APPLICATIONS INFORMATION

TWO-WIRE HALL-EFFECT SWITCHES

by Raymond Dewey

Hall-effect switches are typically operated as open-collector, current-sinking devices requiring only an external pull-up resistor. The output current and voltage limits are more than adequate to allow easy interfacing with standard logic circuitry where the logic signal levels are approximately the supply voltage and ground.

Two-wire switches are often specified for reduced wiring costs (especially in automotive applications). The interfacing, however, is slightly more complicated partially because the logic signals are now two current levels. Three design considerations have to be addressed: 1) the minimum operating supply voltage, 2) the current-sensing resistor, and 3) the comparator reference voltage.

Of *primary importance* is the specified minimum operating supply voltage ($V_{CC(min)}$). For specification purposes, this is the voltage between the supply terminal and its ground (or reference) terminal. In application, the voltage drop across the current-sensing resistor (R_S) subtracts from the supply voltage and it must be considered:

$$V_{SUPPLY} \geq V_{CC(min)} + (I_{OUT(H)(max)} \text{ x } R_S)$$

where V_{SUPPLY} is the required minimum supply value (including tolerances), $I_{OUT(H)}$ is the specified maximum output current and R_S is the maximum sense-resistor value (including tolerances).

A low operating supply voltage requires a low-value current-sensing resistor, but noise and other comparator considerations suggest a high-value current-sensing resistor. Therefore, specify the highest value resistor that will still allow meeting the minimum operating supply voltage requirement.

The nominal comparator reference voltage (trip point) can be calculated as

$$V_{th} = 0.5 \text{ x } R_S(I_{OUT(H)(min)} + I_{OUT(L)(max)}).$$

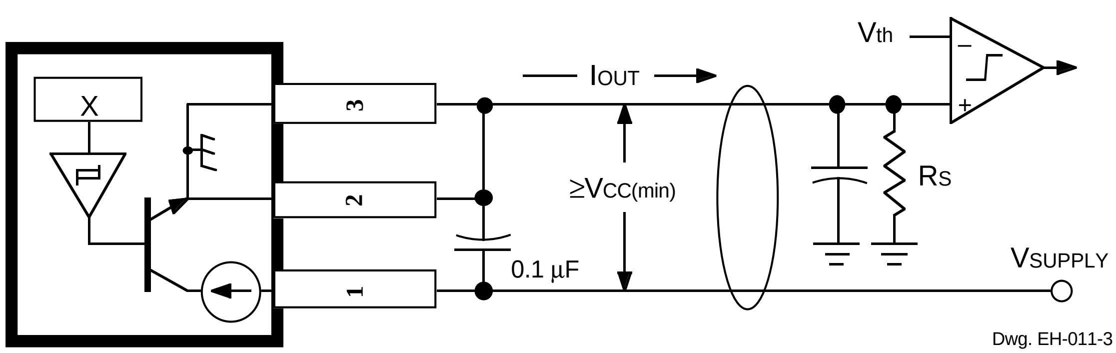
Integrated Hall-effect switches include hysteresis to prevent “chattering” near the switch point. Hysteresis allows clean switching of the sensor even in the presence of external mechanical vibration or electrical noise. Comparator hysteresis should not be a concern except in the case of *severe* noise coupling to the two-wire line.

Two-wire switches also make diagnostics possible because there should always be a specified current flowing, $I_{OUT(H)}$ or $I_{OUT(L)}$. Any current outside of these two narrow ranges is a fault. Additional comparators can be used to report an open-sensor fault

$$V_{th} \leq I_{OUT(L)(min)} \text{ x } R_S$$

or a shorted-sensor fault

$$V_{th} \geq I_{OUT(H)(max)} \text{ x } R_S.$$



Typical Two-Wire Application

TWO-WIRE HALL-EFFECT SWITCHES

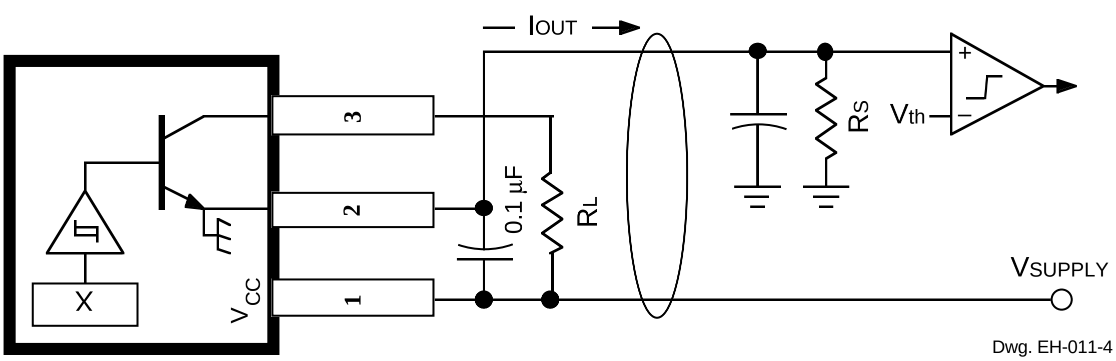
Two-Wire Hall-Effect Switches

Partial Part Number	V_{CC} min (V)	$I_{OUT(H)}$ min (mA)	$I_{OUT(H)}$ max (mA)	$I_{OUT(L)}$ min (mA)	$I_{OUT(L)}$ max (mA)
ATS640	4.3	12	16	4.0	8.0
A3161	3.5	12	19	—	5.0
A3163	3.5	12	17	5.0	6.9
A3260	3.5	11	18	4.0	8.0
A3361	3.5	12	17	5.0	6.9
A3362	3.5	12	17	5.0	6.9

Standard three-wire, open-collector Hall-effect switches can be configured for two-wire operation by adding an appropriate pull-up resistor (R_L) at the sensor. $I_{OUT(L)}$ is then the supply current with the output off ($I_{CC(L)}$) and

$$I_{OUT(H)} = I_{CC(H)} + (V_{SUPPLY} - V_{OUT(SAT)})/R_L.$$

For simplification, the output leakage current and the voltage drop across R_S are not included here. A low value pull-up resistor will provide a high $I_{OUT(H)}$ and maximum output hysteresis. However, the specified minimum operating supply voltage ($V_{CC(min)}$) is still a concern and the maximum allowable output current rating must not be exceeded.



Dwg. EH-011-4

Two-Wire Connection of Three-Wire Device

115 Northeast Cutoff, Box 15036
Worcester, Massachusetts 01615-0036 (508) 853-5000