

## SET/RESET PULSE CIRCUITS FOR HMC1021/22

AN-207

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Honeywell's HMC10021/22 magnetoresistive permalloy sensors are sensitive to magnetic fields less than 100  $\mu$ gauss in a  $\pm 6$  gauss range. In order to achieve this high resolution, the magnetic transducer must first be "set" for maximum sensitivity. This can be achieved by using Honeywell's unique on-chip current strap to SET, or RESET, the permalloy film. This technique is also referred to as flipping the film magnetization and does not require external coils. Several methods for implementing a set/reset pulse circuit are described in this application note.

During manufacture, the easy axis (preferred direction of magnetic field) is set to one direction along the length of the film. This allows the maximum change in resistance for an applied field within the permalloy film. However, the influence of a strong magnetic field (more than 20 gauss) along the easy axis could upset, or flip, the polarity of film magnetization, thus changing the sensor characteristics. Following such an upset field, a strong magnetic field must be applied momentarily to restore, or set, the sensor characteristics. This effect will be referred to as applying a set pulse or reset pulse. The effect of this set or reset restoring pulse only requires 10-50nsec. A pulse width of 1-2msec is recommended. Polarity of the bridge output signal depends upon the direction of this internal film magnetization and is symmetric about the zero field output.

Honeywell has a patented on-chip current strap for performing this re-magnetization, or flipping, electrically in the sensor application. These straps eliminate the need for bulky external coils. The flipping may be performed manually as required, such as detecting an over-range field condition, or automatically at various time intervals depending upon the application. One option is to drive a single set (or reset) pulse upon power-up or whenever a field over-range condition has passed. A second option is to alternate the sensor output polarity for each measurement in a "flipping" fashion. That is, drive a set pulse, take a reading then drive a reset pulse and take a second reading. Subtracting the two readings will eliminate any temperature-induced drift and electronics offsets. This works because the polarity of the sensor output is reversed, but the offsets associated with the sensor and signal conditioning electronics are not, and may be synchronously canceled out, giving an output proportional to absolute field. Because offset of the signal conditioning circuitry is eliminated, lower cost electronic components can be used, and fine offset trimming of the sensor may be eliminated.

There are many ways to design the set/reset pulsing circuit, though, budgets and ultimate field resolution will determine which approach will be best for a given application. The first thing to note is that a set and reset pulse have the same effect on the sensor. The only difference is that the sensor output signal changes sign. In order to completely set, or reset, the permalloy film, a current pulse of 500mA is required. This is a very fast process and only requires a 0.1  $\mu$ sec current pulse to flip. For the circuits in this applications note the pulse width will be about 2  $\mu$ sec. This pulse width has a direct effect on the overall power consumption and can be shortened, or done less often, with care. The only requirement is that a single pulse only drives in one direction. If a +500mA pulse is used to "set" the sensor, the pulse decay should not drop below zero current. Any undershoot of the current pulse will tend to "un-set" the sensor and the sensitivity will not be optimum.

The set/reset straps on the Honeywell magnetic sensors are labeled S/R+ and S/R-. There is no polarity implied since this is simply a metal strap resistance of typically 7.7 $\Omega$  per sensor. It is recommended that for a two or three axis system, the S/R straps be connected in parallel to minimize voltage drop across the straps (see Fig. 1). This also implies that 1A or 1.5A is required from the pulsing circuit for a two or three axis circuit.

The circuit in Fig. 2 generates a strong set/reset pulse under a microprocessor clock driven control. A free running 555 timer can also be used to clock the circuit. The SET current pulse is drawn from the 4.7 $\mu$ F capacitor and a 200 $\Omega$  dropping resistor should be placed in series with the supply to reduce noise.

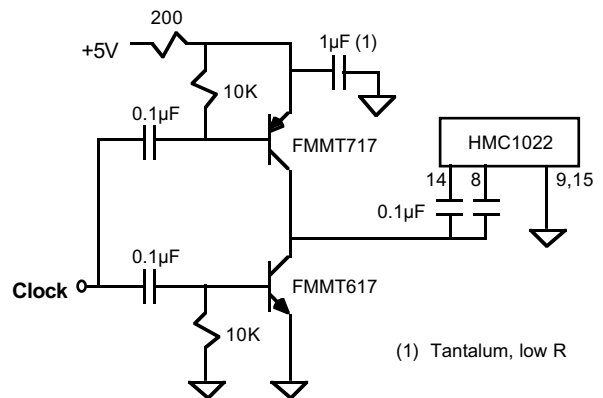
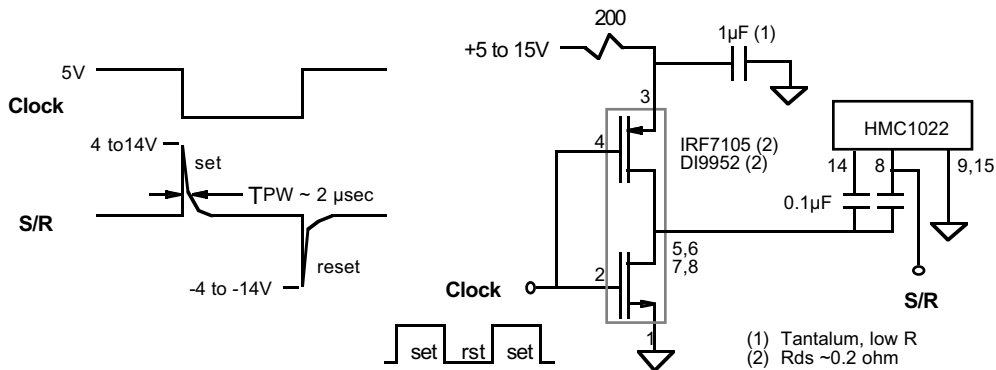


Figure 1 - 5V Circuit for SET/RESET

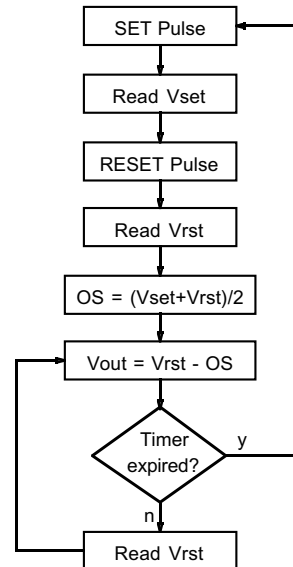


**Figure 2 - Set/Reset Pulse With Clock Control**

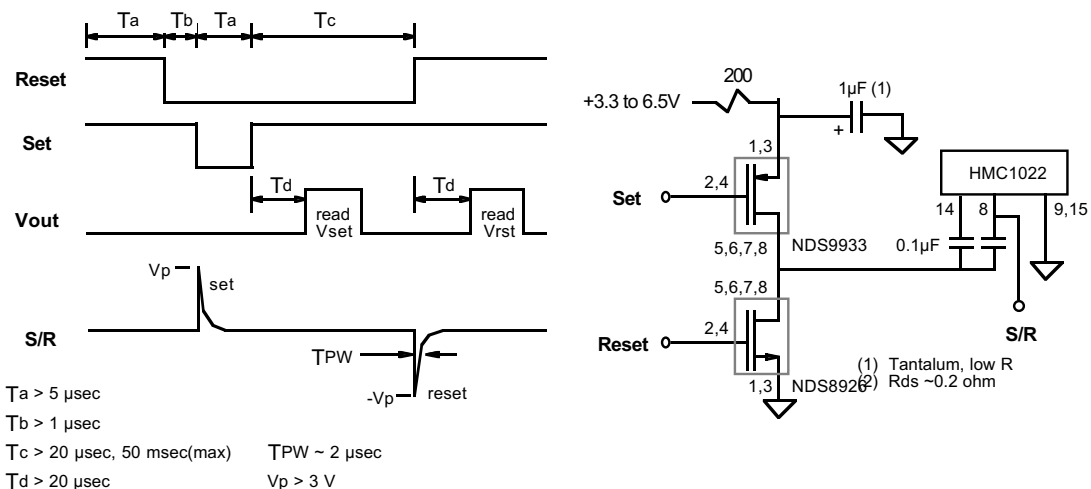
For low power application, down to 3.3 volt supply, the circuit shown in Fig. 4 can be used. These low threshold FETs provide low on-resistance (0.3W) at  $V_{GS} = 2.7V$ . The set/reset pulsing does not need to be continuous. To save power, the SET pulse can be initially applied followed by a single RESET pulse. The offset (OS) can be calculated as:

$$OS = (V_{set} + V_{rst})/2$$

This offset term will contain the DC offset of both the sensor bridge and interface electronics, as well as the temperature drift of the bridge and interface electronics. Store this value and subtract it from all future bridge output readings. Once the bridge is RESET, it will remain in that state for years—or until a disturbing field (>20 gauss) is applied. A timer can be set, say every 10 minutes, to periodically update the offset term. A flow chart is shown in Fig. 3 along with a timing diagram in Fig. 4 to illustrate this process.



**Figure 3 – Low Power Set/Rst Flowchart**



**Figure 4 - Single Clock Set/Reset Pulse Circuit**

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