Application Note: S2

Building an SCR AC 2V ON, 14uA OFF 2-Wire Inductive Proximity Sensor

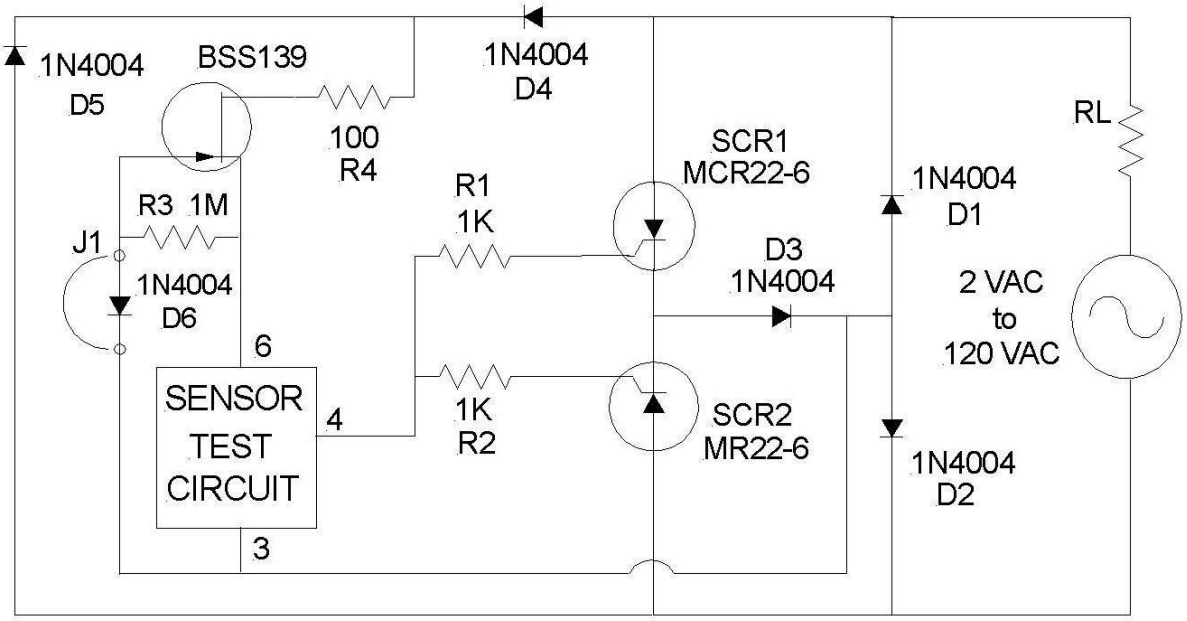
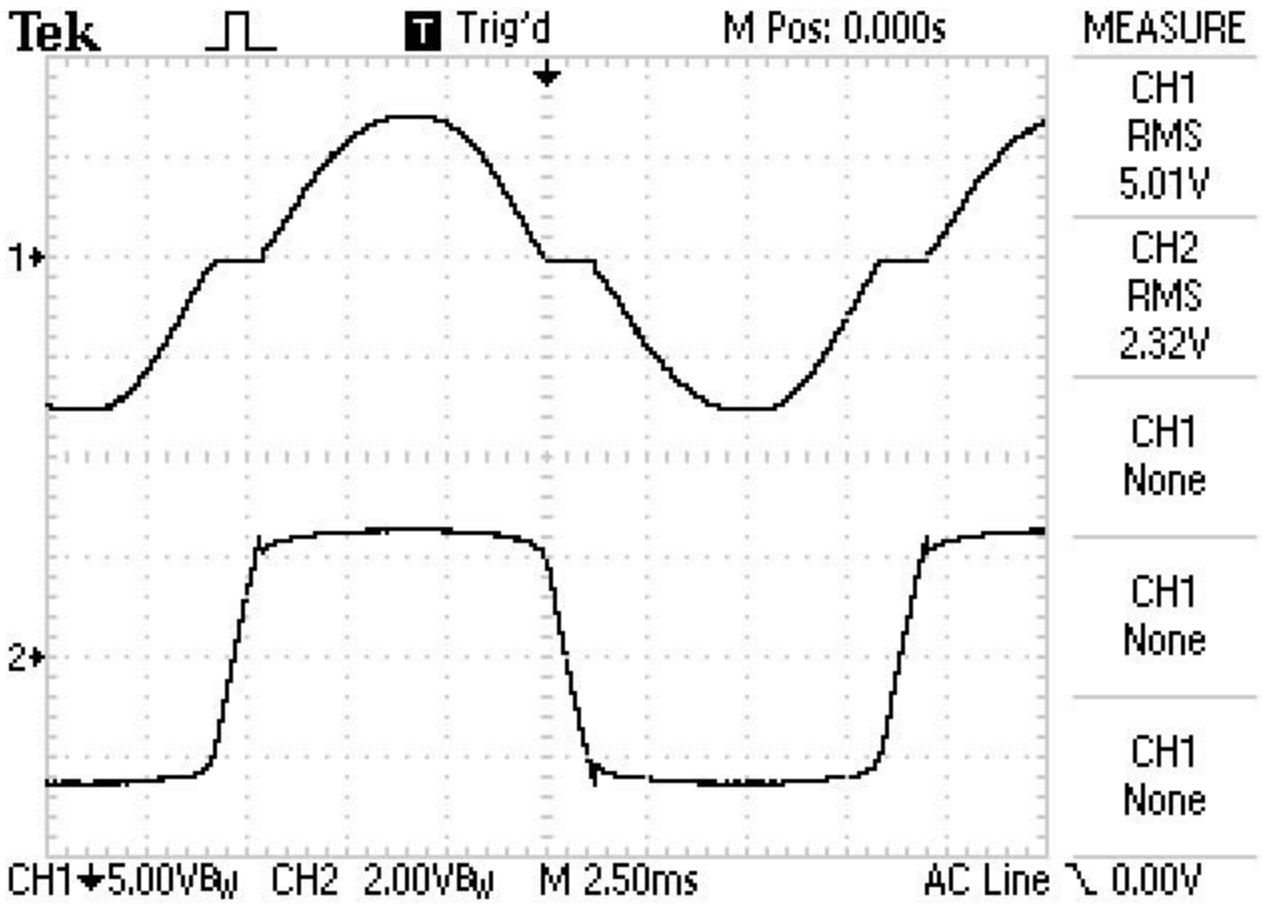


FIG. 1

2V ON at 400mA /Off-State (Leakage) Current ≤14 uA

Introduction;

Two wire sensors greatly benefit from reduced ON voltage drop and OFF leakage current. The lower ON voltage drop reduces the sensor power dissipation allowing a higher load current to be controlled. This also allows a lower supply voltage to be used and more sensors to be placed in series. The leakage current, also known as the Off-State Current, is the current that flows through the load circuit when the sensor is in the OFF-state. The lower leakage current allows more sensors to be placed in parallel before the leakage current adversely affects the load.



AC INPUT $10V_{PK}$
CH1: VOLTAGE ACROSS RL (50 ohm)
CH2: VOLTAGE ACROSS CIRCUIT

Operation;

2-wire AC sensors can be used to sink or source a load. The AC Supply voltage is connected through an external load represented by RL. The value of RL must limit the sensor ON current to 400mA to prevent over heating of SCR1, and SCR2. The power rating of the diodes (D1, D2, D3) are about three times greater than that of the SCR. Each SCR has an average current equal to ½ of the load current. This is since each SCR conducts current for only ½ half of the time the load is turned ON. The actual SCR power dissipation is determined from the manufactures data sheet. By attaching both SCRs to heat sinks the load current can be increased greatly. Another approach is to use a higher power SCR such as the C106.

The maximum voltage ratings of SCR1, SCR2, and D1..D5 are 400V and the BSS139 is 250V. This allows safe sensor circuit operation up to 200Vpk or 141Vrms (120Vac power line).

SCR1, SCR2, D1, and D2 are configured to form a full wave bridge rectifier. D3 is placed in series with SCR1, and SCR2 to increase the gate turn ON voltage from about 0.6V to 1.2V. SCRs are used instead of a TRAIC because a SCR has a much greater *gate sensitivity* and *Critical Rate of Rise of Off-State Voltage*. A high *Critical Rate of Rise of Off-State Voltage* rating is especially important when controlling inductive loads to prevent load voltage spikes from switching ON the load current flow regardless of the sensor detecting the presence of metal.

The operation of the Sensor Test Circuit is described in the "MICRO POWER IC For Inductive Proximity Sensors" LS1500 data sheet.

The Sensor Test Circuit needs an operation voltage of 1V min to operate. Since the Sensor Test Circuit output is CMOS, the output voltage at 4 swings between approximately the 0V at 3 and the voltage at 6. D3 prevents either SCR1 or SCR2 turning ON before the voltage at 6 is about 1.2V. R1 and R2 limit the gate current of the SCRs when the Sensor Test Circuit output level is high. R1 and R2 cannot be greater than 1k without affecting the SCR rated break down voltage and leakage current ratings.

BSS139 is a depletion mode NMOS transistor with a $V_{GS(th)}$ of -1.4V typ. Since the IC draws only a few uA, the voltage at 6 is about the same as $V_{GS(th)}$. The circuit will not work if the voltage at 6 is not high enough to turn ON the combination of the SCR and D3. If the actual BSS139 $V_{GS(th)}$ is too low, the voltage at 6 can be increase by cutting jumper wire J1. This increases the voltage at 6 by about 0.3V which is the voltage drop across D6. R3 is used to increase the supply current through the sensor when the sensor is off. This is to insure that when multiple sensors are in series they each have enough voltage drop across them to all operate correctly. R4 is used to limit the surge current through BSS139.

NOTE; The Fig. 1 circuit is only for illustration purposes. Actual use of the circuit in applications requires evaluation for suitability and reliability.