Coil Latching Relay
- Grove - Speaker
- Grove - RJ45 Adapter
- Grove - Fingerprint Sensor
- Grove - Voltage Divider
- Grove - Nunchuck
- Grove - DMX512
- Grove - Flame Sensor
- Grove - MOSFET
- Grove - 12C ADC
- Grove - Recorder
- Grove - EL Driver
- Grove - LED Matrix Driver v1.0

Courtesy of seeed WIKI – Grove
These tiny connectors are difficult to build and may need to be ordered separately.
Phidgets Interface Kit 8/8/8

- 8 Analog Inputs
- 8 Digital Inputs
- 8 Digital Outputs
- The Analog Input can measure a voltage between 0V and 5V.
- The analog measurement is represented in the software as a value between 0 and 1000, so a sensor value of 1 unit represents a voltage of approximately 5 mV.

Courtesy of Phidgets
PhidgetBridge Wheatstone Bridge

- Interfaces to up to four Wheatstone Bridge based sensors
- Great interface for Load Cells and Strain Gauges
- Mini-USB cable and hardware mounting kit included
- Can only be used by a device with a USB port / not meant to be used with microcontrollers (such as Arduino)
- Total current available to Bridge Outputs: 465mA
- Recommended wire size: 16–26AWG
- Differential voltage resolution per channel: 24 bits
- Data rates (affects all channels): 8ms to 1000ms in 8ms increments
Screw Terminal

- Four 3.5mm pitch pins.
- Rating up to 125V @ 6A.
- Terminal can accept 30 to 20AWG wire.

Courtesy of Trussen Robotics
Leap Motion Controller

Watch 1m

Courtesy of Adafruit
Adafruit Ultimate GPS

-165 dBm sensitivity, 10 Hz updates, 66 channels
-5V friendly design and only 20mA current draw
-Breadboard friendly + two mounting holes
-RTC battery-compatible
-Built-in data logging
-PPS output on fix
-Internal patch antenna + u.FL connector for external active antenna
-Fix status LED
DC Voltmeter, LED .28”

- Voltage range: 2.4~ 30V
- Work current: under 30mA
- Size: 30x11.7x9.2 mm
- Measure speed: 200ms/one time
- Accuracy: 3%

There are many voltage, current and power meters, even small oscilloscopes available on EBay. Radio City carries a number of these locally.
Adafruit Panel Temperature Meter

- Separate thermistor bulb can be attached to any object.
- 4.5V to 30V DC input
- 0.1V precision
- 3–4mA draw

Courtesy of Adafruit
Grove Real Time Clock (RTC)

- Real-Time Clock (RTC) Counts Seconds, Minutes, Hours, Date of the Month, Month, Day of the week, and Year with Leap-Year Compensation Valid Up to 2100.
- 56-Byte, Battery-Backed, Nonvolatile (NV)RAM for Data Storage.
- I2C Serial Interface.
- 5V DC supply.
- Programmable Square-Wave Output Signal.
- Automatic Power-Fail Detect and Switch Circuitry.
- Consumes Less than 500nA in Battery-Backup Mode with Oscillator Running.

Courtesy of Trussen Robotics
Vision sensor that can quickly track colored objects and report back their X/Y position to your Arduino or other microcontroller.

Communicates via SPI (default), I²C, UART serial, analog or digital.

Capable of tracking hundreds of objects at 50 times per second.

At any time the pixy can remember up to 7 distinct colors or 'signatures.'
XBees 1mW Communication Module

- Zigbee 802.15.4 wireless communication.
- Send sensory data to your pc from 300 ft.
- 2.4GHz

Courtesy of Trussen Robotics
Grove Wireless Modules

Grove - 315MHz Simple RF Link Kit
Grove - Serial RF Pro
Grove - GPS
Grove - 125KHz RFID Reader
Grove - Serial Bluetooth

Grove - 433MHz Simple RF Link Kit
Grove - XBee Carrier
Grove - Infrared Receiver
Grove - Infrared Emitter
Grove - Bee Socket

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Courtesy of seeed WIKI – Grove
Adafruit Motor/Stepper/Servo Shield for Arduino

- 2 connections for 5V 'hobby' servos connected to the Arduino's high-resolution dedicated timer – no jitter!
- 4 H-Bridges: TB6612 chipset provides 1.2A per bridge (3A for brief 20ms peaks) with thermal shutdown protection, internal kickback protection diodes. Can run motors on 4.5VDC to 13.5VDC.
- Up to 4 bi-directional DC motors with individual 8-bit speed selection (so, about 0.5% resolution).
- Up to 2 stepper motors (unipolar or bipolar) with single coil, double coil, interleaved or micro-stepping.

Courtesy of Adafruit
Grove – \( I^2C \) Motor Driver

- Directly control stepper motor or DC motor.
- Dual channel H–bridge driver chip (L298N) that can handle current up to 2A per channel.
- \( I^2C \) communication.
- Version 1.3 shown.

Courtesy of seeed WIKI – Grove
Hercules Dual Motor Controller

- Full bridge drive circuit based on MOSFET supports two independent channels, each channel up to 15A
- LED shows fuse protection status
- Several Grove ports, conveniently connect with servo, encoder and sensors
- Atmege328 controller, Arduino compatible
- Dual 15A 6–20V Motor Controller is a high current motor drive control board. Dual 15A 6–20V Motor Controller is a high current motor drive control board.
- Includes micro controller processor, motor drive circuit, charging circuit and protection circuit.
UartSBee V4

- FTDI cable compatible USB to Serial adapter equipped with BEE socket (20pin 2.0mm).
- The integrated FT232RL can be used for programming or communicating with MCUs.
- Useful for connecting the Hercules dual motor controller to your pc.

Courtesy of seeed WIKI – Grove
One stepper motor, as well as receive input from two limit switches.

It is based around the Allegro A3982 Stepper Motor Driver with Translator.

The A3982 is capable of driving up to 2A per coil.

Surface mount components require solder paste and hot plate to assemble.
Grove EasyDriver

EasyDriver v4.3 Pins

- Motor Coil A
- Motor Coil B
- PDF Input
- Reset
- Enable
- MS2
- Power In (6-30V)
- GND
- +5V Output
- MS1 Input
- Sleep Input
- Step Input
- Direction Input

Note: MIN/ MAX backwards on silk screen on V4.3

6-wire stepper motor

easyDriver

GND
7...30V
5V

Courtesy of seeed WIKI – Grove
Grove – Vibration Motor

- Mini vibration motor suitable as a non-audible indicator.
- When the input is HIGH, the motor will vibrate just like your cell phone on silent mode.

Grove – Base Shield on an Arduino

Courtesy of seeed WIKI – Grove
Grove Motor Shield

- Driver module for motors that allows you to use Arduino to control the working speed and direction of the motor.

Courtesy of seeed WIKI – Grove
Adafruit Plastic Water Solenoid Valve

- 1/2" Nominal NPS
- Working Pressure: 0.02 Mpa – 0.8 Mpa
- Working Temperature: 1 ℃ – 75 ℃
- Response time (open): ≤ 0.15 sec
- Response time (close): ≤ 0.3 sec
- Actuating voltage: 12VDC (but we found it would work down to 6V)
- Actuating life: ≥ 50 million cycles
- Weight: 4.3 oz
- Dimensions: 3" x 2.25" x 2"
Summary

- Arduino compatible board & kit
- LEDs, switches and potentiometers
- Sensors – environmental & physical monitoring, motion sensing & user interface
- Special purpose – meter, clock and camera
- Wireless data recording
- Actuators – servo & motor