Abstract

Many applications use the ASEN@ and BSEN@ high speed sensor inputs to initiate motions, stop motions or store position information. This Tech Note shows how to connect the more common types of solid state sensor and how to configure the inputs for best results.

Sensor Selection

Two objectives in designing sensor systems are to minimize false triggering and to minimize triggering delays. The sensor type and the way that it is wired have a major impact on these objectives.

There are a vast range of sensing technologies such as optical, laser, magnetic and capacitance to name just four. Within each technology there are different sub-categories reflective vs. transmissive, visual light v. infrared, etc. Each of these technologies and types have advantages and disadvantages that are highly dependent on the application. The best way to select the right sensing technology is to work with a knowledgeable applications engineer from your sensor supplier.

Once you have selected the appropriate sensing technology, you must pick the output type and design the electrical interface, this is where this Tech Note can help you.

There are three common sensor output types:

- Relay contact.
- PNP transistor.
- NPN transistor.

Relay contacts have the obvious problems associated with contact wear, bounce and relatively slow operation. When relay contacts are open, they leave a high impedance noise sensitive input to the DSP axis card input. They are seldom, if ever, the best choice in high speed sensor applications. For this reason the remainder of this Tech Note deals with transistor outputs.

![Diagram of NPN Type Transistor](image)

*Figure 1, NPN Type Transistor*
Figures 1 and 2 show simplified schematics of NPN and PNP type sensor outputs and the way they should be wired to the GEN-III controller.

Figure 2, PNP Type Transistor

Leading or Trailing Edge?

Sensor outputs are most immune to noise if they are set up with the transistor turned on (conducting) while the sensor is waiting to detect the mark. However, the fastest response will usually occur when the transistor is turning on. To exploit both the best noise and response characteristics you must pay attention to how the sensor is configured.

The type of mark you are trying to detect and the sensing technology you choose determines which edge of the mark the sensor will detect most reliably. Most optical sensors have better accuracy on a dark to light transition.

If your sensor will work reliably on the trailing edge of the mark, you will get best overall results by setting it up as follows:

Set the sensor to turn its transistor on when the mark is not present. This gives you the benefit of maximum noise immunity in the state where the sensor spends most of its time. Then set SENS.MODE@ for the DSP axis to trigger on the trailing edge of the mark. This will be the edge where the transistor turns back on, giving the fastest response.

If you must sense the leading edge of the mark, you will need to choose between best noise immunity and fastest response.

SENS.MODE@

For NPN type sensors the voltage at the DSP sensor input is high when the transistor is off and low when the transistor is on (sinking current). So to assert ASEN@ (or BSEN@) when the transistor turns on, you must set SENS.MODE@ to "F" (Falling edge). Setting SENS.MODE@ to "R" (Rising edge) will assert it when the transistor turns off.

PNP type sensors work exactly opposite to NPN. The voltage at the DSP sensor input is high when the transistor is on (sourcing current) and low when it is off. To assert ASEN@ (or
BSEN@) when the transistor turns on, set SENS.MODE@ to "R". To assert it when the transistor turns off, set SENS.MODE@ to "F".

While MotionBASIC® allows you to set the inputs up for level sensing rather than edge sensing using them in level sensing mode will increase the susceptibility of the system to noise and hung sensors.

Jumper J20

J20 is a jumper block on the DSP axis card that allows you to set the pull-up resistance for each high speed sensor input. For PNP sensors the jumper should be positioned over pins 1, 3 and 5 (2, 4 and 6 for BSEN@). For NPN sensors the setting will depend on the current sinking capability of the sensor as shown in the following table:

<table>
<thead>
<tr>
<th>Sensor Input</th>
<th>Pins Shorted</th>
<th>Resistance</th>
<th>Current with 24V sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASEN@</td>
<td>1,3,5,7</td>
<td>3,5,7</td>
<td>5,7</td>
</tr>
<tr>
<td>BSEN@</td>
<td>2,4,6,8</td>
<td>4,6,8</td>
<td>6,8</td>
</tr>
<tr>
<td>Resistance</td>
<td>2.5K</td>
<td>4.4K</td>
<td>20K</td>
</tr>
<tr>
<td>Current with 24V sensor</td>
<td>9.6mA</td>
<td>5.5mA</td>
<td>1.2mA</td>
</tr>
</tbody>
</table>

There may be an additional pullup resistor, in parallel with the above, built into the sensor. If so, you should take this into account. With NPN sensors, the lower the pull-up resistance, the faster the transistor turn off response and the higher the noise immunity.

Leakage Current

Most transistors have some leakage current even when the transistor is turned off. With PNP sensors, high leakage current reduces noise immunity and, if high enough, will prevent the DSP sensor input from ever turning off. This occurs when:

\[
R = \frac{R_c \times R_e}{R_c + R_e} \ (K\Omega)
\]

\[
\text{Leakage current} = \frac{V \left(15 + R\right)}{30R} \ mA
\]

Where: \( R_c \) = Internal collector resistor \((K\Omega)\)

\( R_e \) = External pull-down resistor \((K\Omega)\)

\( V \) = Sensor voltage

If a sensor with a lower leakage is not available, the situation can sometimes be improved by adding an external pull-down resistor which effectively parallels the sensor’s internal collector resistor \( R \). Even when the leakage current is not high enough to keep the input turned on, it does reduce the noise immunity by keeping the voltage significantly above 0 Volts.

With NPN sensors leakage current is seldom a problem due to the DSP Axis Card’s internal pull-up resistors.
Wiring

High speed sensor wiring should always use twisted shielded cable with a foil type shield. Figure 3 (next page) shows the recommended shield termination practice.

Figure 3, Shield Terminations