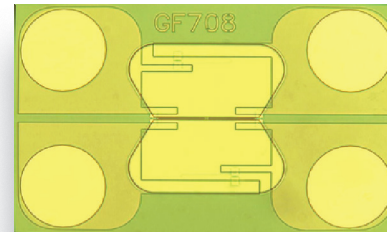


# GF708

## MagnetoResistive Magnetic Field Sensor

The GF708 is a magnetic field sensor based on the GiantMagnetoResistive (GMR) effect. Its functional magnetic layer is pinned within a synthetic spin-valve connected as a Wheatstone bridge. With its on-chip flux concentrators an extremely large sensitivity can be achieved, resulting in an almost step-like bipolar transfer curve. This way the sensor is predestined for two key application fields: As a highly sensitive magnetic field sensor with a sensitivity of 130 mV/V/mT on one hand - on the other hand, the sensor can ideally be employed as an indexing sensor. Here a single magnetic reference pole can be detected with high spatial resolution. The GF708 has distinct performance advantages compared to switching hall sensors.

The product is available as bare die with gold terminals. As flipchip or integrated in a SIL6 or LGA-package the device is suitable for SMD assembly.



### Product Overview GF708

Article description	Package	Delivery Type
GF708APA-AE	Flip-chip	Tape on reel (5000)
GF708ACA-AB	Die on wafer <sup>1)</sup>	Waferbox
GF708AKA-AC	SIL6	Waffle pack (90)
GF708AMA-AE	LGA6S	Tape on reel (2500)

<sup>1)</sup> Minimum order quantities apply.

### Quick Reference Guide

Symbol	Parameter	Min.	Typ.	Max.	Unit
<b>General</b>					
$V_{CC}$	Supply voltage	-	5.0	-	V
$R_B$	Bridge resistance	13	16	19	k $\Omega$
$T_{amb}$	Ambient temperature	-40	-	+125	$^{\circ}C$
<b>Switching Applications</b>					
$B_{op}$	Magnetic operation range <sup>1)</sup>	-18	-	+18	mT
$B_{switch}$	Magnetic switching range	-1.0	-	+1.0	mT
$V_{range}$	Electrical output range	30	56	70	mV/V
<b>Magnetic Field Applications</b>					
S	Sensitivity	80	130	180	mV/V/mT
$V_{lin}$	Linear range of output voltage	30	40	50	mV/V

<sup>1)</sup> Magnetically unambiguous range.

### Features

- Very high magnetic sensitivity
- Extremely low hysteresis
- Step-like bipolar transfer curve
- Simplified mechanical design, due to in-plane sensitivity
- Available in flip-chip design, SIL6 and LGA housing

### Advantages for Magnetic Switching Applications

- Large air gap
- Large permissible air gap tolerances
- High switching accuracy
- Easy identification of field direction
- Simple integration
- Allows use of small magnets

### Advantages for Magnetic Field Measurement Applications

- Allows detection of smaller particles or material defects (NDT)
- Large permissible distance to target
- High resolution for magnetic imaging



### Absolute Maximum Ratings Values

In accordance with the absolute maximum rating system (IEC60134).

Symbol	Parameter	Min.	Max.	Unit
$V_{CC}$	Supply voltage	-9.0	+9.0	V
$T_{amb}$	Ambient temperature	-40	+125	°C
$T_{stg}$	Storage temperature (bare die)	-65	+150	°C
$V_{ESD}$	HBM <sup>1)</sup> ESD classification level 1a	150	-	V

<sup>1)</sup> Human Body Model ESD classification level according MIL-STD-883.

Stresses beyond those listed under "Absolute maximum ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. The device however cannot neither be damaged nor are the specified parametrical limits affected by strong magnetic fields within ambient temperature range.

### General Electrical Data

$T_{amb} = 25\text{ °C}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{CC}$	Supply voltage		-	5.0	-	V
$R_B$	Bridge resistance <sup>2)</sup>		13	16	19	kΩ
$TC_{RB}$	Temperature coefficient of $R_B$ <sup>3)</sup>	$T_1 = 30\text{ °C}, T_2 = 85\text{ °C}$	0.08	0.12	0.14	%/K

<sup>2)</sup> Bridge resistance between pads 1 and 3 or 2 and 4. See Fig.1.

<sup>3)</sup>  $TC_{RB} = 100 \cdot \frac{R_{B(T2)} - R_{B(T1)}}{R_{B(T1)} \cdot (T_2 - T_1)}$  with  $T_1 = +30\text{ °C}$ ;  $T_2 = +85\text{ °C}$ .

### General Electrical Data

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
f	Frequency range		1 <sup>4)</sup>	-	-	MHz

<sup>4)</sup> No significant amplitude attenuation.

In Fig. 1 the resistors  $R_{23}$  and  $R_{41}$  are covered by two flux concentrators (shields) to prevent an applied magnetic field from influencing them. Therefore, when a field is applied, the resistors  $R_{12}$  and  $R_{34}$  decrease in resistance, while the other two resistors under the flux concentrator do not. This imbalance leads to the bridge output.

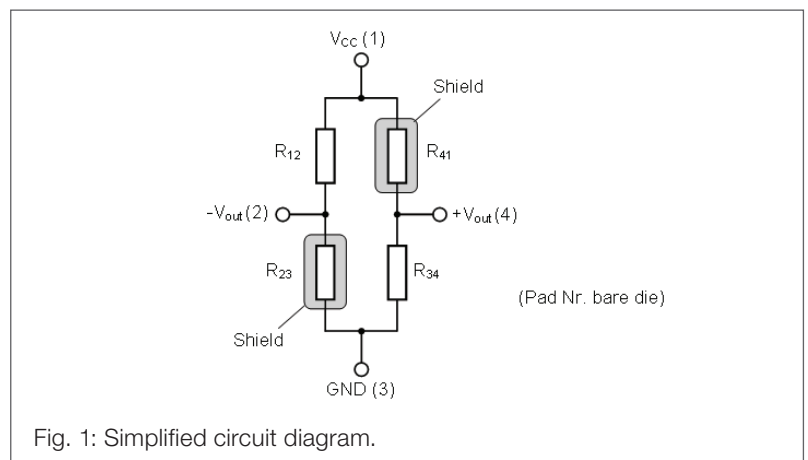
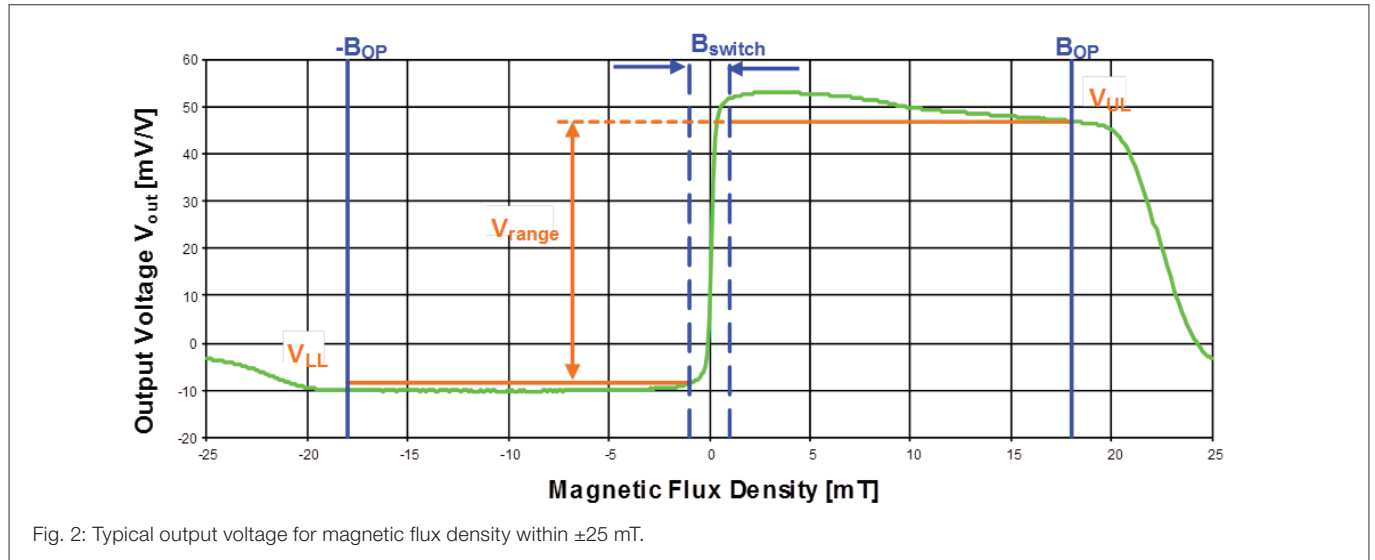


Fig. 1: Simplified circuit diagram.

### Characteristic Transfer Curve Parameters for Switching Applications

GF708 can ideally be employed as reference sensor or in end-point detection applications. Here, the quasi step-like transfer curve of the incorporated spin-valve is unique within the wide operating range  $B_{op}$  of  $\pm 18$  mT and provides a comfortable electrical operating window  $V_{range}$  of 40 mV/V for the switching threshold.



### Magnetic Data

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$B_{switch}$	Magnetic switching range	See Fig. 2	-1.0	-	+1.0	mT
$B_{op}$	Magnetic operation range <sup>1)</sup>	See Fig. 2	-18	-	+18	mT

<sup>1)</sup> Magnetically unambiguous range.

### General Electrical Data

$T_{amb} = 25$  °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{UL}$	Upper limit of electrical output range <sup>2)</sup>	See Fig. 2	20	30	40	mV/V
$V_{LL}$	Lower limit of electrical output range <sup>3)</sup>	See Fig. 2	-25	-12	-2	mV/V
$V_{range}$	Electrical output range	See Fig. 2	30	45	60	mV/V
$TC_{V_{range}}$	Temperature coefficient of $V_{range}$ <sup>4)</sup>	$T_1 = 25$ °C, $T_2 = 85$ °C	-0.5	-0.35	-0.2	%/K
$TC_{V_{LL}}$	Temperature coefficient of $V_{LL}$ <sup>5)</sup>	$T_1 = 25$ °C, $T_2 = 85$ °C	-20	15	50	$\mu$ V/V/K

<sup>2)</sup> The upper limit of the electrical output range is defined as the minimum output voltage in the range (1mT, 18mT).

<sup>3)</sup> The lower limit of the electrical output range is defined as the maximum output voltage in the range (-1mT, -18mT).

$$4) \quad TC_{V_{range}} = 100 \cdot \frac{V_{range(T_2)} - V_{range(T_1)}}{V_{range(T_1)} \cdot (T_2 - T_1)} \quad \text{with } T_1 = +25 \text{ °C; } T_2 = +85 \text{ °C.}$$

$$5) \quad TC_{V_{LL}} = 100 \cdot \frac{V_{LL(T_2)} - V_{LL(T_1)}}{T_2 - T_1} \quad \text{with } T_1 = +25 \text{ °C; } T_2 = +85 \text{ °C.}$$

$V_{LL}$  is always negative within the specified ambient temperature range.

### Characteristic Transfer Curve Parameters for Highly Sensitive Magnetic Field Measurement

GF708 also serves as a highly sensitive magnetic field sensor. Due to the spin-0valve technology the transfer curve within  $\pm 1$  mT features an extremely high sensitivity of 130 mV/V/mT with very low coercivity at the same time. Thus making the device ideal for applications like magnetic particle detection, non-destructive testing of steel or vehicle detection, to just mention a few of them.

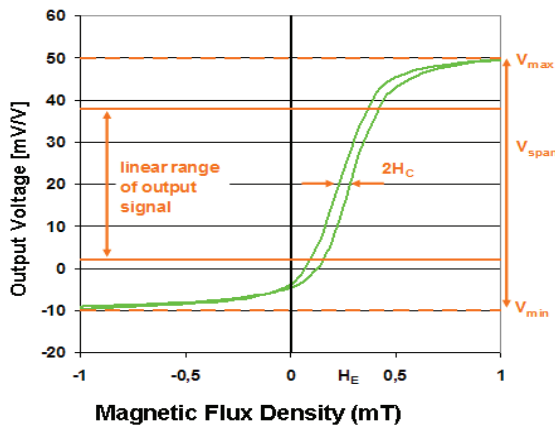


Fig. 3: Typical output voltage for magnetic flux density. within  $\pm 1$  mT.

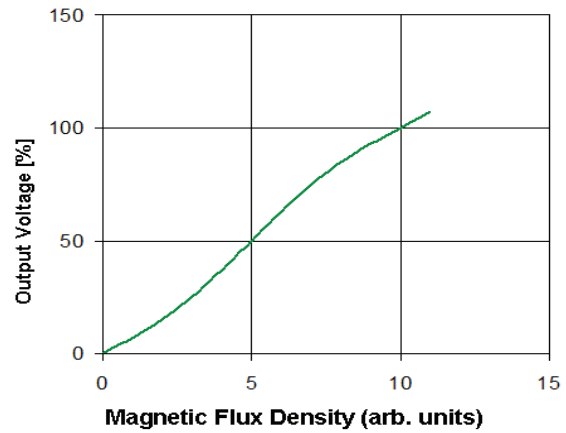


Fig. 4: Definition of linearity error  $\epsilon_{Lin}^{(1)}$  (schematic).

<sup>1)</sup> Linearity error is normalized to the output voltage span  $V_{span} = V_{max} - V_{min}$ .

### Magnetic Data

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$H_E$	Exchange coupling <sup>2)</sup>	See Fig. 3	0	0.11	0.2	mT

<sup>2)</sup>  $H_E$  is the exchange coupling field for the GMR spin valve.

### General Electrical Data

$T_{amb} = 25$  °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{lin}$	Linear range of output voltage <sup>3)</sup>	See Fig. 3	25	35	45	mV/V
S	Sensitivity	for B = -5 to +5 mT	80	130	180	mV/V/mT
$TC_S$	Temperature coefficient of sensitivity <sup>4)</sup>	$T_1 = 25$ °C, $T_2 = 85$ °C	-0.5	-0.24	-0.00	%/K

<sup>3)</sup> The linear range of the out signal is defined as the interval  $[V_{min} + 0.2 * V_{span}; V_{max} - 0.2 * V_{span}]$ .

<sup>4)</sup>  $TCS = 100 \cdot \frac{S_{(T_2)} - S_{(T_1)}}{S_{(T_1)} \cdot (T_2 - T_1)}$  with  $T_1 = +25$  °C;  $T_2 = +85$  °C.

### Accuracy

$T_{amb} = 25$  °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$H_C$	Hysteresis (Coercivity)	For B = -5 to +5 mT (see Fig. 3)	-	0.05	0.1	mT
$\epsilon_{Lin}$	Linearity error <sup>5)</sup>	See Fig. 4	0	6	10	%

<sup>5)</sup> Linearity error is normalized to the output voltage span  $V_{span} = V_{max} - V_{min}$ .

## GF708 as Bare Die and Flip-Chip

### Pinning

Pad	Symbol	Parameter
1	$V_{CC}$	Supply voltage
2	$-V_{out}$	Negative output voltage
3	GND	Ground
4	$+V_{out}$	Positive output voltage

Note:

The orientation of the bare die is given by the human readable product label and the Sensitec logo.

Fig. 5:

Top: Sensitivity of GF708 depending on the direction of the applied magnetic field.

Bottom: Backside view on laser mark with pin1 indication.

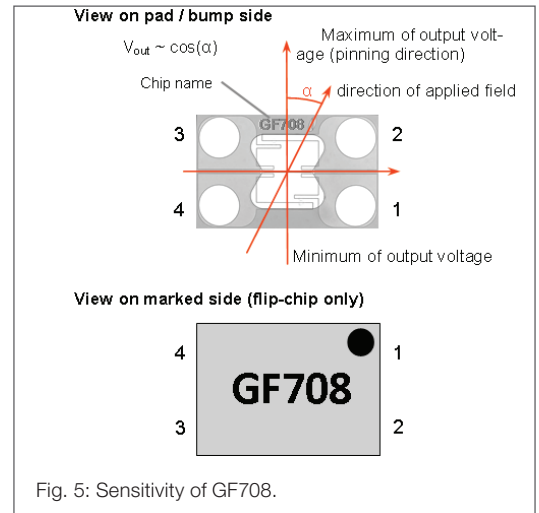


Fig. 5: Sensitivity of GF708.

### Dimensions

Symbol	Parameter	Min.	Typ.	Max.	Unit	
A	Bare die	Length	1420	1460	1500	$\mu\text{m}$
B		Width	920	960	1000	$\mu\text{m}$
C		Height	240	250	260	$\mu\text{m}$
d		Diameter	-	230	-	$\mu\text{m}$
A	Flip-chip	Length	1350	1400	1450	$\mu\text{m}$
B		Width	850	900	950	$\mu\text{m}$
C		Height	400	410	420	$\mu\text{m}$
d		Diameter <sup>1)</sup>	-	300	-	$\mu\text{m}$
S		Standoff <sup>2)</sup>	-	240	-	$\mu\text{m}$
a	Pitch a	-	1000	-	$\mu\text{m}$	
b	Pitch b	-	500	-	$\mu\text{m}$	
e	Margin	-	200	-	$\mu\text{m}$	

<sup>1)</sup> Solder ball diameter before reflow.

<sup>2)</sup> After reflow.

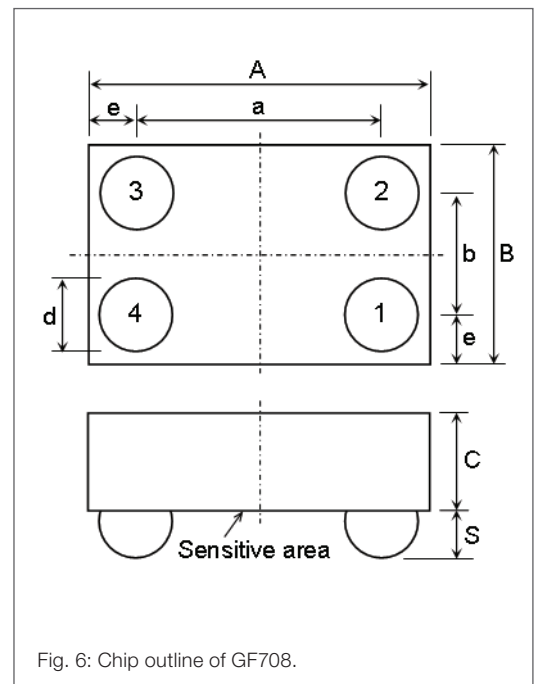


Fig. 6: Chip outline of GF708.

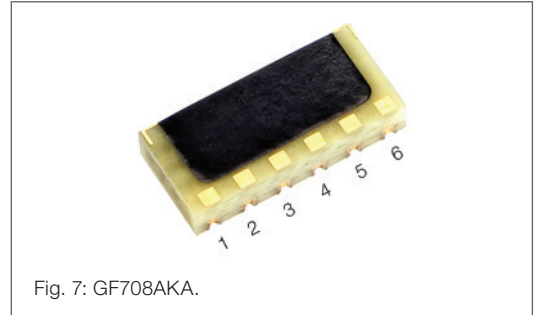
### Data for Packaging and Interconnection Technologies

Symbol	Parameter	Conditions	Value	Unit
Bare die	Pad material		Au	-
	Pad thickness		0.4	$\mu\text{m}$
Flip-chip	Solder ball material		SnAg2.6Cu0.6	-
	Maximum solder temperature	For 6 s	260	$^{\circ}\text{C}$

**GF708AKA SIL6 Package**

**Pinning**

Pad	Symbol	Parameter
1	GND	Ground
2	nc	Not connected
3	+V <sub>out</sub>	Positive output voltage
4	V <sub>CC</sub>	Supply voltage
5	nc	Not connected
6	-V <sub>out</sub>	Negative output voltage



**Dimensions**

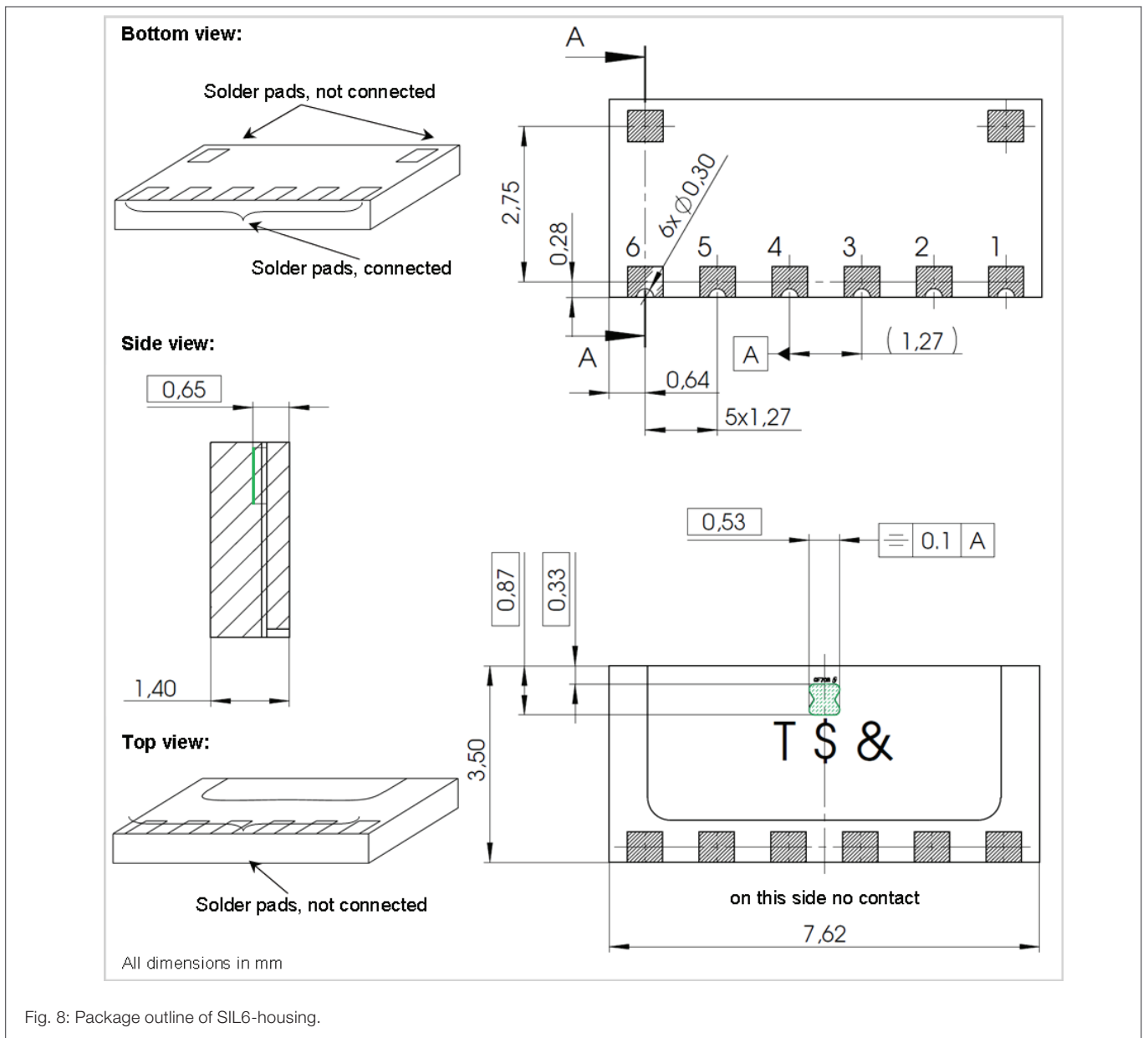


Fig. 8: Package outline of SIL6-housing.

**GF708AMA LGA6S**

**Pinning**

Pad	Symbol	Parameter
1	+V <sub>01</sub>	Positive output voltage bridge 1
2	NC	Not connected
3	GND	Ground
4	V <sub>CC</sub>	Supply voltage
5	-V <sub>01</sub>	Negative output voltage bridge 1
6-8	NC	Not connected

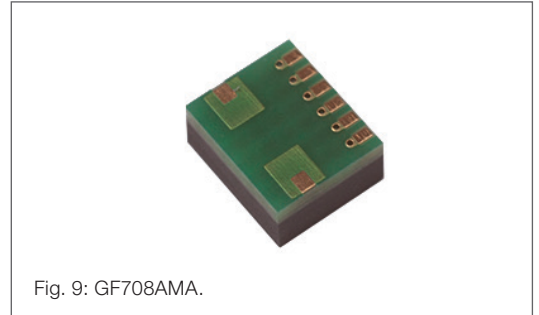


Fig. 9: GF708AMA.

**Dimensions**

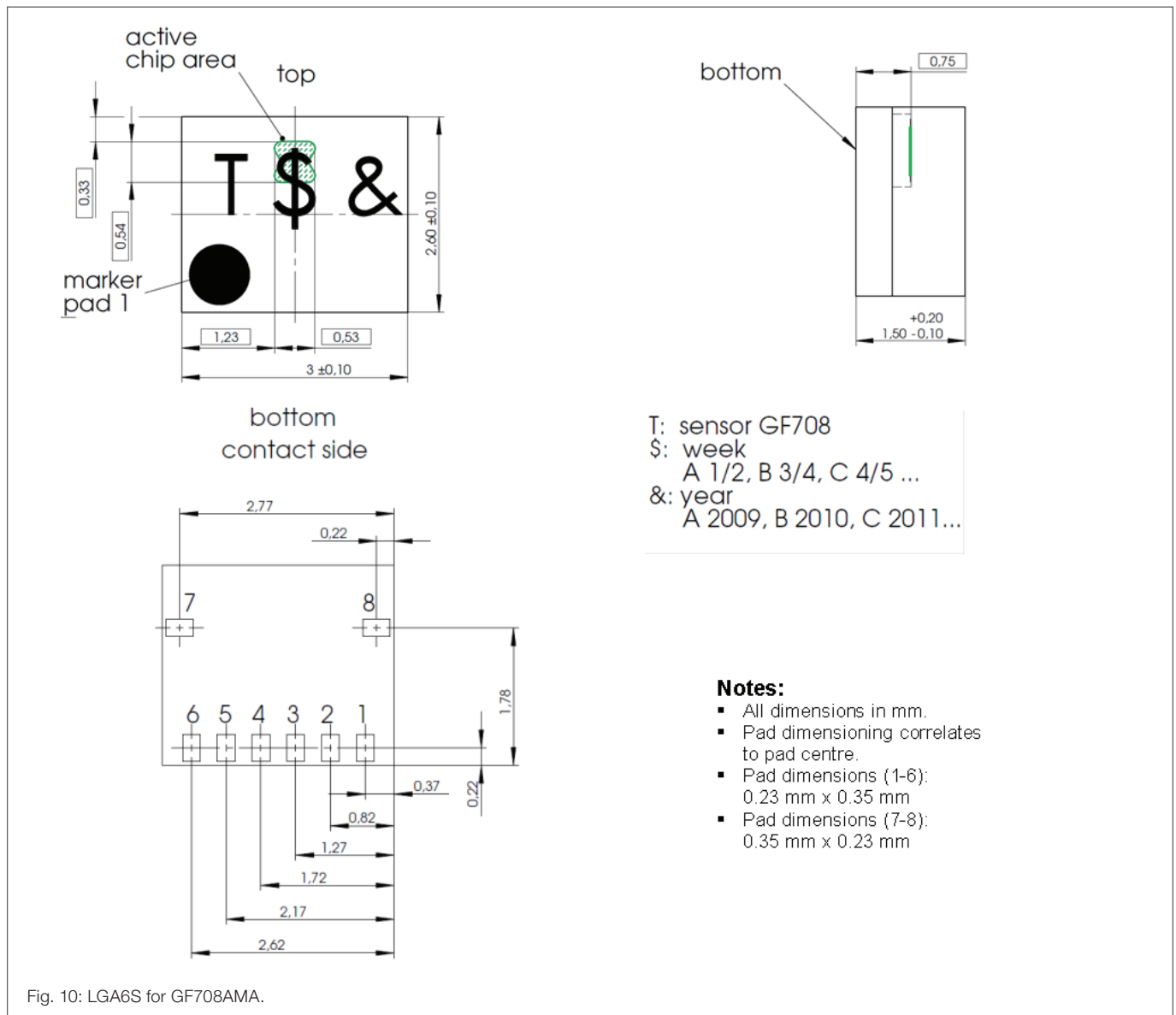


Fig. 10: LGA6S for GF708AMA.

## General Information

### Product Status

Article	Status
GF708APA-AE	The product is undergoing qualification tests. Deliverables have a sample status. The datasheet is preliminary.
GF708ACA-AB	The product is undergoing qualification tests. Deliverables have a sample status. The datasheet is preliminary.
GF708AKA-AC	The product is undergoing qualification tests. Deliverables have a sample status. The datasheet is preliminary.
GF708AMA-AE	The product is undergoing qualification tests. Deliverables have a sample status. The datasheet is preliminary.
<b>Note</b>	The status of the product may have changed since this data sheet was published. The latest information is available on the internet at <a href="http://www.sensitec.com">www.sensitec.com</a> .

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