

## **6.6 Application Notes: Uni- and Bipolar Hall IC Switches**

### **Applications**

- Detection of rotational speed
- Detection of linear position and rotational position
- Non contact limit switch
- Flow-rate measurement
- Brushless commutation

### **Main Features**

- For uni- and bipolar fields
- Clean, rapid and bounce-free switching
- No mechanical wear
- Low power consumption
- Insensitive to contamination
- Wide temperature range
- Reverse polarity protection

### **General Description**

The integrated Uni- and Bipolar Hall IC switch series TLE 49x5 is designed specifically for industrial, automotive and consumer applications. These magnetic sensors with digital output are available as unipolar and bipolar switches and bipolar latches.

The bipolar circuit includes the Hall element, an operational transconduction amplifier and a Schmitt-Trigger. Compensation electronics guarantees a linear temperature behaviour of the switching thresholds with a negative slope. A quadruple Hall cell arrangement minimizes the piezoresistive effect (sensitivity to mechanical stresses). The open-collector output can sink up to 100 mA.

### **Design and Function of the Chip**

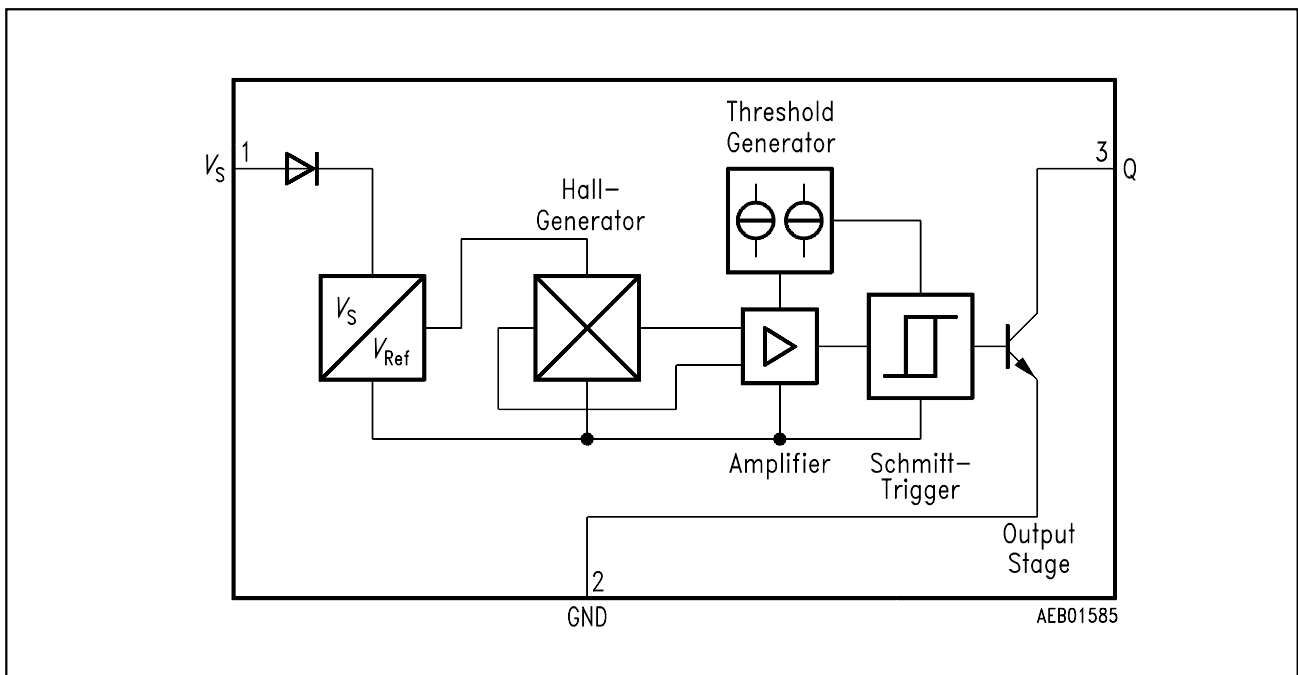
A magnetic field acting perpendicular to the chip surface generates a voltage on the probe terminals of the Hall element. This voltage is amplified and fed into a Schmitt-Trigger that drives an npn-transistor, the collector of which gives the output. If the induction exceeds the turn-on induction, the output transistor will conduct. If the magnetic field is reduced by the hysteresis, the output ceases to conduct.

To minimize the variation of the switching points as a result of supply voltage drift and ambient temperature, the Hall probe is fed from a stabilized voltage source. The switching thresholds are stabilized in the operating temperature range by a compensation circuit.

The devices are protected internally against reverse polarity protection.

The TLE 4905 L is a unipolar switch, i.e. it only reacts to a magnetic south pole. Hereafter the flux caused by a magnetic south (north) pole is defined as a positive (negative) flux. If an applied positive magnetic flux density exceeds the turn-on value  $B_{OP}$ , the output conducts. If the magnetic flux density falls below the positive turn-off value  $B_{RP}$ , the output is inhibited again. The typical application is that of a position switch actuated by the proximity of a permanent magnet.

The TLE 4935/35-2/45 are bipolar switches. They switch into a conducting state when the positive flux density  $B_{OP}$  is exceeded and they do not switch back to the inhibited state until the equally strong negative flux density  $B_{RP}$  is applied. In the absence of a field the output retains in the last state (latch). Bipolar switches are applied for electronic commutation of brushless DC motors, position detection and speed measurement of a rotating magnetic bar or magnetic encoder wheel.



**Figure 41**  
**Block Diagram of Uni- and Bipolar Hall IC Switches**

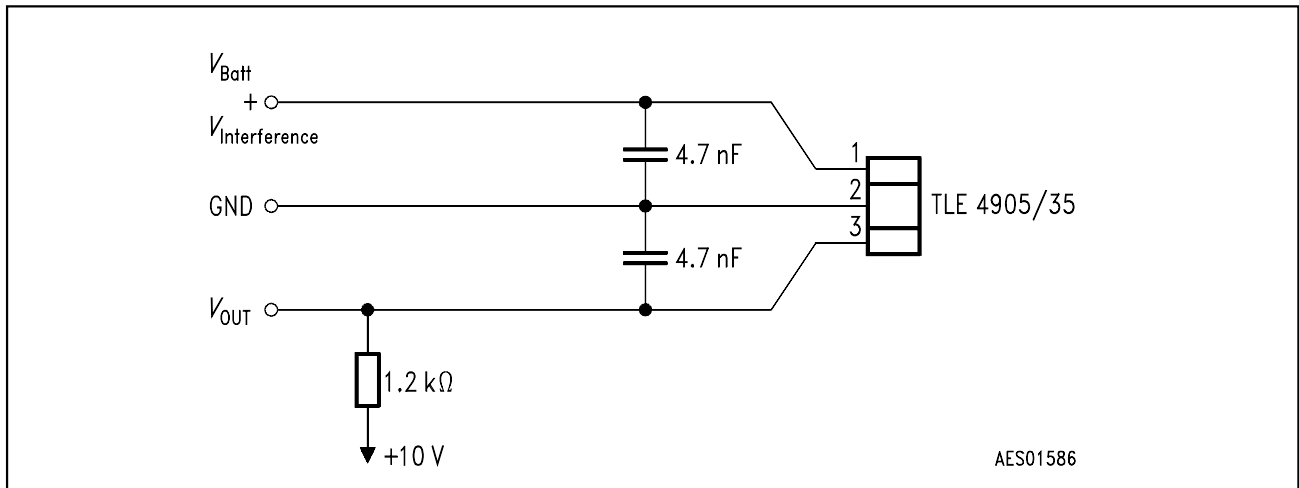
The following sections present the test results of the DIN 40839-1 and -4 tests and show how the Hall IC switches are to be used in equipment guaranteeing Electromagnetic Compatibility.

### Injection of Supply Line Transients (DIN 40839-1)

Internally the devices TLE 4905/35/35-2/45/45-2 have no protection against surge voltages, only against reversal of the supply voltage, **so the supply voltage limit** – **40 V < V<sub>s</sub> ≤ 32 V must not be exceeded under any circumstances.**

### Stage 1: Without External Protection

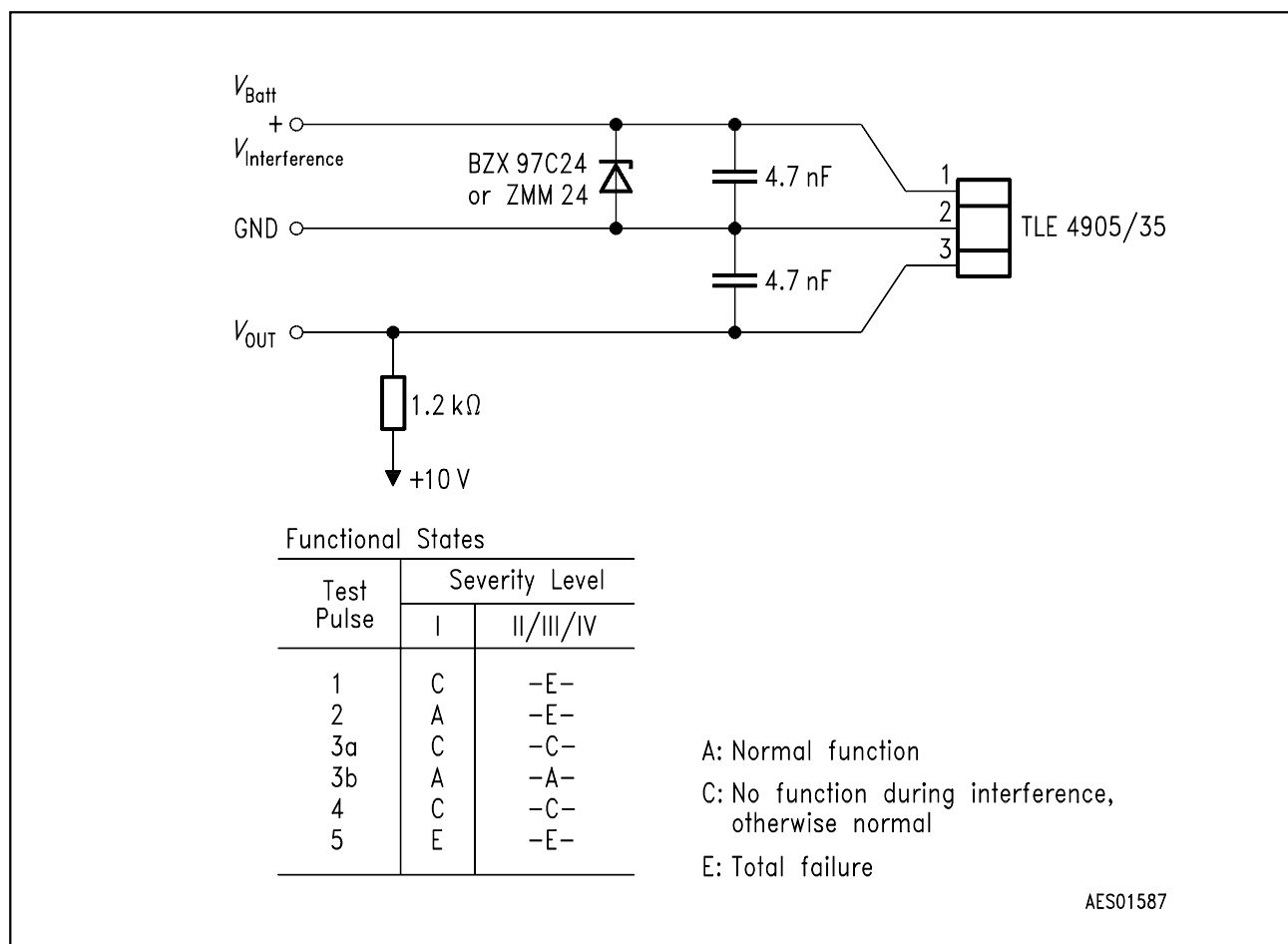
If the devices are operated in the application circuit according to the data sheet, the high pulse amplitudes (with the exception of pulses 1 and 4) exceed the limit of the supply voltage. Without a protection circuit there will naturally be failures.



**Figure 42**  
TLE 4905/35/35-2/45/45-2 without External Protection

### Stage 2: Simple Surge Protection

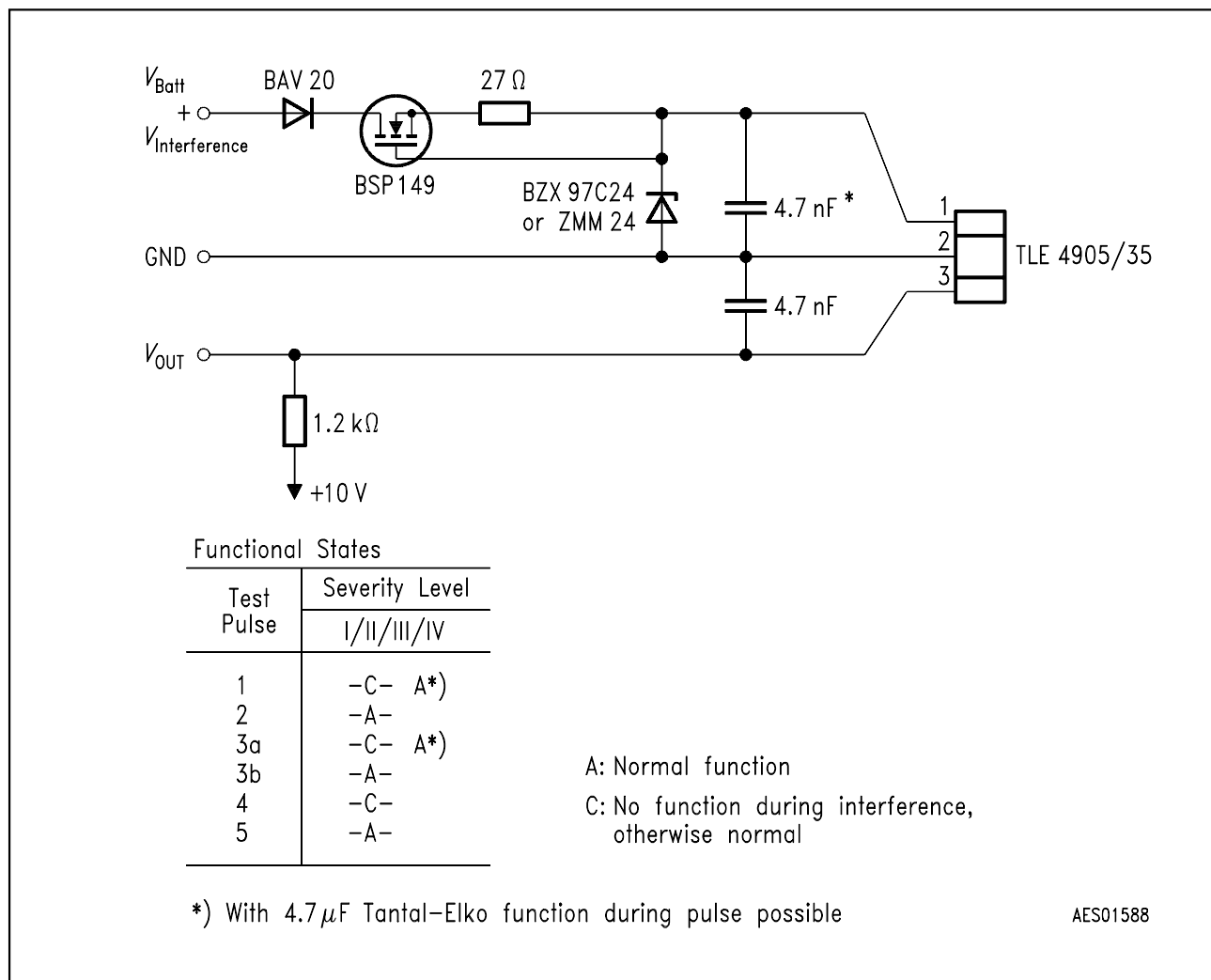
In this case a simple zener diode (or also a suppressor diode) is used for surge protection.



**Figure 43**  
**TLE 4905/35/35-2/45/45-2 with Simple Surge Protection**

### Stage 3: Complete Protection

The illustrated protective circuitry is effective against all standard interference pulses of severity level IV. The lower limit of the supply voltage for the circuit is slightly higher (approx. 1 V) than that of the devices.



**Figure 44**  
**TLE 4905/35/35-2/45/45-2 with Complete Protective Circuitry**

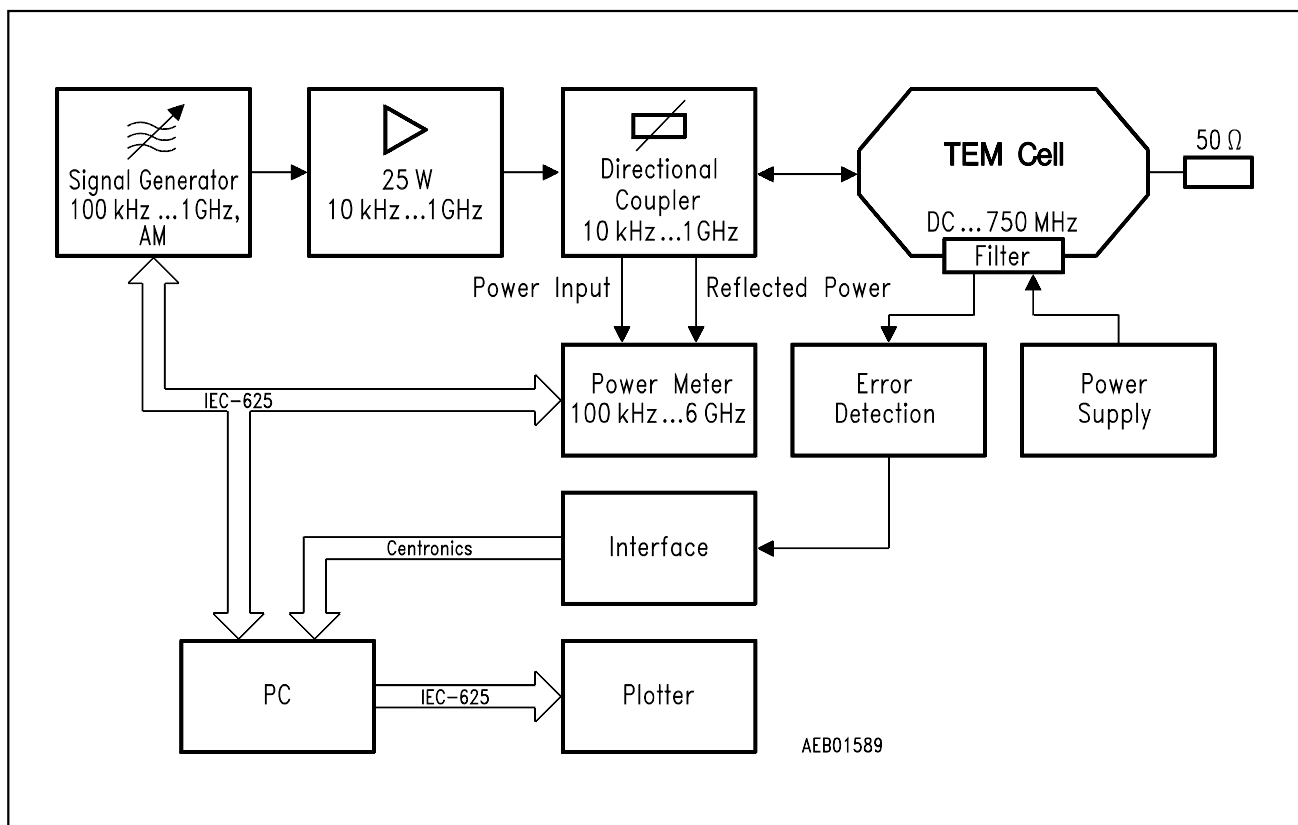
### Radiated Interference (DIN 40839-4)

The device in the application circuit according to **figure 42** is exposed to an electromagnetic field in the range from 100 kHz to 750 kHz with field strength of

100 V/m with 1 kHz AM

200 V/m without AM

in a TEM cell. The tested item is located at the end of a 20 cm long, open adapter board in the center of the cell.



**Figure 45**  
**Test Setup with TEM Cell**

No switching error occurs, the previously set Low or High states are maintained. The same applies for the minimum operating voltage.