



## KMT36H 360° Magnetic Angle Sensor

### SPECIFICATIONS

- ♦ AMR Sensor with 360° capability
- ♦ TDFN outline 2.5x2.5x0.75 mm<sup>3</sup>
- ♦ Three 120° phase-shifted signals
- ♦ Moderate field strength requirements

The **KMT36H** is a magnetic field sensor utilizing the anisotropic magneto resistance effect. Therefore the sensor is sensing the **magnetic field direction** rather than the magnetic field strength. The sensor contains three Wheatstone bridges rotated by 120°. A rotating magnetic field (typical strength 25 kA/m in the sensor plane) will result in three sinusoidal output signals with a period of 180°, phase shifted by 60° field angle. By use of a modified *atan* algorithm the field angle can be calculated with high accuracy.

As an unique feature, the KMT36H is able to measure full 360° by utilizing an additional magnetic field which is generated by a planar coil that is integrated on the chip. The 180°/360° determination is done by a simple sign distinction and may be computed periodically or only once at power up.

### FEATURES

- ♦ Ideal for harsh environments due to magnetic sensing principle
- ♦ Contactless absolute angular measurement over 360°
- ♦ Accuracy better than +/- 0.5°
- ♦ Three bridge signals with 120° phase difference
- ♦ Tiny TDFN-housing 2.5 x 2.5 x 0.8 mm<sup>3</sup>

### APPLICATIONS

- ♦ Absolute angle measurement
- ♦ Potentiometer replacement
- ♦ Motor motion control
- ♦ Camera positioning
- ♦ Robotics

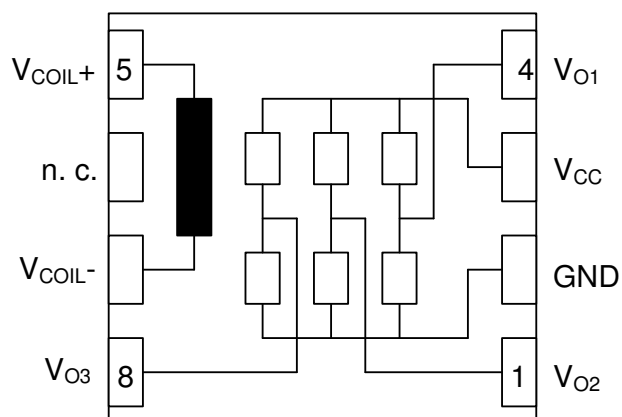
## CHARACTERISTIC VALUES

| Parameter                           | Condition              | Symbol            | Min | Typ  | Max  | Unit |
|-------------------------------------|------------------------|-------------------|-----|------|------|------|
| <b>Mechanical dimensions - TDFN</b> |                        |                   |     |      |      |      |
| Length                              |                        | X                 |     | 2.5  |      | mm   |
| Width                               |                        | Y                 |     | 2.5  |      | mm   |
| Height                              |                        | Z                 |     | 0.75 |      | mm   |
| <b>Mechanical dimensions - SO8</b>  |                        |                   |     |      |      |      |
| Length                              |                        | X                 |     | 4.9  |      | mm   |
| Width                               |                        | Y                 |     | 6.0  |      | mm   |
| Height                              |                        | Z                 |     |      | 1.75 | mm   |
| <b>Operating limits</b>             |                        |                   |     |      |      |      |
| Supply voltage                      |                        | V <sub>CC</sub>   |     | 5    | 12   | V    |
| Coil current                        | T = 25 °C, H = 25 kA/m | I <sub>COIL</sub> |     | 20   | 50   | mA   |
| Operating temperature               |                        |                   | -40 |      | +125 | °C   |
| Storage temperature                 |                        |                   | -40 |      | +125 | °C   |

| Parameter                             | Condition                   | Symbol                            | Min | Typ   | Max  | Unit       |
|---------------------------------------|-----------------------------|-----------------------------------|-----|-------|------|------------|
| <b>Sensor specification</b>           |                             |                                   |     |       |      |            |
| Applied magnetic field                | 2), 3)                      | H                                 | 15  | 25    | 60   | kA/m       |
| Bridge resistance                     | T = 25 °C                   | R <sub>B</sub>                    | 2.4 | 3.0   | 3.6  | k $\Omega$ |
| max. signal range                     | T = 25 °C, H = 25 kA/m      | $\pm V/V_{CC}$                    | 18  | 22    | 26   | mV/V       |
| Offset voltage 4)                     | T = 25 °C                   | V <sub>OFF</sub> /V <sub>CC</sub> | -3  |       | +3   | mV/V       |
| Hysteresis 1) (Repeatability)         | H = 25 kA/m                 | Hyst                              |     | 0.15  | 0.30 | deg        |
| Accuracy 1)                           | H = 25 kA/m                 | $\pm \vartheta$                   |     | 0.15  | 0.30 | deg        |
| TC of amplitude                       | H = 25 kA/m, 5)             | TC <sub>AMP</sub>                 |     | -0.35 |      | %/K        |
| TC of bridge resistance               | 5)                          | TC <sub>R</sub>                   |     | +0.35 |      | %/K        |
| Coil resistance                       | T = 25 °C                   | R <sub>COIL</sub>                 | 75  | 100   | 150  | $\Omega$   |
| Thermal resistance (junction-ambient) | T <sub>amb</sub> = 25°C, 6) | R <sub>thJA</sub>                 |     | 280   |      | K/W        |

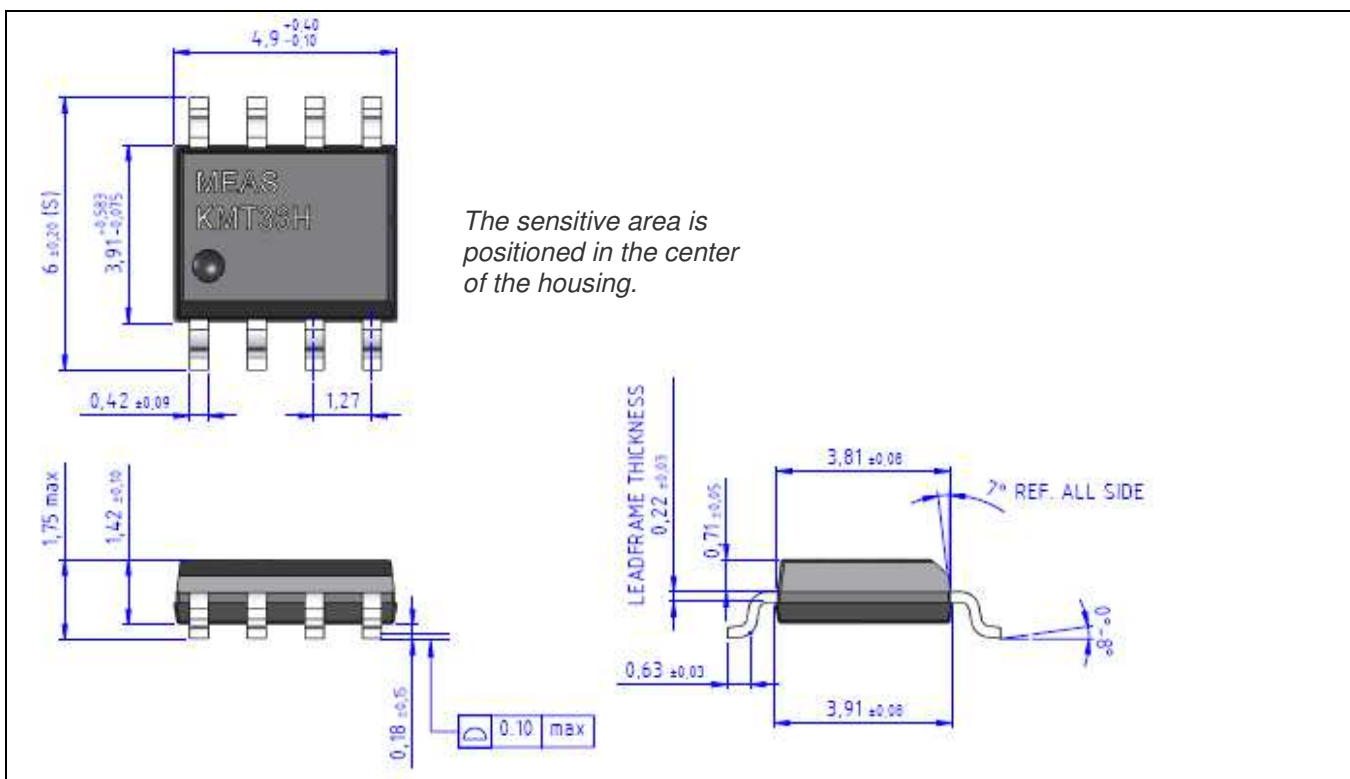
- 1) Hysteresis and accuracy are depending nearly inversely proportional on the magnetic field strength. The accuracy is defined as the max. angular difference between actual field angle and measured angle calculated from the third and fifth harmonics of the Fourier spectrum. The hysteresis is defined as angular difference between left and right turn.
- 2) Generated with reference magnet 67.044 Magnetfabrik Bonn (25 kA/m @ 5.2 mm distance).
- 3) Minimum value depends on decreasing accuracy, upper limit on decreasing coil influence. Both are no absolute limits, but depend on the given application requirements.
- 4) Offset voltages measured as difference voltages V<sub>O1</sub>-V<sub>O2</sub>, V<sub>O2</sub>-V<sub>O3</sub> and V<sub>O3</sub>-V<sub>O1</sub> in relation to V<sub>CC</sub>.
- 5) Reference temperature T<sub>ref</sub> = -25 °C, calculated from values at -25°C and +125 °C
- 6) TDFN soldered on standard test PCB, heat sink without solder connection

## BLOCK DIAGRAM

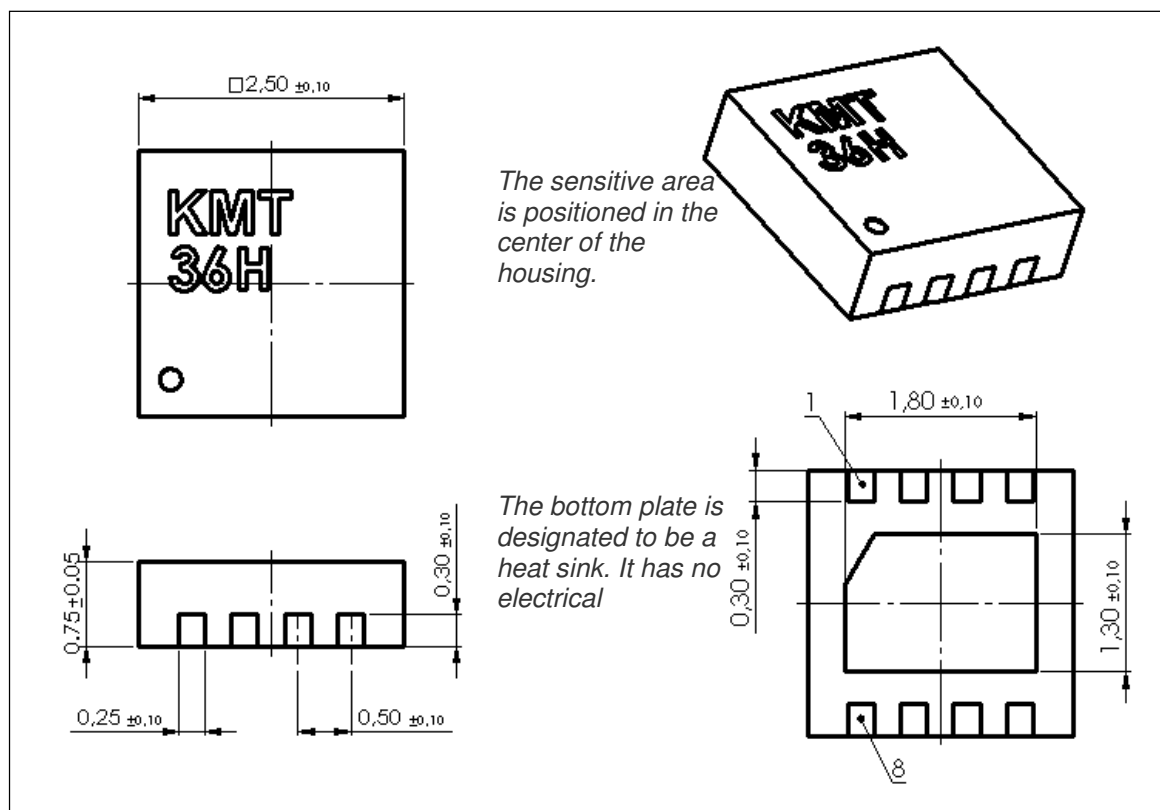


**Figure 1:** internal and external connections (TDFN and SO8, Chip)

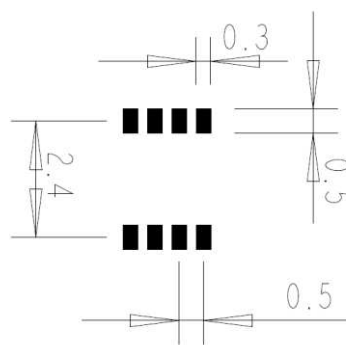
## SENSOR OUTLINE



**Figure 2:** SO8 outline

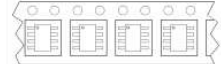

**Figure 3: TDFN outline**
**Pin Assignment for TDFN and SO8:**

| Pin | Symbol             | Function                |
|-----|--------------------|-------------------------|
| 1   | V <sub>O2</sub>    | signal output 2         |
| 2   | GND                | negative supply voltage |
| 3   | V <sub>CC</sub>    | positive supply voltage |
| 4   | V <sub>O1</sub>    | signal output 1         |
| 5   | V <sub>COIL+</sub> | positive coil input     |
| 6   | n. c.              | not connected           |
| 7   | V <sub>COIL-</sub> | negative coil input     |
| 8   | V <sub>O3</sub>    | signal output 3         |

**Recommended Solder Layout for TDFN:**


Recommended solder reflow process according to IPC/JEDEC J-STD-020D (Pb-Free Process)

## TAPE AND REEL PACKAGING INFORMATION

| DESCRIPTION | REEL SIZE | UNITS/REEL | PIN 1 ORIENTATION               | NOTE                                                                                |
|-------------|-----------|------------|---------------------------------|-------------------------------------------------------------------------------------|
| KMT36H      | 7"        | 3,000      | Top-right of sprocket hole side |  |
| KMT36H/SO   | 13"       | 2,500      | Top-left of sprocket hole side  |  |

## TYPICAL PERFORMANCE CURVES

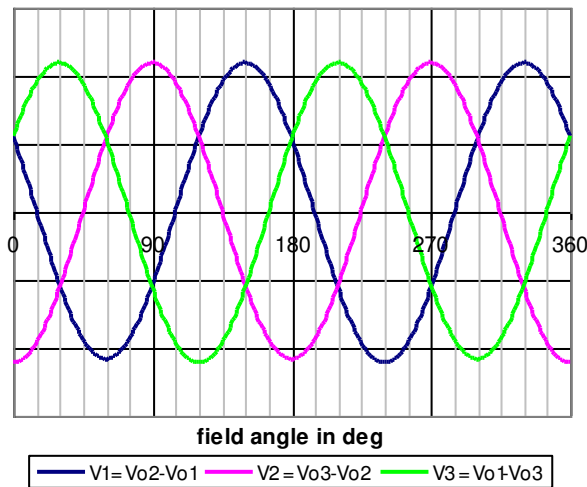


Figure 3: output voltages

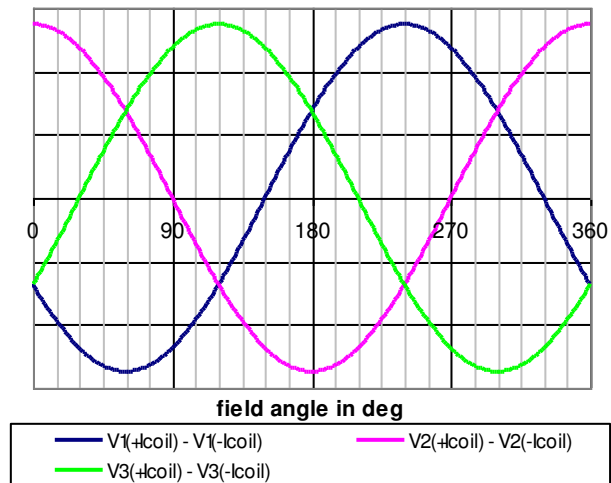


Figure 4: output voltage change due to coil influence

## SIGNAL EVALUATION

### 180° EVALUATION

As output voltages ( $V_1$ ,  $V_2$ ,  $V_3$ ) we use the three possible differences between the three signal outputs (see fig. 3). At first the true offsets must be subtracted from the raw signals. The field angle  $\Rightarrow$  in a 180°-range then can be calculated in the following manner:

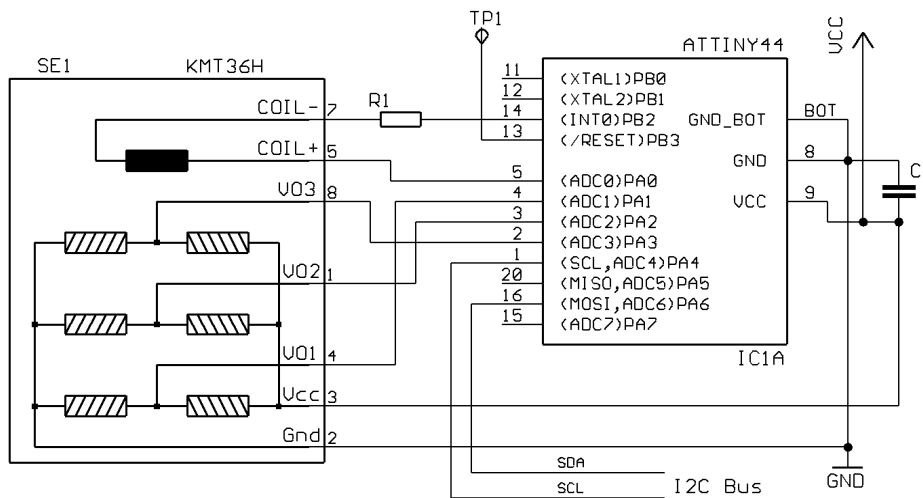
$$\checkmark \bullet \frac{1}{2} \arctan \frac{V_n}{V_m \sqrt{3}}$$

Using the three possible combinations of output signals ( $m, n = 1, 2 ; 2, 3 ; 3, 1$ ) three results are obtained, which can be averaged to increase accuracy. Comparing the three results gives additional information about their reliability.

### 360° EVALUATION

In order to distinguish between  $\Rightarrow$  and  $\Rightarrow + 180^\circ$  two additional measurements are needed: one with positive, the other with negative coil current. In the next step the change in the signals due to the influence of the coil current must be calculated. The sign of these coil-induced output voltage changes gives the 360°-information by case differentiation (see *figure 4*). In principle, this 360° discrimination needs to be computed only once at start up. Nevertheless, it is recommended to check the measurement periodically. Further details can be found in the corresponding application note.

### APPLICATION EXAMPLE



**Figure 5:** An exemplary hardware configuration using an Atmel ATtiny44 microcontroller

## ORDERING CODE

| DEVICE    | PACKAGE                        | MOQ    | PART NUMBER       |
|-----------|--------------------------------|--------|-------------------|
| KMT36H    | TDFN 2.5 x 2.5                 | 1 Reel | G-MRCO-021        |
| KMT36H/SO | SO8 (References: JEDEC MS-012) | 1 Reel | <i>on request</i> |

## ORDERING INFORMATION

### NORTH AMERICA

Measurement Specialties, Inc.,  
a TE Connectivity Company  
Phone: +1-800-522-6752  
Email: [customercare.hmp1@te.com](mailto:customercare.hmp1@te.com)

### EUROPE

MEAS Deutschland GmbH (Europe)  
a TE Connectivity Company  
Phone: +49-800-440-5100  
Email: [customercare.dtm1@te.com](mailto:customercare.dtm1@te.com)

### ASIA

Measurement Specialties (China), Ltd.,  
a TE Connectivity Company  
Phone: +86-400-820-6015  
Email: [customercare.shzn@te.com](mailto:customercare.shzn@te.com)

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