

# Apéndice A

## Hojas de Características





**State-of-the-Art Pointing Solutions for the OEM**



# **FSR<sup>®</sup>**

## **Force Sensing Resistor<sup>®</sup>**

### **Integration Guide and**

### **Evaluation Parts Catalog**

**400 Series Evaluation Parts**  
**With Suggested Electrical Interfaces**

**INTERLINK**   
**ELECTRONICS**

546 Flynn Road • Camarillo, CA 93012  
(805) 484-1331 • Fax (805) 484-8989  
<http://www.interlinkelectronics.com>

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## **FSR® Integration Guide & Evaluation Parts Catalog With Suggested Electrical Interfaces**

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Interlink Electronics manufactures custom FSR devices to meet the needs of specific customer applications. FSR devices can be produced in almost any shape, size, and geometry. To discuss custom design or to obtain a quote, contact Interlink Electronics at (805) 484-8855.



## Force Sensing Resistors *An Overview of the Technology*

Force Sensing Resistors (FSR) are a polymer thick film (PTF) device which exhibits a decrease in resistance with an increase in the force applied to the active surface. Its force sensitivity is optimized for use in human touch control of electronic devices. FSRs are not a load cell or strain gauge, though they have similar properties. FSRs are not suitable for precision measurements.

### Force vs. Resistance

The force vs. resistance characteristic shown in Figure 2 provides an overview of FSR typical response behavior. For interpretational convenience, the force vs. resistance data is plotted on a log/log format. These data are representative of our typical devices, with this particular force-resistance characteristic being the response of evaluation part # 402 (0.5" [12.7 mm] diameter circular active area). A stainless steel actuator with a 0.4" [10.0 mm] diameter hemispherical tip of 60 durometer polyurethane rubber was used to actuate the FSR device. In general, FSR response approximately follows an inverse power-law characteristic (roughly  $1/R$ ).

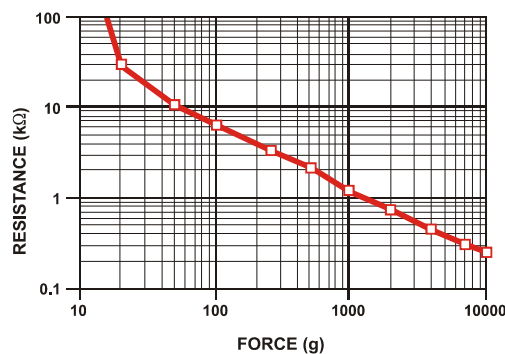


Figure 2: Resistance vs. Force

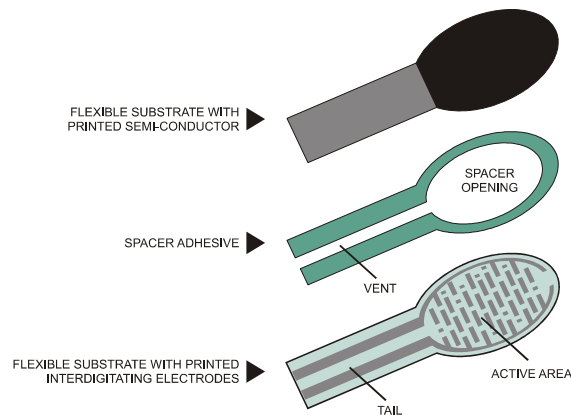


Figure 1: FSR Construction

Referring to Figure 2, at the low force end of the force-resistance characteristic, a switch-like response is evident. This turn-on threshold, or 'break force', that swings the resistance from greater than 100 kΩ to about 10 kΩ (the beginning of the dynamic range that follows a power-law) is determined by the substrate and overlay thickness and flexibility, size and shape of the actuator, and spacer-adhesive thickness (the gap between the facing conductive elements). Break force increases with increasing substrate and overlay rigidity, actuator size, and spacer-adhesive thickness. Eliminating the adhesive, or keeping it well away from the area where the force is being applied, such as the center of a large FSR device, will give it a lower rest resistance (e.g. stand-off resistance).

At the high force end of the dynamic range, the response deviates from the power-law behavior, and eventually saturates to a point where increases in force yield little or no decrease in resistance. Under these conditions of Figure 2, this saturation force is beyond 10 kg. The saturation point is more a function of pressure than force. The saturation pressure of a typical FSR is on the order of 100 to 200 psi. For the data shown in Figures 2, 3 and 4, the actual measured pressure range is 0 to 175 psi (0 to 22 lbs applied over 0.125 in<sup>2</sup>). Forces higher than the saturation force can be measured by spreading the force over a greater area; the overall pressure is then kept below the saturation point, and dynamic response is maintained. However, the converse of this effect is also true, smaller actuators will saturate FSRs earlier in the dynamic range, since the saturation point is reached at a lower force.

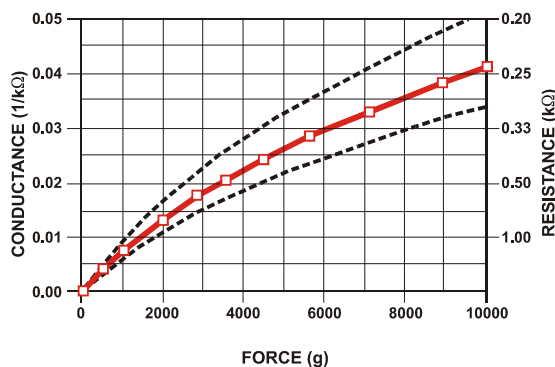


Figure 3:  
Conductance vs. Force (0-10Kg)

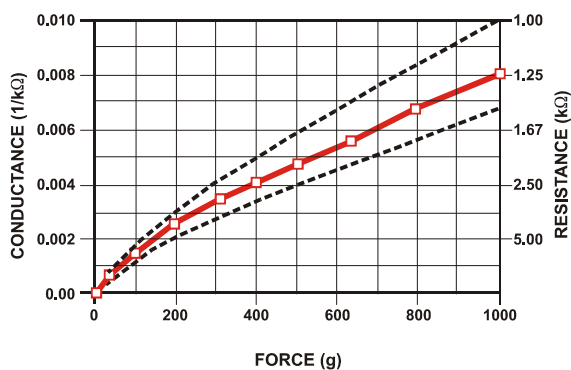


Figure 4:  
Conductance vs. Force (0-1Kg) Low Force Range

## Force vs. Conductance

In Figure 3, the conductance is plotted vs. force (the inverse of resistance:  $1/r$ ). This format allows interpretation on a linear scale. For reference, the corresponding resistance values are also included on the right vertical axis. A simple circuit called a current-to-voltage converter (see page 21) gives a voltage output directly proportional to FSR conductance and can be useful where response linearity is desired. Figure 3 also includes a typical part-to-part repeatability envelope. This error band determines the maximum accuracy of any general force measurement. The spread or width of the band is

strongly dependent on the repeatability of any actuating and measuring system, as well as the repeatability tolerance held by Interlink Electronics during FSR production. Typically, the part-to-part repeatability tolerance held during manufacturing ranges from  $\pm 15\%$  to  $\pm 25\%$  of an established nominal resistance.

Figure 4 highlights the 0-1 kg (0-2.2 lbs) range of the conductance-force characteristic. As in Figure 3, the corresponding resistance values are included for reference. This range is common to human interface applications. Since the conductance response in this range is fairly linear, the force resolution will be uniform and data interpretation simplified. The typical part-to-part error band is also shown for this touch range. In most human touch control applications this error is insignificant, since human touch is fairly inaccurate. Human factors studies have shown that in this force range repeatability errors of less than  $\pm 50\%$  are difficult to discern by touch alone.

## **FSR Integration Notes**

### ***A Step-by-Step Guide to Optimal Use***

For best results, follow these seven steps when beginning any new product design, proof-of-concept, technology evaluation, or first prototype implementation:

#### **1. Start with Reasonable Expectations (Know Your Sensor)**

The FSR sensor is not a strain gauge, load cell or pressure transducer. While it can be used for dynamic measurement, only qualitative results are generally obtainable. Force accuracy ranges from approximately  $\pm 5\%$  to  $\pm 25\%$  depending on the consistency of the measurement and actuation system, the repeatability tolerance held in manufacturing, and the use of part calibration.

Accuracy should not be confused with resolution. The force resolution of FSR devices is better than  $\pm 0.5\%$  of full use force.

#### **2. Choose the Sensor that Best Fits the Geometry of Your Application**

Usually sensor size and shape are the limiting parameters in FSR integration, so any evaluation part should be chosen to fit the desired mechanical actuation system. In general, standard FSR products have a common semiconductor make-up and only by varying actuation methods (e.g. overlays and actuator areas) or electrical interfaces can different response characteristics be achieved.

#### **3. Set-up a Repeatable and Reproducible Mechanical Actuation System**

When designing the actuation mechanics, follow these guidelines to achieve the best force repeatability:

- Provide a consistent force distribution. FSR response is very sensitive to the distribution of the applied force. In general, this precludes the use of dead weights for characterization since exact duplication of the weight distribution is rarely repeatable cycle-to-cycle. A consistent weight (force) distribution is more difficult to achieve than merely obtaining a consistent total applied weight (force). As long as the distribution is the same cycle-to-cycle, then repeatability will be maintained. The use of a thin elastomer between the applied force and the FSR can help absorb error from inconsistent force distributions.
- Keep the actuator area, shape, and compliance constant. Changes in these parameters significantly alter the response characteristic of a given sensor. Any test, mock-up, or evaluation conditions should be closely matched to the final use conditions. The greater the cycle-to-cycle consistency of these parameters, the greater the device repeatability. In human interface applications where a finger is the mode of actuation, perfect control of these parameters is not generally possible. However, human force sensing is somewhat inaccurate; it is rarely sensitive enough to detect differences of less than  $\pm 50\%$ .
- Control actuator placement. In cases where the actuator is to be smaller than the FSR active area, cycle-to-cycle consistency of actuator placement is necessary. (Caution: FSR layers are held together by an adhesive that surrounds the electrically active areas. If force is applied over an area which includes the adhesive, the resulting response characteristic will be drastically altered.) In an extreme case (e.g., a large, flat, hard actuator that bridges the bordering adhesive), the adhesive can present FSR actuation

- Keep actuation cycle time consistent. Because of the time dependence of the FSR resistance to an applied force, it is important when characterizing the sensor system to assure that increasing loads (e.g. force ramps) are applied at consistent rates (cycle-to-cycle). Likewise, static force measurements must take into account FSR mechanical setting time. This time is dependent on the mechanics of actuation and the amount of force applied and is usually on the order of seconds.

#### 4. Use the Optimal Electronic Interface

In most product designs, the critical characteristic is Force vs. Output Voltage, which is controlled by the choice of interface electronics. A variety of interface solutions are detailed in the TechNote section of this guide. Summarized here are some suggested circuits for common FSR applications.

- For FSR Pressure or Force Switches, use the simple interfaces detailed on pages 16 and 17.
- For dynamic FSR measurements or Variable Controls, a current-to-voltage converter (see pages 18 and 19) is recommended. This circuit produces an output voltage that is inversely proportional to FSR resistance. Since the FSR resistance is roughly inversely proportional to applied force, the end result is a direct proportionality between force and voltage; in other words, this circuit gives roughly linear increases in output voltage for increases in applied force. This linearization of the response optimizes the resolution and simplifies data interpretation.

#### 5. Develop a Nominal Voltage Curve and Error Spread

When a repeatable and reproducible system has been established, data from a group of FSR parts can be collected. Test several FSR parts in the system. Record the output voltage at various pre-selected force points throughout the range of interest. Once a family of curves is obtained, a nominal force vs. output voltage curve and the total force accuracy of the system can be determined.

#### 6. Use Part Calibration if Greater Accuracy is Required

For applications requiring the highest obtainable force accuracy, part calibration will be necessary. Two methods can be utilized: gain and offset trimming, and curve fitting.

- Gain and offset trimming can be used as a simple method of calibration. The reference voltage and feedback resistor of the current-to-voltage converter are adjusted for each FSR to pull their responses closer to the nominal curve.
- Curve fitting is the most complete calibration method. A parametric curve fit is done for the nominal curve of a set of FSR devices, and the resultant equation is stored for future use. Fit parameters are then established for each individual FSR (or sensing element in an array) in the set. These parameters, along with the measured sensor resistance (or voltage), are inserted into the equation to obtain the force reading. If needed, temperature compensation can also be included in the equation.

#### 7. Refine the System

Spurious results can normally be traced to sensor error or system error. If you have any questions, contact Interlink Electronics' Sales Engineers to discuss your system and final data.

## **FSR Usage Tips** ***The Do's and Don'ts***

- **Do** follow the seven steps of the FSR Integration Guide.
- **Do**, if possible, use a firm, flat and smooth mounting surface.
- **Do** be careful if applying FSR devices to curved surfaces. Pre-loading of the device can occur as the two opposed layers are forced into contact by the bending tension. The device will still function, but the dynamic range may be reduced and resistance drift could occur. The degree of curvature over which an FSR can be bent is a function of the size of the active area. The smaller the active area, the less effect a given curvature will have on the FSR's response.
- **Do** avoid air bubbles and contamination when laminating the FSR to any surface. Use only thin, uniform adhesives, such as Scotch® brand double-sided laminating adhesives. Cover the entire surface of the sensor.
- **Do** be careful of kinks or dents in active areas. They can cause false triggering of the sensors.
- **Do** protect the device from sharp objects. Use an overlay, such as a polycarbonate film or an elastomer, to prevent gouging of the FSR device.
- **Do** use soft rubber or a spring as part of the actuator in designs requiring some travel.
- **Do not** kink or crease the tail of the FSR device if you are bending it; this can cause breaks in the printed silver traces. The smallest suggested bend radius for the tails of evaluation parts is about 0.1" [2.5 mm]. In custom sensor designs, tails have been made that bend over radii of 0.03" (0.8 mm). Also, be careful if bending the tail near the active area. This can cause stress on the active area and may result in pre-loading and false readings.
- **Do not** block the vent. FSR devices typically have an air vent that runs from the open active area down the length of the tail and out to the atmosphere. This vent assures pressure equilibrium with the environment, as well as allowing even loading and unloading of the device. Blocking this vent could cause FSRs to respond to any actuation in a non-repeatable manner. Also note, that if the device is to be used in a pressure chamber, the vented end will need to be kept vented to the outside of the chamber. This allows for the measurement of the differential pressure.
- **Do not** solder directly to the exposed silver traces. With flexible substrates, the solder joint will not hold and the substrate can easily melt and distort during the soldering. Use Interlink Electronics' standard connection techniques, such as solderable tabs, housed female contacts, Z-axis conductive tapes, or ZIF (zero insertion force) style connectors.
- **Do not** use cyanoacrylate adhesives (e.g. Krazy Glue®) and solder flux removing agents. These degrade the substrate and can lead to cracking.
- **Do not** apply excessive shear force. This can cause delamination of the layers.
- **Do not** exceed 1mA of current per square centimeter of applied force (actuator area). This can irreversibly damage the device.



Evaluation Parts

## Descriptions and Dimensions

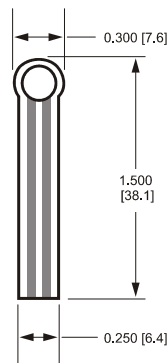


Figure 5:  
Part No. 400 (0.2" Circle)

**Active Area:** 0.2" [5.0] diameter

**Nominal Thickness:** 0.012" [0.30 mm]

**Material Build:**

**Semiconductive layer**

0.004" [0.10] PES

**Spacer adhesive**

0.002" [0.05] Acrylic

**Conductive layer**

0.004" [0.10] PES

**Rear adhesive**

0.002" [0.05] Acrylic

**Connector options**

- No connector
- Solder Tabs (not shown)
- AMP Female connector

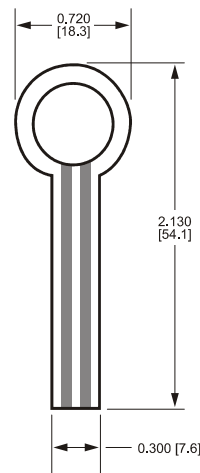


Figure 6:  
Part No. 402 (0.5" Circle)

**Active Area:** 0.5" [12.7] diameter

**Nominal thickness:** 0.018" [0.46 mm]

**Material Build:**

**Semiconductive Layer**

0.005" [0.13] Ultem

**Spacer Adhesive**

0.006" [0.15] Acrylic

**Conductive Layer**

0.005" [0.13] Ultem

**Rear Adhesive**

0.002" [0.05] Acrylic

**Connector**

- No connector
- Solder Tabs (not shown)
- AMP Female connector

Dimensions in brackets: millimeters • Dimensional Tolerance:  $\pm 0.015"$  [0.4] • Thickness Tolerance:  $\pm 10\%$

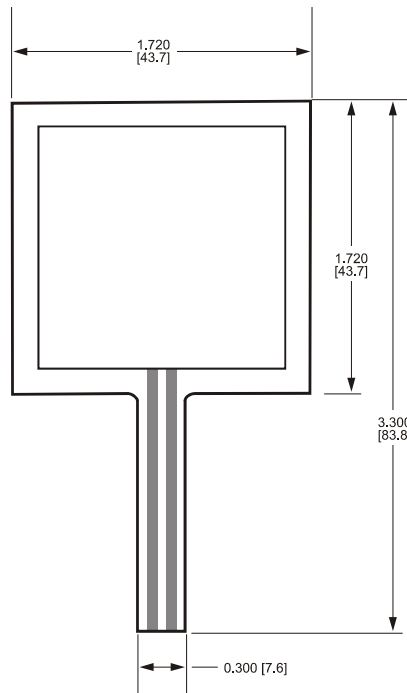


Figure 7:  
**Part No. 406 (1.5" Square)**

**Active Area:** 1.5" [38.1] x 1.5" [38.1]

**Nominal thickness:** 0.018" [0.46 mm]

**Material Build:**

**Semiconductive Layer**

0.005" [0.13] Ultem

**Spacer Adhesive**

0.006" [0.15] Acrylic

**Conductive Layer**

0.005" [0.13] Ultem

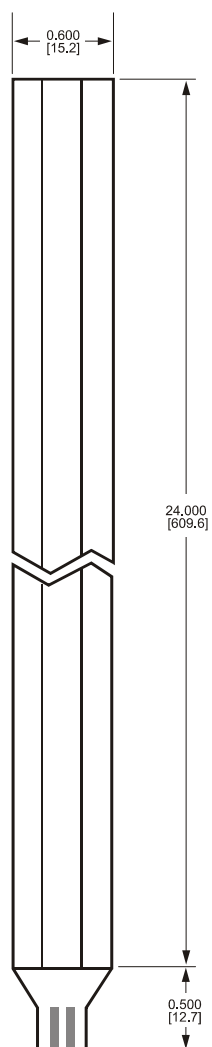
**Rear Adhesive**

0.002" [0.05] Acrylic

**Connectors**

- a. No connector
- b. Solder Tabs (not shown)
- c. AMP Female connector

*Dimensions in brackets: millimeters • Dimensional Tolerance:  $\pm 0.015$ " [0.4] • Thickness Tolerance:  $\pm 10\%$*



**Active Area:** 24" [609.6] x 0.25" [6.3]

**Nominal thickness:** 0.135" [0.34 mm]

**Material Build:**

**Semiconductive Layer**

0.004" [0.10] PES

**Spacer Adhesive**

0.0035" [0.089] Acrylic

**Conductive Layer**

0.004" [0.10] PES

**Rear Adhesive**

0.002" [0.05] Acrylic

**Connectors**

- a. No connector
- b. Solder Tabs (not shown)
- c. AMP Female connector

Figure 8  
Part No. 408 (24" Trimmable Strip)

*Dimensions in brackets: millimeters*  
*Dimensional Tolerance:  $\pm 0.015"$  [0.4]*  
*Thickness Tolerance:  $\pm 10\%$*



## General FSR Characteristics

These are typical parameters. The FSR is a custom device and can be made for use outside these characteristics. Consult Sales Engineering with your specific requirements.

### Simple FSR Devices and Arrays

PARAMETER	VALUE	NOTES
<b>Size Range</b>	Max = 20" x 24" (51 x 61 cm) Min = 0.2" x 0.2" (0.5 x 0.5 cm)	Any shape
<b>Device thickness</b>	0.008" to 0.050" (0.20 to 1.25 mm)	Dependent on materials
<b>Force Sensitivity Range</b>	< 100 g to > 10 kg	Dependent on mechanics
<b>Pressure Sensitivity Range</b>	< 1.5 psi to > 150 psi (< 0.1 kg/cm <sup>2</sup> to > 10 kg/cm <sup>2</sup> )	Dependent on mechanics
<b>Part-to-Part Force Repeatability</b>	± 15% to ± 25% of established nominal resistance	With a repeatable actuation system
<b>Single Part Force Repeatability</b>	± 2% to ± 5% of established nominal resistance	With a repeatable actuation system
<b>Force Resolution</b>	Better than 0.5% full scale	
<b>Break Force (Turn-on Force)</b>	20 g to 100 g (0.7 oz to 3.5 oz)	Dependent on mechanics and FSR build
<b>Stand-Off Resistance</b>	> 1MΩ	Unloaded, unbent
<b>Switch Characteristic</b>	Essentially zero travel	
<b>Device Rise Time</b>	1-2 msec (mechanical)	
<b>Lifetime</b>	> 10 million actuations	
<b>Temperature Range</b>	-30°C to +70°C	Dependent on materials
<b>Maximum Current</b>	1 mA/cm <sup>2</sup> of applied force	
<b>Sensitivity to Noise/Vibration</b>	Not significantly affected	
<b>EMI / ESD</b>	Passive device	
<b>Lead Attachment</b>	Standard flex circuit techniques	

### For Linear pots

PARAMETER	VALUE	NOTES
<b>Positional Resolution</b>	0.003" to 0.02" (0.075 to 0.5 mm)	Dependent on actuator size
<b>Positional Accuracy</b>	Better than $\pm 1\%$ of full length	

*FSR terminology is defined on pages 14 and 15 of this guide.*

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## Glossary of Terms

<b>Active Area</b>	The area of an FSR device that responds to normal force with a decrease in resistance.
<b>Actuator</b>	The object which contacts the sensor surface and applies force to FSRs.
<b>Applied Force</b>	The force applied by the actuator on the active area of the sensor.
<b>Array</b>	Any grouping or matrix of FSR sensors which can be individually actuated and measured.
<b>Break Force</b>	The minimum force required, with a specific actuator size, to cause the onset of the FSR response.
<b>Cross-talk</b>	Measurement noise or inaccuracies of a sensor as a result of the actuation of another sensor on the same substrate. See also false triggering.
<b>Drift</b>	The change in resistance with time under a constant (static) load. Also called resistance drift.
<b>Durometer</b>	The measure of the hardness of rubber.
<b>EMI</b>	Electromagnetic interference.
<b>ESD</b>	Electrostatic discharge.
<b>False triggering</b>	The unwanted actuation of a FSR device from unexpected stimuli; e.g., bending or cross-talk.
<b>Fixed Resistor</b>	The printed resistor on linear potentiometers that is used to measure position.
<b>Footprint</b>	Surface area and force distribution of the actuator in contact with the sensor surface.
<b>Force Resolution</b>	The smallest measurable difference in force.
<b>FSR™</b>	Force Sensing Resistors®. A polymer thick film device with exhibits a decrease in resistance with an increase in force applied normal to the device surface.
<b>Graphic Overlay</b>	A printed substrate that covers the FSR. Usually used for esthetics and protection.
<b>Housed Female</b>	A stitched on AMP connector with a receptacle (female) ending. A black plastic housing protects the contacts. Suitable for removable ribbon cable connector and header pin attachment.
<b>Hysteresis</b>	In a dynamic measurement, the difference between instantaneous force measurements at a given force for an increasing load versus a decreasing load.
<b>Interdigitating Electrodes</b>	The conductor grid. An interweaving pattern of linearly offset conductor traces used to achieve electrical contact. This grid is shunted by the semiconductor layer to give the FSR response.
<b>Lead Out or Busing System</b>	The method of electrically accessing each individual sensor.
<b>Lexan®</b>	Polycarbonate. A substrate used for graphic overlays and labels. Available in a variety of surface textures.

<b>Melinex®</b>	A brand of polyester(PET). A substrate with lower temperature resistance than Ulterm® or PES, but with excellent flexibility and low cost. Similar to Mylar™.
<b>Part or Device</b>	The FSR. Consists of the FSR semiconductive material, conductor, adhesives, graphics or overlays, and connectors.
<b>PES</b>	Polyethersulfone. A transparent substrate with excellent temperature resistance, moderate chemical resistance, and good flexibility.
<b>Pin Out</b>	The descriptions of a FSR's electrical access at the connector pad (tail).
<b>Repeatability</b>	The ability to repeat, within a tolerance, a previous response characteristic.
<b>Response Characteristic</b>	The relationship of force or pressure vs. resistance.
<b>Saturation Pressure</b>	The pressure level beyond with the FSR response characteristic deviates from its inverse power law characteristic. Past the saturation pressure, increases in force yield little or no decrease in resistance.
<b>Sensor</b>	Each area of the FSR device that is independently force sensitive (as in an array).
<b>Solder-tabs</b>	Stitched on AMP connectors with tab endings. Suitable for direct PC board connection or for soldering to wires.
<b>Space and Trace</b>	The widths of the gaps and fingers of the conductive grid; also called pitch.
<b>Spacer Adhesive</b>	The adhesive used to laminate FSR devices tighter. Dictates stand-off.
<b>Stand-off</b>	The gap or distance between the opposed polymer film layers when the sensor is unloaded and unbent.
<b>Stand-off Resistance</b>	The FSR resistance when the device is unloaded and unbent.
<b>Substrate</b>	Any base material on which the FSR semi-conductive or metallic polymers are printed. (For example, polyetherimide, polyethersulfone and polyester films).
<b>Tail</b>	The region where the lead out or busing system terminates. Generally, the tail ends in a connector.
<b>Ulterm®</b>	Polyetherimide (PEI). A yellow, semi-transparent substrate with excellent temperature and chemical resistance and limited flexibility.

Interlink Electronics, Inc. holds international patents for its Force Sensing Resistor technology. FSR is a trademark and Force Sensing Resistors is a registered trademark of Interlink Electronics. Interlink and the six dot logotype are registered marks of Interlink Electronics.

Ultem and Lexan are registered trademarks of G.E., Melinex is a registered trademark of ICI, and Mylar is a trademark of E.I. Dupont & Co.

## Suggested Electrical Interfaces Basic FSRs

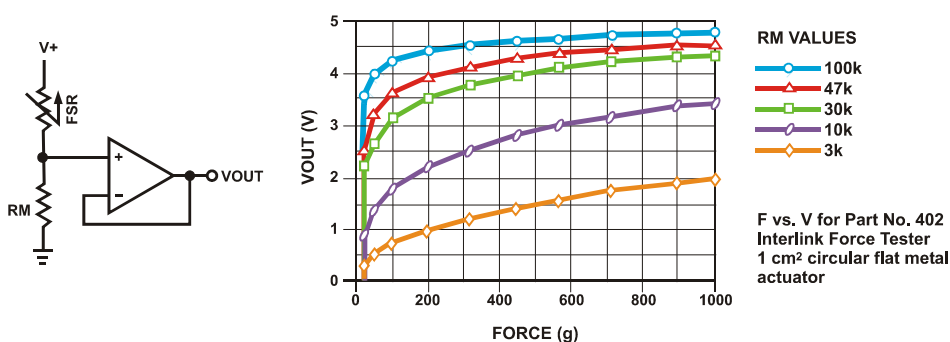


Figure 9  
FSR Voltage Divider

### FSR Voltage Divider

For a simple force-to-voltage conversion, the FSR device is tied to a measuring resistor in a voltage divider configuration. The output is described by the equation:

$$V_{OUT} = (V+) / [1 + R_{FSR}/R_M]$$

In the shown configuration, the output voltage increases with increasing force. If  $R_{FSR}$  and  $R_M$  are swapped, the output swing will decrease with increasing force. These two output forms are mirror images about the line  $V_{OUT} = (V+) / 2$ .

The measuring resistor,  $R_M$ , is chosen to maximize the desired force sensitivity range and to limit current. The current through the FSR should be limited to less than 1 mA/square cm of applied force. Suggested op-amps for single sided supply designs are LM358 and LM324. FET input devices such as LF355 and TL082 are also good. The low bias currents of these op-amps reduce the error due to the source impedance of the voltage divider.

A family of FORCE vs.  $V_{OUT}$  curves is shown on the graph above for a standard FSR in a voltage divider configuration with various  $R_M$  resistors. A  $(V+)$  of +5V was used for these examples.



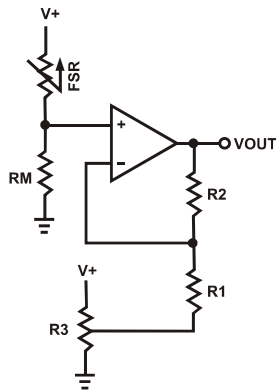


Figure 10  
Adjustable Buffer

## Adjustable Buffers

Similar to the FSR Voltage Divider, these interfaces isolate the output from the high source impedance of the Force Sensing Resistor. However, these alternatives allow adjustment of the output offset and gain.

In Figure 10, the ratio of resistors R2 and R1 sets the gain of the output. Offsets resulting from the non-infinite FSR resistance at zero force (or bias currents) can be trimmed out with the potentiometer, R3. For best results, R3 should be about one-twentieth of R1 or R2. Adding an additional pot at R2 makes the gain easily adjustable. Broad range gain adjustment can be made by replacing R2 and R1 with a single pot.

The circuit in Figure 11 yields similar results to the previous one, but the offset trim is isolated from the adjustable gain. With this separation, there is no constraint on values for the pot. Typical cal for R5 and the pot are around 10kΩ.

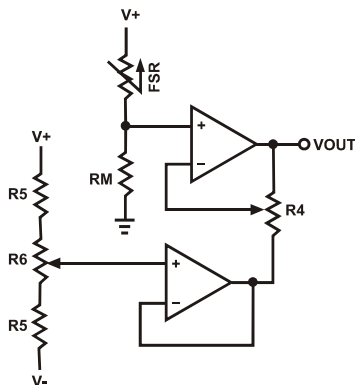


Figure 11  
Adjustable Buffer

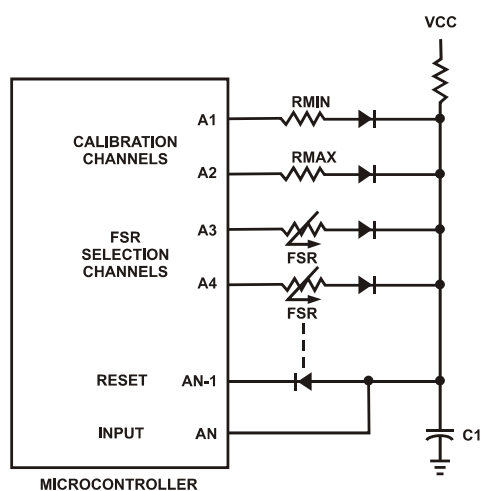


Figure 12  
Multi-Channel FSR-to-Digital Interface

## Multi-Channel to FSR-to-Digital Interface

Sampling Cycle (any FSR channel):

The microcontroller switches to a specific FSR channel, toggling it high, while all other FSR channels are toggled low. The RESET channel is toggled high, a counter starts and the capacitor C1 charges, with its charging rate controlled by the resistance of the FSR ( $t \sim RC$ ). When the capacitor reaches the high digital threshold of the INPUT channel, the counter shuts off, the RESET is toggled low, and the capacitor discharges.

The number of “counts” it takes from the toggling of the RESET high to the toggling of the INPUT high is proportional to the resistance of the FSR. The resistors RMIN and RMAX are used to set a minimum and maximum “counts” and therefore the range of the “counts”. They are also used periodically to re-calibrate the reference. A sampling cycle for RMIN is run, the number of “counts” is stored and used as a new zero. Similarly, a sampling cycle for RMAX is run and the value is stored as the maximum range (after subtracting the RMIN value). Successive FSR samplings are normalized to the new zero. The full range is “zoned” by dividing the normalized maximum “counts” by the number of desired zones. This will delineate the window size or width of each zone.

Continual sampling is done to record changes in FSR resistance due to change in force. Each FSR is selected sequentially.

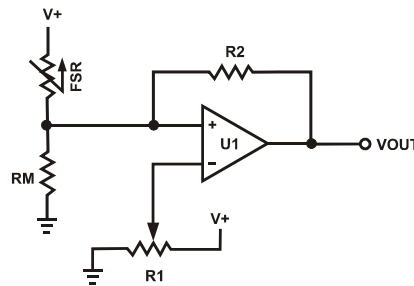


Figure 13  
 FSR Variable Force Threshold Switch

## FSR Variable Force Threshold Switch

This simple circuit is ideal for applications that require on-off switching at a specified force, such as touch-sensitive membrane, cut-off, and limit switches. For a variation of this circuit that is designed to control relay switching, see the following page.

The FSR device is arranged in a voltage divider with  $R_M$ . An op-amp, U1, is used as a comparator. The output of U1 is either high or low. The non-inverting input of the op-amp is driven by the output of the divider, which is a voltage that increases with force. At zero force, the output of the op-amp will be low. When the voltage at the non-inverting input of the op-amp exceeds the voltage of the inverting input, the output of the op-amp will toggle high. The triggering voltage, and therefore the force threshold, is set at the inverting input by the pot R1. The hysteresis, R2, acts as a “debouncer”, eliminating any multiple triggerings of the output that might occur.

Suggested op-amps are LM358 and LM324. Comparators like LM393 also work quite well. The parallel combination of R2 with  $R_M$  is chosen to limit current and to maximize the desired force sensitivity range. A typical value for this combination is about  $47k\Omega$ .

The threshold adjustment pot, R1, can be replaced by two fixed value resistors in a voltage divider configuration.

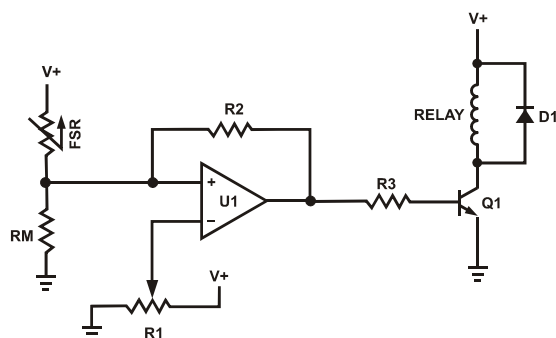


Figure 14  
FSR Variable Force Threshold Relay Switch

## FSR Variable Force Threshold Relay Switch

This circuit is a derivative of the simple FSR Variable Force Threshold Switch on the previous page. It has use where the element to be switched requires higher current, like automotive and industrial control relays.

The FSR device is arranged in a voltage divider with  $R_M$ . An op-amp, U1, is used as a comparator. The output of U1 is either high or low. The non-inverting input of the op-amp sees the output of the divider, which is a voltage that increases with force. At zero force, the output of the op-amp will be low. When the voltage at the non-inverting input of the op-amp exceeds the voltage of the inverting input, the output of the op-amp will toggle high. The triggering voltage, and therefore the force threshold, is set at the inverting input by the pot R1. The transistor Q1 is chosen to match the required current specification for the relay. Any medium power NPN transistor should suffice. For example, an NTE272 can sink 2 amps, and an NTE291 can sink 4 amps. The resistor R3 limits the base current (a suggested value is 4.7k $\Omega$ ). The hysteresis resistor, R2, acts as a “debouncer”, eliminating any multiple triggerings of the output that might occur.

Suggested op-amps are LM358 and LM324. Comparators like LM393 and LM339 also work quite well, but must be used in conjunction with a pull-up resistor. The parallel combination of R2 with  $R_M$  is chosen to limit current and to maximize the desired force sensitivity range. A typical value for this combination is about 47k $\Omega$ .

The threshold adjustment pot, R1, can be replaced by two fixed value resistors in a voltage divider configuration. The diode D1 is included to prevent flyback, which could harm the relay and the circuitry.

## FSR Current-to-Voltage Converter

In this circuit, the FSR device is the input of a current-to-voltage converter. The output of this amplifier is described by the equation:

$$V_{OUT} = V_{REF} \cdot [-R_G/R_{FSR}].$$

With a positive reference voltage, the output of the op-amp must be able to swing below ground, from 0V to  $-V_{REF}$ , therefore dual sided supplies are necessary. A negative reference voltage will yield a positive output swing, from 0V to  $+V_{REF}$ .

$$V_{OUT} = (-R_G \cdot V_{REF}) / R_{FSR}.$$

$V_{OUT}$  is inversely proportional to  $R_{FSR}$ . Changing  $R_G$  and/or  $V_{REF}$  changes the response slope. The following is an example of the sequence used for choosing the component values and output swing:

For a human-to-machine variable control device, like a joystick, the maximum force applied to the FSR is about 1kg. Testing of a typical FSR shows that the corresponding  $R_{FSR}$  at 1kg is about 4.6k $\Omega$ . If  $V_{REF}$  is  $-5V$ , and an output swing of 0V to  $+5V$  is desired, then  $R_G$  should be approximately equal to this minimum  $R_{FSR}$ .  $R_G$  is set at 4.7k $\Omega$ . A full swing of 0V to  $+5V$  is thus achieved. A set of FORCE vs.  $V_{OUT}$  curves is shown in Figure 15 for a standard FSR using this interface with a variety of  $R_G$  values.

The current through the FSR device should be limited to less than 1 mA/square cm of applied force. As with the voltage divider circuit, adding a resistor in parallel with  $R_{FSR}$  will give a definite rest voltage, which is essentially a zero-force intercept value. This can be useful when resolution at low forces is desired.

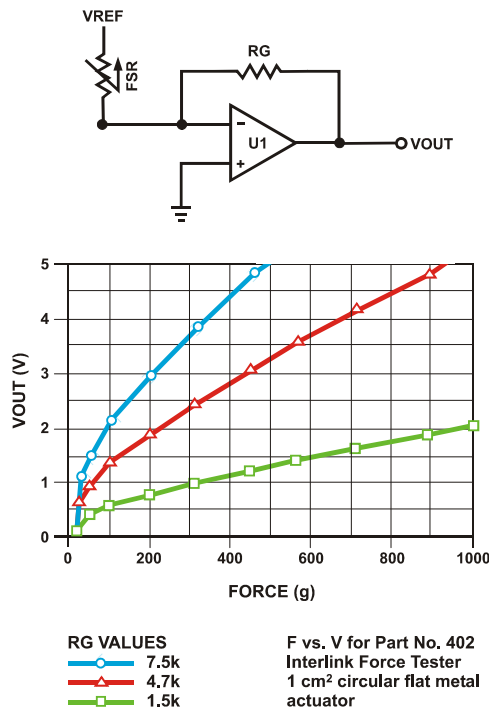


Figure 15  
FSR Current-to-Voltage Converter

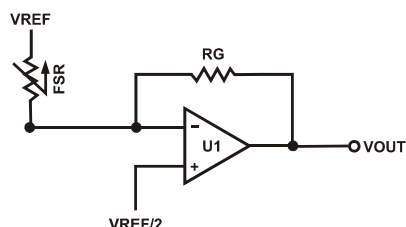


Figure 16  
Add'l FSR Current-to-Voltage Converter

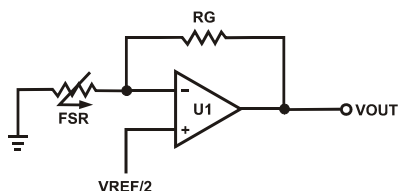


Figure 17  
Add'l FSR Current-to-Voltage Converter

## Additional FSR Current-to-Voltage Converters

These circuits are a slightly modified version of the current-to-voltage converter detailed on the previous page. Please refer to it for more detail.

The output of Figure 16 is described by the equation:

$$V_{OUT} = [V_{REF}/2] * [1 - R_G/R_{FSR}]$$

The output swing of this circuit is from  $(V_{REF}/2)$  to 0V. In the case where  $R_G$  is greater than  $R_{FSR}$ , the output will go into negative saturation.

The output of Figure 17 is described by the equation:

$$V_{OUT} = V_{REF}/2 * [1 + R_G/R_{FSR}]$$

The output swing of this circuit is from  $(V_{REF}/2)$  to  $V_{REF}$ . In the case where  $R_G$  is greater than  $R_{FSR}$ , the output will go into positive saturation.

For either of these configurations, a zener diode placed in parallel with  $R_G$  will limit the voltage built up across  $R_G$ . These designs yield one-half the output swing of the previous circuit, but only require single sided supplies and positive reference voltages. Like the preceding circuit, the current through the FSR should be limited to less than 1 mA/square cm of applied force.

Suggested op-amps are LM358 and LM324.

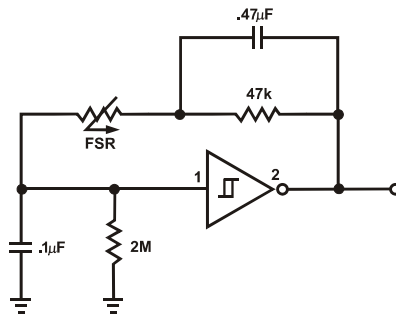
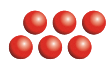


Figure 18  
FSR Schmitt Trigger Oscillator

## FSR Schmitt Trigger Oscillator

In this circuit, an oscillator is made using the FSR device as the feedback element around a Schmitt Trigger. In this manner, a simple force-to-frequency converter is made. At zero force, the FSR is an open circuit. Depending on the last stage of the trigger, the output remains constant, either high or low. When the FSR is pressed, the oscillator starts, its frequency increasing with increasing force. The 2MΩ resistor at the input of the trigger insures that the oscillator is off when FSRs with non-infinite resistance at zero force are used. The 47kΩ resistor and the 0.47 μF capacitor control the force-to-frequency characteristic. Changes in the “feel” of this circuit can be made by adjusting these values. The 0.1μF capacitor controls the frequency range of the oscillator. By implementing this circuit with CMOS or TTL, a digital process can be controlled by counting leading and/or trailing edges of the oscillator output. Suggested Schmitt Triggers are CD40106, CD4584 or 74C14.



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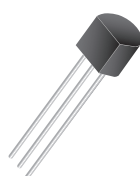




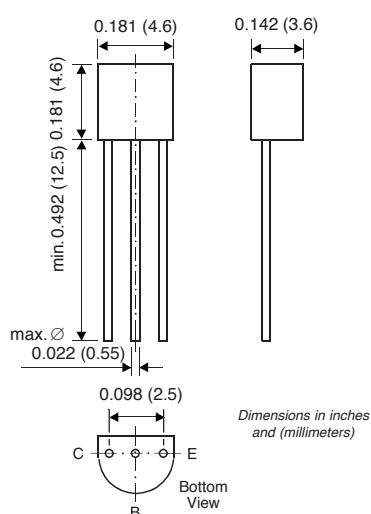
## BC337 and BC338

Vishay Semiconductors  
formerly General Semiconductor

### Small Signal Transistors (NPN)



TO-226AA (TO-92)



#### Features

- NPN Silicon Epitaxial Planar Transistors for switching and amplifier applications. Especially suited for AF-driver stages and low power output stages.
- These types are also available subdivided into three groups -16, -25, and -40, according to their DC current gain. As complementary types, the PNP transistors BC327 and BC328 are recommended.
- On special request, this transistor is also manufactured in the pin configuration TO-18.

#### Mechanical Data

**Case:** TO-92 Plastic Package

**Weight:** approx. 0.18g

**Packaging Codes/Options:**

E6/Bulk – 5K per container, 20K/box

E7/4K per Ammo mag., 20K/box

#### Maximum Ratings & Thermal Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

Parameter		Symbol	Value	Unit
Collector-Emitter Voltage	BC337 BC338	$V_{CES}$	50 30	V
Collector-Emitter Voltage	BC337 BC338	$V_{CEO}$	45 25	V
Emitter-Base Voltage		$V_{EBO}$	5	V
Collector Current		$I_C$	800	mA
Peak Collector Current		$I_{CM}$	1	A
Base Current		$I_B$	100	mA
Power Dissipation at $T_{amb} = 25^\circ\text{C}$		$P_{tot}$	625 <sup>(1)</sup>	mW
Thermal Resistance Junction to Ambient Air		$R_{\theta JA}$	200 <sup>(1)</sup>	$^\circ\text{C/W}$
Junction Temperature		$T_J$	150	$^\circ\text{C}$
Storage Temperature Range		$T_S$	-65 to +150	$^\circ\text{C}$

**Note:**

(1) Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

## BC337 and BC338

Vishay Semiconductors  
formerly General Semiconductor

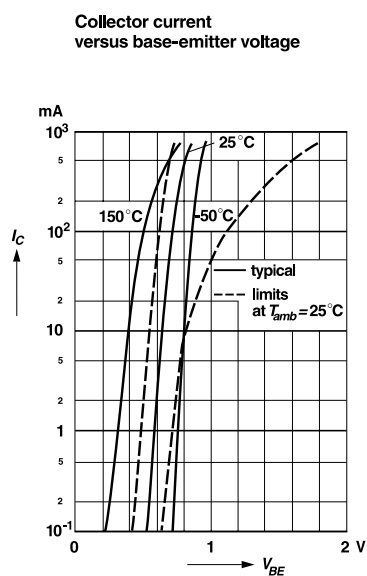
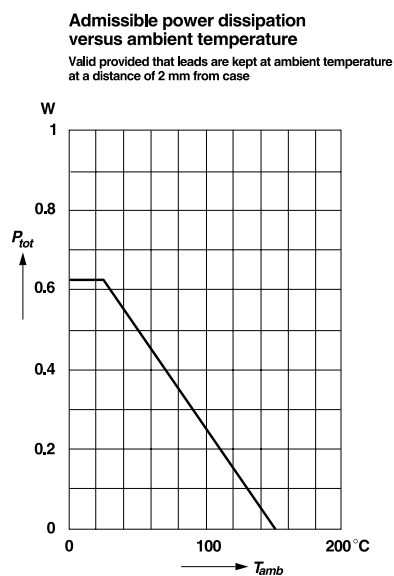


### Electrical Characteristics (T<sub>J</sub> = 25°C unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
DC Current Gain	h <sub>FE</sub>	V <sub>CE</sub> = 1 V, I <sub>C</sub> = 100 mA	100	160	250	—
			160	250	400	
			250	400	630	
		V <sub>CE</sub> = 1 V, I <sub>C</sub> = 300 mA	60	130	—	
			100	200	—	
			170	320	—	
Collector-Emitter Cutoff Current	I <sub>CES</sub>	V <sub>CE</sub> = 45 V	—	2	100	nA
		V <sub>CE</sub> = 25 V	—	2	100	nA
		V <sub>CE</sub> = 45 V, T <sub>amb</sub> = 125°C	—	—	10	μA
		V <sub>CE</sub> = 25 V, T <sub>amb</sub> = 125°C	—	—	10	μA
Collector-Emitter Breakdown Voltage	V <sub>(BR)CEO</sub>	I <sub>C</sub> = 10 mA	45 20	— —	— —	V
Collector-Emitter Breakdown Voltage	V <sub>(BR)CES</sub>	I <sub>C</sub> = 0.1 mA	50 30	— —	— —	V
Emitter-Base Breakdown Voltage	V <sub>(BR)EBO</sub>	I <sub>E</sub> = 0.1 mA	5	—	—	V
Collector Saturation Voltage	V <sub>CEsat</sub>	I <sub>C</sub> = 500 mA, I <sub>B</sub> = 50 mA	—	—	0.7	V
Base-Emitter Voltage	V <sub>BE</sub>	V <sub>CE</sub> = 1 V, I <sub>C</sub> = 300 mA	—	—	1.2	V
Gain-Bandwidth Product	f <sub>T</sub>	V <sub>CE</sub> = 5 V, I <sub>C</sub> = 10 mA f = 50 MHz	—	100	—	MHz
Collector-Base Capacitance	C <sub>CB0</sub>	V <sub>CB</sub> = 10 V, f = 1 MHz	—	12	—	pF

### Ratings and

### Characteristic Curves (T<sub>A</sub> = 25°C unless otherwise noted)





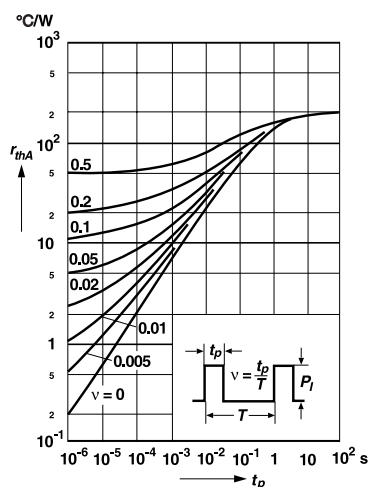
## BC337 and BC338

Vishay Semiconductors  
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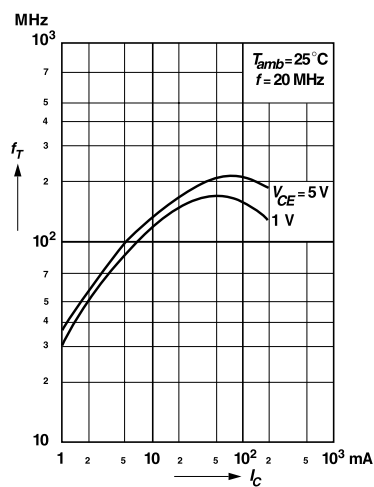
### Ratings and Characteristic Curves ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

#### Pulse thermal resistance versus pulse duration

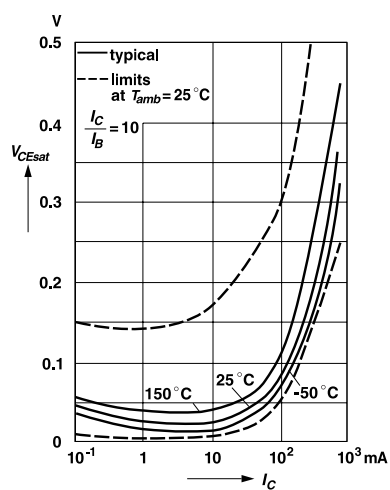
Valid provided that leads are kept at ambient temperature  
at a distance of 2 mm from case



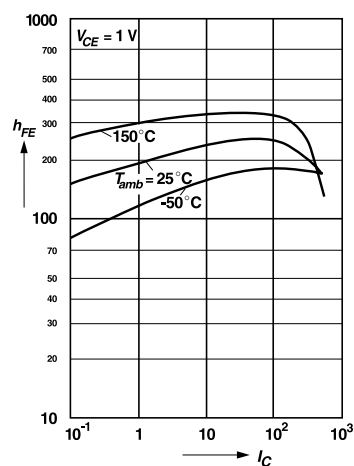
#### Gain-bandwidth product versus collector current



#### Collector saturation voltage versus collector current



#### DC current gain versus collector current



## BC337 and BC338

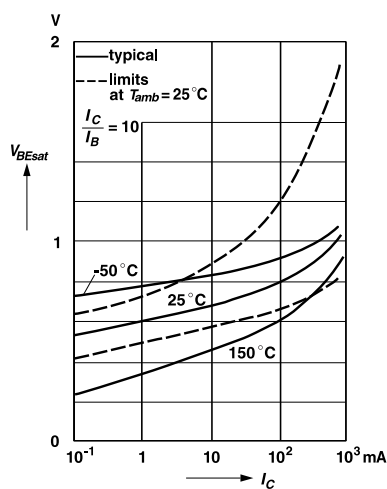
Vishay Semiconductors  
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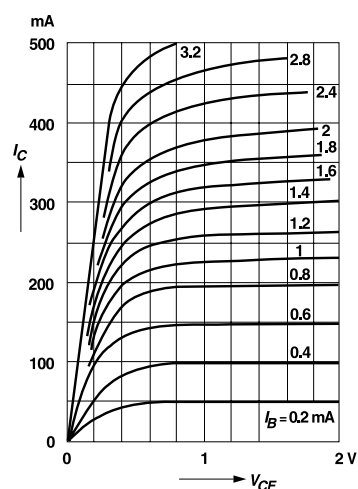
### Ratings and

### Characteristic Curves (TA = 25°C unless otherwise noted)

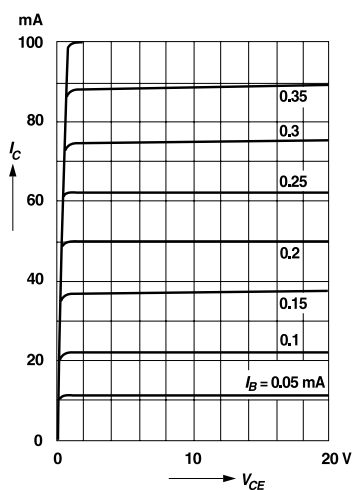
Base saturation voltage  
versus collector current



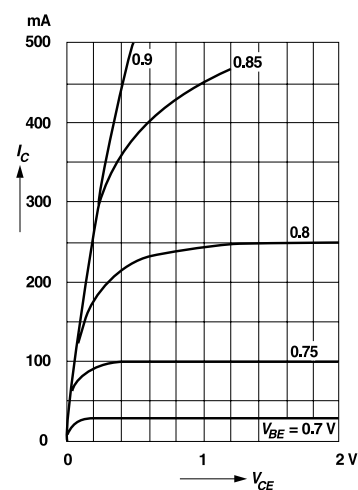
Common emitter  
collector characteristics



Common emitter  
collector characteristics



Common emitter  
collector characteristics



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Datasheets for electronics components.





HE851

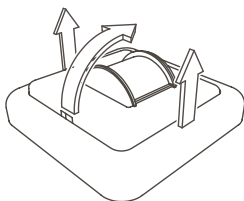
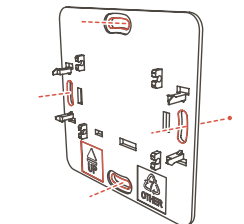
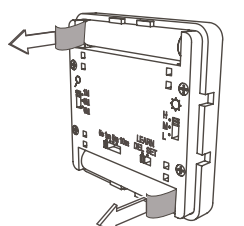
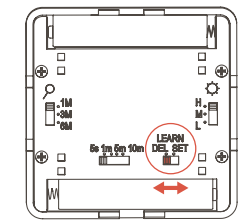
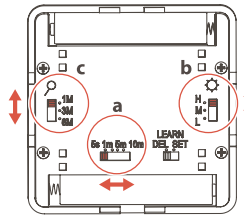
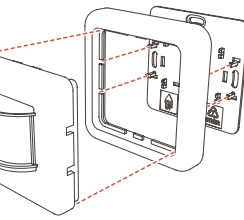
Indoor motion detector  
Bewegungsmelder für Innenräume  
Binnen-bewegungsdetector  
Détecteur de mouvement d'intérieur  
Wewnętrzny czujnik ruchu  
Detector de movimiento para interiores

**Specifications:**

Maximum range (meters): 50.  
Time adjustment: 5 sec. – 10 min.  
Sensitivity adjustment: 3M – 12M.  
Detection range: Up to 8m x 140°.  
Battery: 2 x 1.5V, type AAA (incl.).  
1 Channel.

CE + R&TTE  
APPROVED  
433.92MHz.

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**2a****2b****2c****3****4****5a****GB****1 Preparation for use**

- Install the motion detector (HE851) at least 1.2 m above the floor.
- Do not install the motion detector in direct sunlight.
- Do not install the motion detector in front of a window, fan or air-conditioning.
- Do not install the motion detector over or next to a heat source.

**2 Installation motion detector (HE851) part 1**

- a Firstly, remove the protective cover and then the frame from the mounting plate.
- b Fix the mounting plate to the desired spot on the wall with the supplied plugs and screws. *Note the up arrow.*
- c Activate the batteries by pulling out the tabs of the motion detector. *Attention: wait 60 seconds until the motion detector has warmed up.*

**3 Linking the motion detector to a receiver**

- a Slide the lower right switch on the back of the protective cover to the DEL position. *Switch your receiver in the linking mode; follow the manual of the receiver.*
- b Slide the switch to the SET position. The LED on the receiver turns off, the motion detector is now linked. Repeat these steps for any other receiver.

**4 Setting the motion detector**

- a Slide the lower left switch on the back of the protective cover on 5 sec, 1 min, 5 min or 10 min to set the time that the receiver remains switched on after movement is detected.
- b Slide the switch at the right side on the back of the protective cover on H (high), M (medium) or L (low) to set the light level in which you want the lamp to switch on.
- c Slide the switch at the left side on the back of the protective cover on 1M, 3M or 6M to set the sensitivity of the motion detector. 1M = low sensitive. 3M = sensitive. 6M = very sensitive.

**5 Installation motion detector part 2**

- a First, mount the frame and then the protective cover on the mounting plate. Note the latching tabs.

**D****1 Vorbereitung vor Inbetriebnahme**

- Montieren Sie den Bewegungsmelder (HE851) mindestens 1,2 m über dem Boden.
- Installieren Sie den Bewegungsmelder nicht in direktem Sonnenlichteinfall.
- Installieren Sie den Bewegungsmelder nicht vor einem Fenster, Ventilator oder vor einer Klimaanlage.
- Installieren Sie den Bewegungsmelder nicht über oder in der Nähe einer Wärmequelle.

**2 Installation des Bewegungsmelders (HE851), Teil 1**

- a Entfernen Sie zuerst die Schutzabdeckung und den Rahmen von der Montageplatte.
- b Befestigen Sie die Montageplatte mit den mitgelieferten Dübeln und Schrauben an der gewünschten Stelle an der Wand. *Beachten Sie den nach oben gerichteten Pfeil.*
- c Aktivieren Sie die Batterien, indem Sie die Streifen aus dem Bewegungsmelder herausziehen. *Achtung: Warten Sie 60 Sekunden, bis sich der Bewegungsmelder aufgewärmt hat.*

**3 Verbindung des Bewegungsmelders mit einem Empfänger**

- a Schieben Sie den rechten, unteren Schalter auf der Rückseite der Schutzabdeckung auf die Position DEL. *Schalten Sie den Empfänger auf Verbindungsmodus, folgen Sie der Bedienungsanleitung des Empfängers.*
- b Schieben Sie den Schalter auf die Position SET. Die LED des Empfängers schaltet sich aus, der Bewegungsmelder ist jetzt verbunden. Wiederholen Sie diese Schritte für jeden weiteren Empfänger.

**4 Einrichten des Bewegungsmelders**

- a Schieben Sie den linken, unteren Schalter auf der Rückseite der Schutzabdeckung auf 5 Sek., 1 Min., 5 Min. oder 10 Min., um die Zeit festzulegen, die der Empfänger eingeschaltet bleibt, nachdem eine Bewegung festgestellt wurde.
- b Schieben Sie den rechten Schalter auf der Rückseite der Schutzabdeckung auf die Position H (hoch), M (mittel) oder L (niedrig), um den Helligkeitsgrad festzulegen, bei dem die Lampe eingeschaltet werden soll.
- c Um die Empfindlichkeit des Bewegungsmelders festzulegen, schieben Sie den linken Schalter auf der Rückseite der Schutzabdeckung auf 1M, 3M oder 6M. 1M = niedrige Empfindlichkeit. 3M = hohe Empfindlichkeit. 6M = sehr hohe Empfindlichkeit.

**5 Installation des Bewegungsmelders, Teil 2**

- a Montieren Sie zuerst den Rahmen und dann die Schutzabdeckung auf der Montageplatte. Beachten Sie die Anreiterungsschrauben.

**NL****1 Voorbereiding voor gebruik**

- Plaats de bewegingsdetector (HE851) minimaal 1,2 m boven de grond.
- Plaats de bewegingsdetector niet in direct zonlicht.
- Plaats de bewegingsdetector niet voor een raam, ventilator of airconditioning.
- Plaats de bewegingsdetector niet boven of naast een warmtebron.

**2 Installatie bewegingsdetector (HE851) deel 1**

- a Verwijder eerst de beschermingskap en dan het frame van de montageplaat.
- b Bevestig de montageplaat op de gewenste plaats op de muur met de meegeleverde pluggen en schroeven. *Let op de pijl omhoog.*
- c Activeer de batterijen door de lipjes uit de bewegingsdetector te trekken. *Let op: wacht 60 seconden tot de bewegingsdetector is opgewarmd.*

**3 De bewegingsdetector aan een ontvanger koppelen**

- a Zet de schakelaar rechtsom op de achterkant van de beschermingskap op DEL. *Zet uw ontvanger in de koppelmodus, volg hiervoor de handleiding van de ontvanger.*
- b Zet de schakelaar op SET. De LED op de ontvanger dooft, de bewegingsdetector is nu gekoppeld. Herhaal deze stappen voor eventuele overige ontvangers.

**4 De bewegingsdetector instellen**

- a Zet de schakelaar linksom op de achterkant van de beschermingskap op 5 sec, 1 min, 5 min of 10 min om de tijd in te stellen die de ontvanger aanblijft nadat beweging is gedetecteerd.
- b Zet de schakelaar rechts op de achterkant van de beschermingskap op H (hoog), M (middel) of L (laag) om het lichtniveau in te stellen waarbij u wilt dat de lamp aan gaat.
- c Zet de schakelaar links op de achterkant van de beschermingskap op 1M, 3M of 6M om de gevoeligheid van de bewegingsdetector in te stellen. 1M = weinig gevoelig. 3M = gevoelig. 6M = zeer gevoelig.

**5 Installatie bewegingsdetector deel 2**

- a Plaats eerst het frame en dan de beschermingskap terug op de montageplaat. Let op de klikvingers.

**F****1 Préparation à l'utilisation**

- Installez le détecteur de mouvement (HE851) à au moins 1,2 m du sol.
- N'installez pas le détecteur de mouvement sous les rayons directs du soleil.
- N'installez pas le détecteur de mouvement en face d'une fenêtre, d'un ventilateur ou d'un climatiseur.
- N'installez pas le détecteur de mouvement sur ou près d'une source de chaleur.

**2 Partie 1 de l'installation du détecteur de mouvement (HE851)**

- a Tout d'abord, retirez le cache de protection et ensuite le cadre de la plaque de fixation.
- b Installez la plaque de fixation à l'endroit désiré sur le mur avec les vis et les chevilles fournies. *Notes la flèche vers le haut.*
- c Actionnez les piles en tirant sur les onglets du détecteur de mouvement. *Attention : patientez 60 secondes pendant que le détecteur de mouvement se met en route.*

**3 Réaliser la liaison entre le détecteur de mouvement et un récepteur**

- a Glissez le commutateur du bas à droite sur l'arrière du cache de protection sur la position DEL (Annulation).
- b Placez le commutateur sur la position SET (Réglage). L'indicateur lumineux du récepteur s'éteint, le détecteur de mouvement est à présent associé. Répétez ces étapes pour tous les autres récepteurs.

**4 Réglage du détecteur de mouvement**

- a Glissez le commutateur du bas à gauche sur l'arrière du cache de protection sur 5 s, 1 min, 5 min ou 10 min pour régler la durée pendant laquelle le récepteur reste actif une fois un mouvement détecté.
- b Glissez le commutateur sur le côté droit à l'arrière du cache de protection sur H (high - élevé), M (medium - moyen) ou L (low - faible) pour régler l'intensité lumineuse souhaitée de la lampe à allumer.
- c Glissez le commutateur sur le côté gauche à l'arrière du cache de protection sur 1 M, 3 M ou 6 M pour régler la sensibilité du détecteur de mouvement. 1 M = faible sensibilité. 3 M = bonne sensibilité. 6 M = forte sensibilité.

**5 Partie 2 de l'installation du détecteur de mouvement**

- a D'abord, montez le cadre et ensuite le cache de protection de la plaque de fixation. Notez les onglets de verrouillage.

**PL****1 Przygotowanie do użycia**

- Zainstaluj czujnik ruchu (HE851) przynajmniej 1,2 m nad podłogą.
- Nie instaluj czujnika ruchu w miejscu nasłonecznionym.
- Nie instaluj czujnika ruchu przed oknem, wentylatorem lub klimatyzacją.
- Nie instaluj czujnika ruchu nad lub obok źródła ciepła.

**2 Instalacja czujnika ruchu (HE851) część 1**

- a Najpierw zdejmij pokrywę ochronną, a następnie ramkę z płytki montażowej.
- b Za pomocą dołączonych kołków z wkrętami umocuj płytkę montażową w wybranym miejscu na ścianie. *Zwróć uwagę na strzałkę w górę.*
- c Uaktywnij baterie poprzez wyciągnięcie paszków zabezpieczających na czujniku ruchu. *Uwaga: odczekaj 60 sekund, aż czujnik ruchu się rozgrzeje.*

**3 Łączenie czujnika ruchu z odbiornikiem**

- a Przesuń przełącznik w prawym dolnym rogu z tyłu pokrywy ochronnej na pozycję DEL.
- b Przesuń przełącznik na pozycję SET (Ustawiony). Dioda LED na odbiorniku zgśnie, czujnik ruchu jest teraz połączony. Powtórz te kroki dla każdego innego odbiornika.

**4 Ustawianie czujnika ruchu**

- a Przesuń przełącznik w lewym dolnym rogu z tyłu pokrywy ochronnej na 5 sek, 1 min, 5 min lub 10 min, aby ustawić czas, na jak długo po wykryciu ruchu odbiornik ma pozostać włączony.
- b Przesuń przełącznik po prawej stronie z tyłu pokrywy ochronnej na H (wysoki), M (średni) lub L (niski), aby ustawić natężenie światła, z jakim ma się włączyć lamp.
- c Przesuń przełącznik po lewej stronie z tyłu pokrywy ochronnej na 1M, 3M lub 6M, aby ustawić czułość czujnika ruchu. 1M = mało czuły. 3M = czuły. 6M = bardzo czuły.

**5 Instalacja czujnika ruchu część 2**

- a Najpierw zamontuj ramkę, a następnie pokrywę ochronną na płytce montażowej. Zwróć uwagę na zatrzaski.

**E****1 Preparación para el uso**

- Instale el detector de movimiento (HE851) al menos a 1,2 m por encima del suelo.
- No permita que el detector de movimiento reciba la luz solar directamente.
- No instale el detector de movimiento delante de una ventana, un ventilador o una unidad de aire acondicionado.
- No instale el detector de movimiento por encima o cerca de una fuente de calor.

**2 Instalación del detector de movimiento (HE851) primera parte**

- a En primer lugar, extraiga la cubierta protectora y a continuación el marco de la placa de montaje.
- b Coloque la placa de montaje en el lugar de la pared que desee y fíjela con los tacos y los tornillos proporcionados. *Observe la flecha hacia arriba.*
- c Active las baterías tirando de las pestañas del detector de movimiento. *Atención: espere 60 segundos hasta que el detector de movimiento se haya calentado.*

**3 Conexión del detector de movimiento a un receptor**

- a Deslice el interruptor inferior derecho de la parte posterior de la cubierta protectora hasta la posición DEL.
- b Desplace el interruptor hasta la posición de SET. La luz LED del receptor se apagará y así se indica que el detector de movimiento ya está conectado. Repita estos pasos para cualquier otro receptor.

**4 Programación del detector de movimiento**

- a Deslice el interruptor inferior izquierdo de la parte posterior de la cubierta protectora hasta la posición de 5 segundos, 1 minuto, 5 minutos o 10 minutos para programar el tiempo que el receptor permanecerá encendido tras detectar algún movimiento.
- b Deslice el interruptor situado en el lado derecho de la parte posterior de la cubierta protectora hasta H (alto), M (medio) o L (bajo) para seleccionar el nivel de intensidad con el que se encenderá la luz.
- c Deslice el interruptor situado en el lado izquierdo de la parte posterior de la cubierta protectora hasta 1M, 3M o 6M para seleccionar la sensibilidad del detector de movimiento. 1M = sensibilidad baja. 3M = sensible. 6M = muy sensible.

**5 Instalación del detector de movimiento segunda parte**

- a En primer lugar, monte el marco y después la cubierta protectora en la placa de montaje. Observe las pestañas de fijación.



**Inomhus rörelsedetektor**  
**Innendørs bevegelsesføler**  
**Ανιχνευτής κίνησης εσωτερικού χώρου**  
**Vnitřní detektor pohybu**  
**Beltéri mozgásérzékelő**  
**Senzor interior de mișcare**

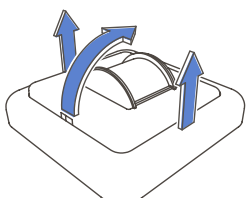


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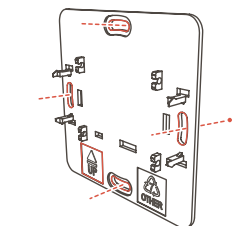


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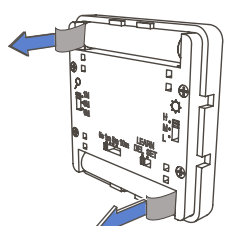
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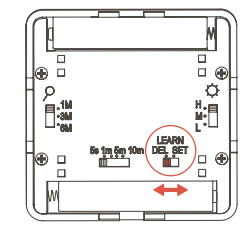
**2b**



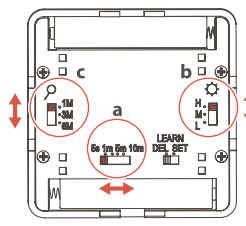
**2c**



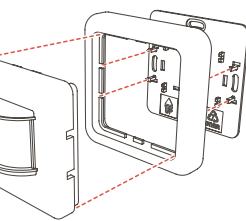
**3**



**4**



**5a**



**S**

**1 Förberedelser för användning**

- Installera rörelsedetektorn (HE851) minst 1,2 m över golvet.
- Installera inte rörelsedetektorn i direkt solljus.
- Installera inte rörelsedetektorn framför ett fönster, fläkt eller luftkonditionering.
- Installera inte rörelsedetektorn över eller bredvid en värmekälla.

**2 Installation rörelsedetektor (HE851) del 1**

- a** För det första, ta bort skyddshöljet och sedan ramen från monteringsplattan.
- b** Fäst monteringsplattan på önskad plats på väggen med de medföljande pluggarna och skruvorna. *Notera uppåt!*
- c** Aktivera batterierna genom att dra ut filarna i rörelsedetektorn. *Observera: vänta 60 sekunder tills rörelsedetektorn har värmts upp.*

**3 Ansluta rörelsedetektorn till en mottagare**

- a** Skjut den nedre högra omkopplaren på baksidan av skyddshöljet till DEL-läget. *Vrid mottagaren i anslutningsläge, följ bruksanvisningen för mottagaren.*
- b** Skjut omkopplaren till INSTÄLLNING-läget. Lysdiolen på mottagaren släcks, rörelsedetektorn är nu ansluten. Upprepa dessa steg för alla andra mottagare.

**4 Inställning av rörelsedetektorn**

- a** Skjut den nedre vänstra omkopplaren på baksidan av skyddshöljet till 5 sekunder, 1 minut, 5 minuter eller 10 minuter för att ställa in tiden som mottagaren förblir påslagen efter att rörelse detekteras.
- b** Skjut omkopplaren till höger på baksidan av skyddshöljet till H (hög), M (medium) eller L (låg) för att ställa in den önskade ljusnivån du vill att lampen tänds på.
- c** Skjut omkopplaren till vänster på baksidan av skyddshöljet till 1M, 3M eller 6M för att ställa in känsligheten för rörelsedetektorn. 1M = låg känslighet. 3M = känslig. 6M = mycket känslig.

**5 Installation rörelsedetektor (HE851) del 2**

- a** Först, montera ramen och sedan skyddshöljet på monteringsplattan. *Notera de låsande filarna.*

**NO**

**1 Klargjöring för bruk**

- Installera bevegelsesføleren (HE851) minst 1,2 m over gulvet.
- Ikke installer bevegelsesføleren i direkte sollys.
- Ikke installer bevegelsesføleren foran et vindu, air-conditioning eller vifte.
- Ikke installer bevegelsesføleren over eller ved siden av en varmekilde.

**2 Installasjon bevegelsesføler (HE851) del 1**

- a** Fjern først beskyttelsesdekslet og deretter rammen til monteringsplaten.
- b** Fest monteringsplattan på ønsket punkt på veggen med de medfølgende skruene. *Legg merke til opp-pilen.*
- c** Aktiver batteriet ved å trekke ut stripen på beskyttelsesføleren. *OBS: vent 60 sekunder, innstil bevegelsesføleren har varmet opp.*

**3 Tilkobling av en bevegelsesføler til en mottaker**

- a** Skyv den nedre høyre bryteren på baksiden av beskyttelsesdekslet til posisjonen DEL.
- Slutt mottakeren din i koblings-modus, følg brukermanualen til mottakeren.*
- b** Skyv bryteren til posisjonen SET. LED på mottakeren slås av, bevegelsesføleren er nå koblet til. Gjenta disse trinnene for enhver annen mottaker.

**4 Innstilling av bevegelsesføleren**

- a** Skyv den nedre høyre bryteren på baksiden av beskyttelsesdekslet til 5 sek, 1 min, 5 min eller 10 min for å angi tiden da mottakeren er slått på etter at en bevegelse er oppdaget.
- b** Skyv bryteren på høyre side av beskyttelsesdekslet til H (høy), M (medium) eller L (lav) for å angi det lysnivået du ønsker at lampen skal tennes på.
- c** Skyv bryteren på venstre side av baksiden på det beskyttende dekslet til 1M, 3M eller 6M for å angi følsomheten til bevegelsesføleren. 1M = lav følsomhet. 3M = følsom. 6M = meget følsom.

**5 Installasjon bevegelsesføler del 2**

- a** Monter først rammen og deretter beskyttelsesdekslet på monteringsplaten. *Legg merke til låsebenene.*

**GR**

**1 Προετοιμασία για τη χρήση**

- εγκαταστήστε τον ανιχνευτή κίνησης (HE851) τουλάχιστον 1,2 μέτρα πάνω από το δάπεδο.
- Μην εγκαθιστάτε τον ανιχνευτή κίνησης σε άμεση έκθεση στο ηλιακό φως.
- Μην εγκαθιστάτε τον ανιχνευτή κίνησης μπροστά από παράθυρο, ανεμιστήρα ή κλιματιστικό.
- Μην εγκαθιστάτε τον ανιχνευτή κίνησης πάνω από ή δίπλα σε μηχανή θερμότητας.

**2 Εγκατάσταση του ανιχνευτή κίνησης (HE851) μέρος 1**

- a** Πρώτα αφαιρέστε το προστατευτικό καλύμμα και έπειτα το πλαίσιο από τη βάση συναρμολόγησης.
- b** Στερεώστε τη βάση συναρμολόγησης στο επιθυμητό σημείο πάνω στον τοίχο με τις βίδες και τα βραχίονα που παρέχονται. *Προσέξτε στο βέλος που δείχνει προς τα επάνω.*
- c** Ενεργοποιήστε τις μπαταρίες τραβώντας προς τα έξω τις ταινίες ασφαλήσεως που βρίσκονται στον ανιχνευτή κίνησης. *Προσέξτε: περιμένετε 60 δευτερόλεπτα μέχρι να προθερμανθεί ο ανιχνευτής κίνησης.*

**3 Σύνδεση του ανιχνευτή κίνησης με ένα δέκτη**

- a** Σέρτε τον κάτω δεξιά διακόπτη που βρίσκεται στο πίσω μέρος του προστατευτικού καλύμματος στη θέση DEL.
- Ρυθμίστε το δέκτη σας στη λειτουργία σύνδεσης, ακολουθήστε τις οδηγίες χρήσεως του δέκτη.*
- b** Σέρτε τον διακόπτη στη θέση SET. Θα ανάψει η ενδεικτική λυχνία στο δέκτη. Ο ανιχνευτής κίνησης είναι πλέον συνδεδεμένος. Επαναλάβετε το βήματα αυτά για κάθε επιπλέον δέκτη.

**4 Ρύθμιση του ανιχνευτή κίνησης**

- a** Πρώτα αφαιρέστε το προστατευτικό καλύμμα και έπειτα το πίσω μέρος του προστατευτικού καλύμματος, στα 5 δευτ., 1 λεπτό, 5 λεπτά ή 10 λεπτά για να ορίσετε το χρόνο για τον οποίο ο ανιχνευτής κίνησης θα παραμείνει ενεργοποιημένος μετά από ανίχνευση κίνησης.
- b** Σέρτε τον διακόπτη που βρίσκεται στη δεξιά πλευρά στο πίσω μέρος του προστατευτικού καλύμματος στο H (υψηλό), M (μεσαίο) ή L (χαμηλό) για να ορίσετε το επίπεδο φωτός στο οποίο επιθυμείτε να ανάψει η λυχνία.
- c** Σέρτε τον διακόπτη στην αριστερή πλευρά στο πίσω μέρος του προστατευτικού καλύμματος, στα 1M, 3M ή 6M για να ορίσετε την ευαισθησία του ανιχνευτή κίνησης. 1M = χαμηλή ευαισθησία. 3M = ευαίσθητο. 6M = πολύ ευαίσθητο.

**5 Εγκατάσταση του ανιχνευτή κίνησης μέρος 2**

- a** Πρώτα τοποθετήστε στη θέση του το πλαίσιο και έπειτα το προστατευτικό καλύμμα πάνω στη βάση συναρμολόγησης. Προσέξτε τα σημεία ασφάλισης.

**CZ**

**1 Příprava pro použití**

- Namontujte detektor pohybu (HE851) minimálně 1,2 m nad podlahu.
- Nemontujte detektor pohybu na přímé sluneční světlo.
- Nemontujte detektor pohybu před okno, ventilátor anebo klimatizaci.
- Nemontujte detektor pohybu nad nebo vedle zdrojů tepla.

**2 Montáž detektoru pohybu (HE851) část 1**

- a** Nejprve odstraňte ochranný kryt a pak rám z montážní desky.
- b** Upevněte montážní desku na požadované místo na zdi pomocí dodaných hmoždinek a šroubků. *Řiďte se šipkou nahoru.*
- c** Aktivujte baterie vyjmutím záložek z detektoru pohybu. *Pozor: počkejte 60 sekund, než se detektor pohybu zahřeje.*

**3 Spojení detektoru pohybu s přijímačem**

- a** Přepněte pravý spodní spínač na zadní straně ochranného krytu do polohy DEL.
- Přepněte přijímač do režimu párování; dodržujte návod od přijímače.*
- b** Přepněte spínač do polohy SET (nastaví). LED na přijímači zhasne, detektor pohybu je nyní spárován. Opakujte tyto kroky pro jakýkoliv jiný přijímač.

**4 Nastavení detektoru pohybu**

- a** Přepněte levý spodní spínač na zadní straně ochranného krytu na 5 s, 1 min, 5 min nebo 10 min pro nastavení času, během kterého přijímač zůstává zapnutý po detekci pohybu.
- b** Přepněte pravý spínač na zadní straně ochranného krytu na H (vysoká), M (střední) nebo L (nízká) pro nastavení intenzity světla, se kterou chcete světlo zapnout.
- c** Přepněte levý spínač na zadní straně ochranného krytu na 1M, 3M nebo 6M pro nastavení citlivosti detektoru pohybu. 1M = nízká citlivost. 3M = citlivý. 6M = vysoká citlivost.

**5 Montáž detektoru pohybu, část 2**

- a** Nejprve namontujte rám a pak ochranný kryt na montážní desku. Dejte pozor na západkové jazyčky.

**H**

**1 Üzembé helyezés előtt**

- A mozgásérzékelőt (HE851) legalább 1,2 m-re a padló szintje felett helyezze el.
- A mozgásérzékelőt ne helyezze közvetlen napfényre.
- A mozgásérzékelőt ne helyezze ablak, ventilátor vagy légkondicionáló elé.
- A mozgásérzékelőt ne helyezze hőforrás fölé vagy közelébe.

**2 Mozgásérzékelő (HE851) üzembé helyezése, 1. rész**

- a** Első lépésben távolítsuk el a védőborítást, majd a keretet a rögzítőalapról.
- b** Szereljük fel a rögzítőalapot a kívánt helyre a falon a mellékelt csavarok és tiplik segítségével. *Ne hagyja figyelmen kívül a felfelé mutató nyilat.*
- c** Aktiválja az elemeket a mozgásérzékelőn található LED kialszik. *Figyelem: várjon 60 mp-et, amíg a mozgásérzékelő beemelegszik.*

**3 A mozgásérzékelő és egy vevőegység összekapcsolása**

- a** Csúsztassa a védőborítás hátoldalán található jobb alsó kapcsolót a DEL állásba. *Kapcsolja a vevőegységet a kapcsolódás üzemmódba; ehhez kövesse a vevőegység használati útmutatóját.*
- b** Kapcsolja a kapcsolót SET állásba. A vevőegységen található LED kialszik, a mozgásérzékelő csatlakozott. További vevőegységek csatlakozáshoz ismételje meg a fenti lépéseket.

**4 A mozgásérzékelő beállítása**

- a** Kapcsolja a védőborítás hátoldalán található bal alsó kapcsolót 5 mp (5 sec), 1 perc (1 min), 5 perc (5 min) vagy 10 perc (10 min) állásba. Így állítható be az az időtartam ameddig a vevőegység bekapcsolva marad a mozgás érzékelése esetén.
- b** Kapcsolja a védőborítás hátoldalán található jobb oldali kapcsolót H (magas), M (közepes) vagy L (alacsony) állásba. Így állítható be az a fényerősség, amellyel szeretné, hogy a világítás bekapcsoljon.
- c** Kapcsolja a védőborítás hátoldalán található bal oldali kapcsolót 1M, 3M vagy 6M állásba. Így állítható be a mozgásérzékelő érzékenysége. 1M = kevéssé érzékeny 3M = érzékeny 6M = nagyon érzékeny.

**5 Mozgásérzékelő üzembé helyezése, 2. rész**

- a** Első lépésben rögzítse a keretet, majd a védőborítást a rögzítőlapra. Vegye figyelembe a rögzítőfüleket.

**RO**

**1 Pregătirea pentru utilizare**

- Montați senzorul de mișcare (HE851) la cel puțin 1,2 m deasupra podelei.
- Nu montați senzorul de mișcare în lumina directă a soarelui.
- Nu montați senzorul de mișcare în fața unei ferestre, ventilator sau aparatură de aer condiționat.
- Nu montați senzorul de mișcare deasupra sau lângă o sursă de căldură.

**2 Montarea senzorului de mișcare (HE851) partea 1**

- a** Mai întâi scoateți capacul de protecție și apoi cadrul plăcii de montaj.
- b** Fixați placa de montaj pe locul dorit de pe perete cu ajutorul șuruburilor și diblurilor furnizate. *Observați săgeata de sus.*
- c** Activați bateriile trăgând de clapetele senzorului de mișcare. *Atenție: așteptați 60 secunde până se încălzește senzorul de mișcare.*

**3 Conectarea senzorului de mișcare la un receptor**

- a** Găsiți comutatorul din partea dreaptă de jos din spatele capacului de protecție până la poziția DEL.
- Comutați receptorul la modul de conectare; urmăriți manualul receptorului.*
- b** Găsiți comutatorul în poziția SET. LED-ul receptorului se stinge, senzorul de mișcare este acum conectat. Repetați acești pași pentru oricare alt receptor.

**4 Setarea senzorului de mișcare**

- a** Găsiți comutatorul din partea stângă de jos din spatele capacului de protecție la 5 sec, 1 min, 5 min sau 10 min pentru a seta timpul în care receptorul rămâne aprins după ce detectează mișcare.
- b** Găsiți comutatorul din partea dreaptă de pe spatele capacului de protecție la H (înalt), M (mediu) sau L (jos) pentru a seta nivelul de lumină cu care doriți să se aprindă becul.
- c** Găsiți comutatorul din partea stângă de pe spatele capacului de protecție la 1M, 3M sau 6M pentru a seta sensibilitatea senzorului de mișcare. 1M = puțin sensibil 3M = sensibil 6M = foarte sensibil.

**5 Montarea senzorului de mișcare partea 2**

- a** Mai întâi montați cadrul și apoi capacul de protecție pe placa de montaj. *Observați clemele de închidere.*