

UGN-3013T AND UGN-3013U LOW-COST HALL EFFECT DIGITAL SWITCHES

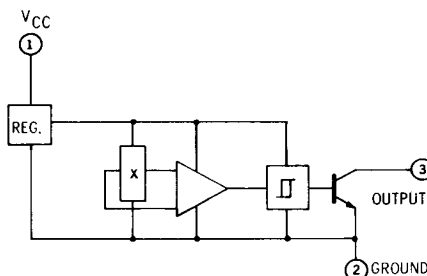
FEATURES

- 4.5 V to 24 V Operation
- Magnetically Driven Output
- High Reliability—No Moving Parts
- Small Size
- Output Compatible with All Digital Logic Families
- Constant Output Amplitude

LOW-COST Type UGN-3013 Hall Effect integrated circuits excel in applications not requiring extreme magnetic sensitivity, broadly spaced hysteresis boundaries, or premium operating temperature ranges. In all other respects, the economical, magnetically activated switches meet the high standards for fast, rugged, and reliable performance set by other Sprague Hall Effect devices.

Each Hall Effect circuit includes a voltage regulator, Hall voltage generator, signal amplifier, Schmitt trigger, and open-collector output on a single silicon chip. The on-board regulator permits operation over a wide range of supply-voltages.

The switches' open-collector outputs can sink up to 20 mA at a conservatively rated repetition rate of 100 kHz. They can be used directly with bipolar



Dwg. No. A-11,002A

FUNCTIONAL BLOCK DIAGRAM

or MOS logic circuits. Selected devices, with outputs capable of sinking 50 mA, are available on special order.

Types UGN-3013T and UGN-3013U are rated for operation over the temperature range of -20°C to $+85^{\circ}\text{C}$. The Hall Effect switches are offered in two three-pin plastic packages—a 60-mil (1.54 mm) magnetically optimized "U" package, and one 80 mils (2.03 mm) thick specified by the suffix "T"

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{CC}	25 V
Magnetic Flux Density, B	Unlimited
Output OFF Voltage	25 V
Output ON Current, I_{SINK}	25 mA
Operating Temperature Range, T_A	
UGN-3013T	-20°C to $+85^{\circ}\text{C}$
UGN-3013U	-20°C to $+85^{\circ}\text{C}$
Storage Temperature Range, T_S	-65°C to $+150^{\circ}\text{C}$

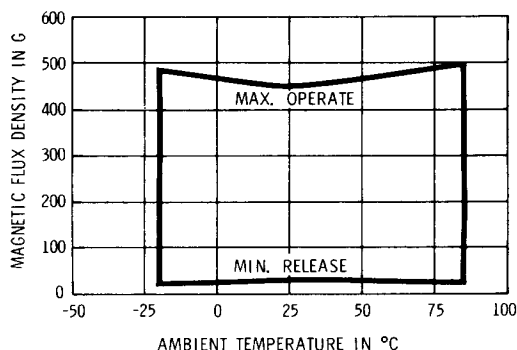
These Hall Effect sensors are also supplied in SOT 89 (TO-243AA) packages for surface-mount application. The regular SOT 89 package is specified by substituting an "LT" for the last character of the part number. The long loaded SOT 89 package is specified by substituting an "LL" for the last character of the part number and the Low profile "U" package is available by substituting "UA" for the last character of the part number (e.g., UGN-3XXXLT, UGN-3XXXLL, UGN-3XXXUA).

ELECTRICAL CHARACTERISTICS at $T_A = +25^\circ\text{C}$, $V_{CC} = 4.5\text{ V to }24\text{ V}$ (unless otherwise noted)

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Operate Point*	B_{OP}		—	300	450	G
Release Point*	B_{RP}		25	225	—	G
Hysteresis*	B_H		30	75	—	G
Output Saturation Voltage	$V_{CE(SAT)}$	$B \geq 450\text{ G}$, $I_{SINK} = 20\text{ mA}$	—	85	400	mV
Output Leakage Current	I_{OFF}	$B \leq 25\text{ G}$, $V_{OUT} = 24\text{ V}$	—	0.05	10	μA
Supply Current	I_{CC}	$B \leq 25\text{ G}$, $V_{CC} = 4.5\text{ V}$, Output Open	—	2.3	5.0	mA
		$B \leq 25\text{ G}$, $V_{CC} = 24\text{ V}$, Output Open	—	3.0	5.0	mA
Output Rise Time	t_r	$V_{CC} = 12\text{ V}$, $R_L = 820\Omega$, $C_L = 20\text{ pF}$	—	150	—	ns
Output Fall Time	t_f	$V_{CC} = 12\text{ V}$, $R_L = 820\Omega$, $C_L = 20\text{ pF}$	—	400	—	ns

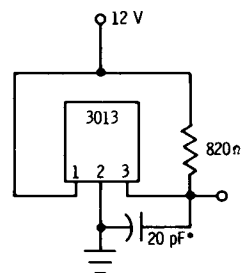
*Magnetic flux density is measured at most sensitive area of device located at $0.036'' \pm 0.002''$ (0.91 mm \pm 0.05 mm) below the branded face of the 'T' package and $0.016'' \pm 0.002''$ (0.41 mm \pm 0.05 mm) below the branded face of the 'U' package.

**GUARANTEED OPERATE AND RELEASE POINTS
AS FUNCTIONS OF TEMPERATURE**



Dwg. No. A-12,579

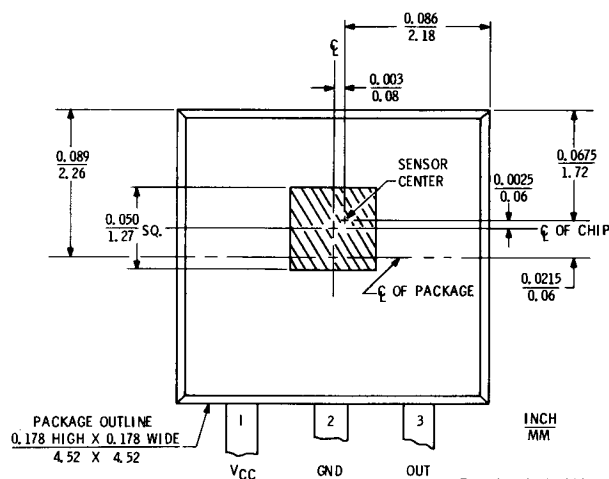
TEST CIRCUIT



Dwg. No. A-12,604

*Includes probe and test fixture capacitance.

SENSOR-CENTER LOCATION



Dwg. No. A-12,399A

OPERATION

The most common modes of operation are head-on and slide-by. As shown in the drawing at right, the magnet's polar axis is the centerline of the Hall Effect package. Change of operating states in the head-on mode is accomplished by decreasing or increasing the distance between the magnet and Hall cell.

The output transistor is OFF when the flux density of the magnetic field perpendicular to the surface of the chip is below threshold (the operate point). When flux density reaches the operate point, the output transistor switches ON and is capable of sinking 25 mA of current.

Note that the device is turned ON by presenting the south pole of the magnet to the branded face of the package, which is opposite the side with the ejector pin indentation. With the branded side facing you and the pins pointing down, pinouts are, from left to right: (1) V_{CC} , (2) GND, (3) V_{OUT} .

The output transistor is switched OFF when flux density of the magnetic field falls below the release point, which is less than the operate point. Hysteresis, as illustrated in the Transfer Characteristics graph, prevents ambiguity and oscillation.

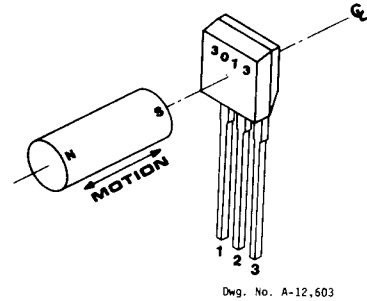
TOTAL EFFECTIVE AIR GAP

Type 3013 Hall Effect switches are offered in two packages, "T" and "U". The "U" package is about 0.020" (0.05 mm) thinner than the "T" package. The difference is found in the distance from the surface of the Hall cell to the branded face of the package: The active area depth. The "T" pack's active area depth is 0.036" (0.9 mm); the "U" pack's is 0.016" (0.4 mm).

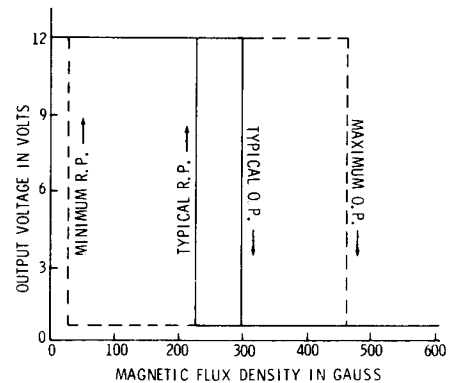
Total effective air gap is the sum of active area depth and the distance between the package's surface and the magnet's surface. The graph of Flux Density as a Function of Effective Air Gap illustrates the considerable increase in flux density at the sensor provided by the thinner package. The actual gain depends on the characteristic slope of flux density for a particular magnet.

A wide variety of magnets is commercially available. Each type of magnet exhibits unique magnetic field characteristics. The magnets used to construct the Flux Density graph were measured for the head-on mode of operation, but the graph's information is valid for peak flux density in the slide-by mode of switch activation.

HEAD-ON MODE



TRANSFER CHARACTERISTICS AT $T_A = +25^\circ\text{C}$



MAGNETIC FLUX DENSITY AS A FUNCTION OF TOTAL EFFECTIVE AIR GAP Air Gap = 0.1"

