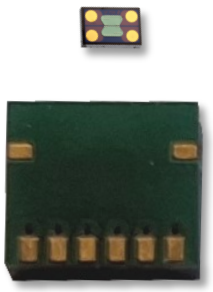
SENSITEC
MAGNETORESISTIVE SENSORS

DATA SHEET

GF708

MagnetoResistive Magnetic Field Sensor

The GF708 is a magnetic fi eld 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 suitable for two key application fields: On one hand a highly sensitive magnetic field sensor with a sensitivity of 130 mV/V/mT - on the other hand, the sensor can be used as an index sensor for encoders. Here a single magnetic reference pole can be detected with high spatial resolution. 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.
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 ±18 mT and provides a comfortable electrical operating window V_{range} of 40 mV/V for the switching threshold.
GF708 also serves as a highly sensitive magnetic field sensor. Due to the spin-valve technology the transfer curve within ±1 mT features an extremely high sensitivity of 130 mV/V/mT with very low coercitivity at the same time. Thus the sensor is ideally suited for e. g. magnetic particle detection, non-destructive testing applications or vehicle detection. Furthermore, the sensor can also be used as an index sensor on encoders.



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

Product Overview of GF708

Article description	Package	Delivery Type
GF708ACA-AB [1)]	Die on Wafer	Waferbox
GF708APA-AE	Flip-chip	Tape on reel (2000 pcs)
GF708AKA-AC	SIL6	Waffle pack (90 pcs)
GF708AMA-AE	LGA6S	Tape on reel (2000 pcs)
GF708 Evalboard	Evalboard	ESD-Box

[1)] minimum order quantities apply.

Advantages for Magnetic Switching Applications

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

Quick Reference Guide General

Symbol	Parameter	min.	typ.	max.	Unit
V_{CC}	Supply voltage	-	5.0	-	V
R_B	Sensor resistance	13.0	16.0	19.0	kΩ
T_{amb}	Ambient temperature	-40	-	+125	°C

Advantages for Magnetic Field Measurement Applications

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

Quick Reference Guide Switching Application

Symbol	Parameter	min.	typ.	max.	Unit
S	Magnetic operation range [1)]	-18.0	-	+18.0	mV/deg
V_{off}	Magnetic switching range	-1.0	-	+1.0	mT
V_{peak}	Electrical output range	30.0	56.0	70.0	mV/V

Quick Reference Guide Magnetic Field Application

Symbol	Parameter	min.	typ.	max.	Unit
S	Sensitivity	80.0	130.0	180.0	mV/V/mT
V_{lin}	Linear range of output voltage	30.0	40.0	50.0	mV/V

ESD

Absolute Maximum Ratings

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 ESD classification level 1a	-	150	V

[1] 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.

General Electrical Data

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

Symbol	Parameter	Conditions	min.	typ.	max.	Unit
V_{CC}	Supply voltage		-	5.0	-	V
R_B	Bridge resistance [2]		13	16	19	kΩ
TC_{RB}	Temperature coefficient of R_B [3]	T_{amb} = (+30…+85)°C	0.08	0.12	0.14	%/K
V_{UL}	Upper limit of electrical output range [4], [5]		20.0	30.0	40.0	mV/V
V_{LL}	Lower limit of electrical output range [4], [6]		-25.0	-12.0	-2.0	mV/V
V_{range}	Electrical output range [4]		30.0	45.0	60.0	mV/V
TC_{Vrange}	Temperature coefficient of V_{range} [4], [7]	T_{amb} = (+25…+85)°C	-0.50	-0.35	-0.20	%/K
TC_{VLL}	Temperature coefficient of V_{LL} [4], [8]	T_{amb} = (+25…+85)°C	-20.0	15.0	+50.0	(µV/V)/K
V_{lin}	Linear range of output voltage [9], [10]		25.0	35.0	45.0	mV/V
S	Sensitivity [9]	For B=-5 to +5 mT	80.0	130.0	180.0	mV/V/mT
TC_S	Temperature coefficient of S [9], [11]	T_{amb} = (+25…+85)°C	-0.50	-0.24	-0.00	%/K
FIT	FIT-Rate		-	2.2	-	x10^9 h
MTTF	Mean time to failure	At 55 °C	-	251142	-	years

[2] Bridge resistance between V_{CC} and Gnd, $+V_{out}$ and $-V_{out}$.

[3] $TC_{RB}=100\cdot\frac{R_{B(T2)}-R_{B(T1)}}{R_{B(Tamb)}\cdot(T_2-T_1)}$ with T_1 = +30°C; T_2 = +85°C.

[4] For switching applications

[5] The upper limit of the electrical output range is defi ned as the minimum output voltage in the range (1mT, 18mT).

[6] The lower limit of the electrical output range is defi ned as the minimum output voltage in the range (-1mT, -18mT).

[7] $TC_{range}=100\cdot\frac{V_{range(T2)}-V_{range(T1)}}{V_{range(T1)}\cdot(T_2-T_1)}$ with T_1 = +25°C; T_2 = +85°C.

[8] $TC_{VLL}=100\cdot\frac{V_{LL(T2)}-V_{LL(T1)}}{T_2-T_1}$ with T_1 = +25°C; T_2 = +85°C, V_{LL} is always negative within the specificed ambient temperature range.

[9] For magnetic field applications.

[10] The linear range of the out signal is defined as the interval $|V_{min} + 0.2V_{span}; V_{min} - 0.2V_{span}|$.

[11] $TC_S=100\cdot\frac{S_{(T2)}-S_{(T1)}}{S_{(T1)}\cdot(T_2-T_1)}$ with T_1 = +25°C; T_2 = +85°C.

Dynamic Data

Symbol	Parameter	Conditions	min.	typ.	max.	Unit
f	Frequency range		1.0 [12]	-	-	MHz

[12] No significant amplitude loss in this frequency range.

Magnetic Data

Symbol	Parameter	Conditions	min.	typ.	max.	Unit
B_{switch}	Magnetic switching range [1]		-1.0	+	+1.0	mT
B_{op}	Magnetic operation range [1, 2]		-18.0	+	+18.0	mT
H_E	Exchange coupling [3, 4]		0	0.11	0.2	mT

[1] For switching applications.

[2] Magnetically unambiguous range.

[3] For magnetic field applications.

[4] H_E is the exchange coupling field for the GMR spin valve.

Accuracy

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

Symbol	Parameter	Conditions	min.	typ.	max.	Unit
H_C	Hysteresis (Coercitivity) [3]	For B=-5 to +5 mT	-	0.05	0.1	mT
ε_{lin}	Linear error [3, 5]		0.0	6.0	10.0	%

[5] Linearity error is normalized to the output voltage span $V_{span} = V_{max} - V_{min}$.

Output Signal Information

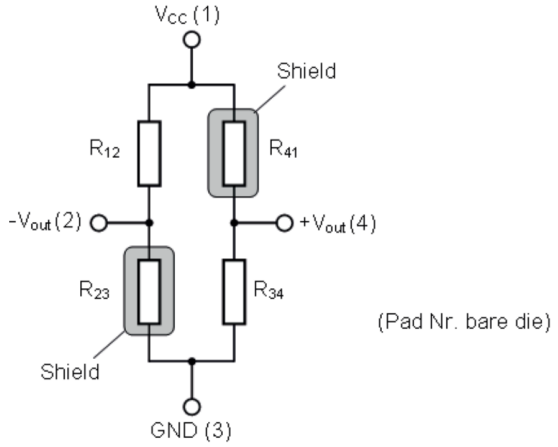


Fig 1: Simplified circuit diagram. The resistors R23 and R41 are covered by two flux concentrators (shields) to prevent an applied magnetic field from influencing them. Therefore, when a field is applied, the resistors R12 and R34 decrease in resistance, while the other two resistors under the flux concentrator do not. This imbalance leads to the bridge output.

Output Signal Information

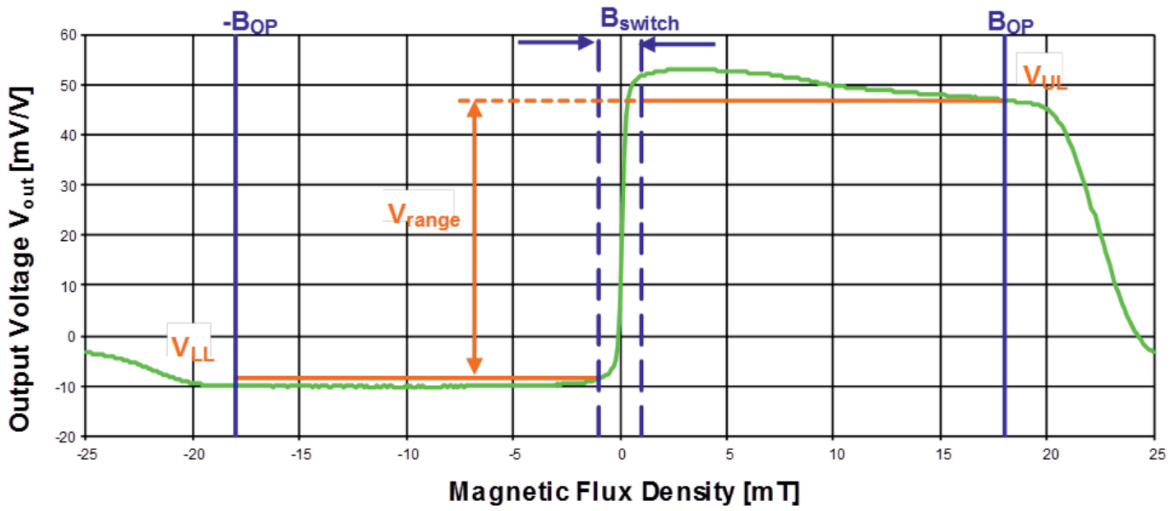


Fig 2: Typical output voltage for magnetic flux density within ±25 mT in switching applications.

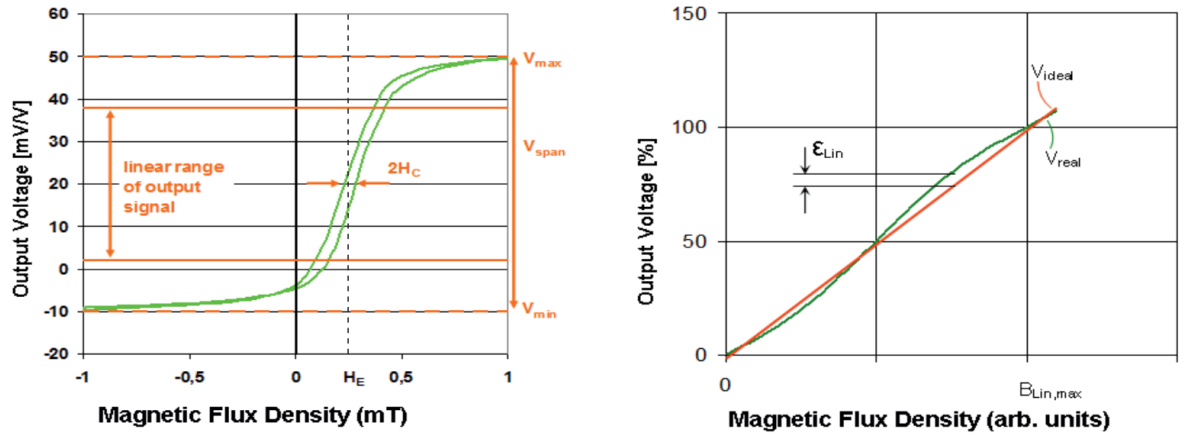


Fig 3: Left: Typical output voltage for magnetic flux density within ±1 mT in magnetic field measurment applications.
Right: Definition of linear error [1] (schematic).

[1] Linearity error is normalized to the output voltage span $V_{span} = V_{max} - V_{min}$.

GF708 Bare Die/Flip-Chip

Pinout

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 for the pinout of the bare die is given by product label.

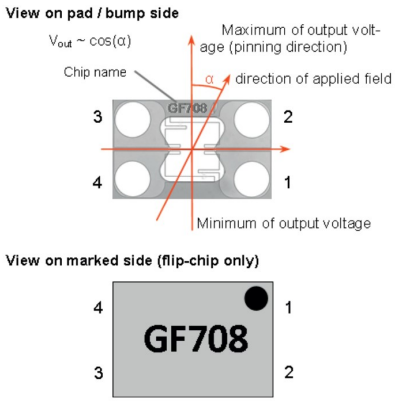


Fig. 5: Sensitivity of GF708, Botom: Backside view on laser mark with pin1 indication.

Dimensions

Symbol		Parameter	Min.	Typ.	Max.	Unit
A	Bare die	Length	1420	1460	1500	µm
B		Width	920	960	1000	µm
C		Height	240	250	260	µm
d		Diameter	-	230	-	µm
A	Flip-chip	Length	1350	1400	1450	µm
B		Width	850	900	950	µm
C		Height	400	410	420	µm
d		Diameter [1]	-	300	-	µm
S		Standoff [2]	-	240	-	µm
a		Pitch a	-	1000	-	µm
b		Pitch b	-	500	-	µm
e		Margin	-	200	-	µm

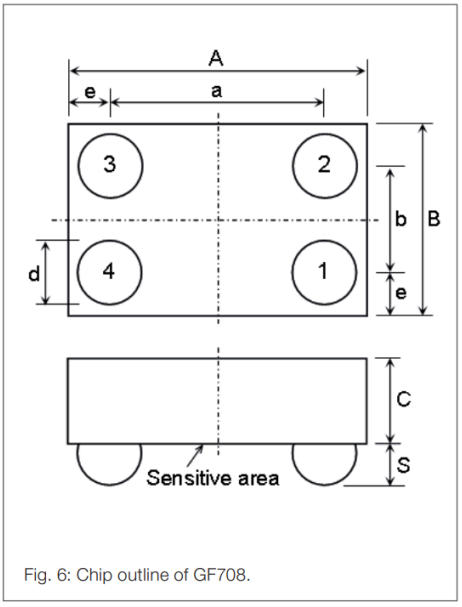


Fig. 6: Chip outline of GF708.

[1] Solder ball diameter before reflow.

[2] After reflow.

Data for Packaging and Interconnection Technologies

Parameter		Value	Unit
Pad material [3]		Au	-
Pad thickness [3]		0.4	µm
Solder ball material [4]		SnAg2.6Cu0.6	-
Pad thickness [4]	For 6 sec.	260	°C

[3] Bare die

[4] Flip-chip

GF708AKA SIL6 Package

Pinout

Pad	Symbol	Parameter
1	$-V_{O2}$	Negative output voltage bridge 2
2	$-V_{O1}$	Negative output voltage bridge 1
3	GND	Ground
4	$+V_{O1}$	Positive output voltage bridge 1
5	$+V_{O2}$	Positive output voltage bridge 2
6	V_{CC}	Supply voltage

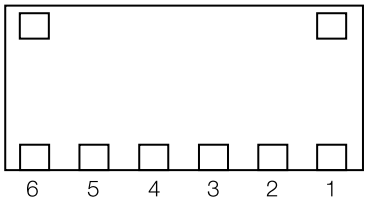
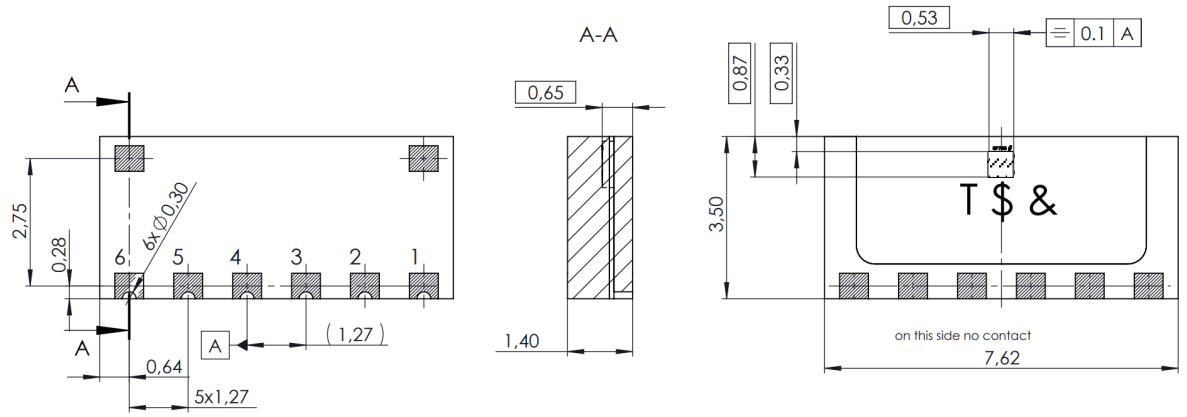


Fig. 4: Pinout of the GF708AKA SIL6 Package

Dimensions



Sensor marking:

T: Sensor GF708
$: Week (A:1/2, B: 3/4, …)
&: Year (A: 2009, B: 2010, …)

Notes:

- All Dimensions in mm
- Pad dimensioning correlates to pad center.
- Pad dimensions: 0.6 mm x 0.55 mm
- The green shaded area denotes the active chip area.

Fig. 5: SIL6 outline for GF708AKA.

GF708AMA LGA6S Package

Pinout

Pad	Symbol	Parameter
1	$+V_{O1}$	Positive output voltage bridge 1
2	NC	Not connected
3	GND	Ground
4	V_{CC}	Supply voltage
5	$-V_{O1}$	Negative output voltage bridge 1
6	NC	Not connected
7-8	NC	Not connected

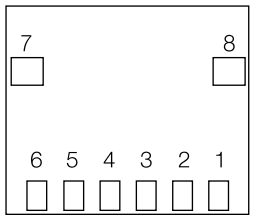
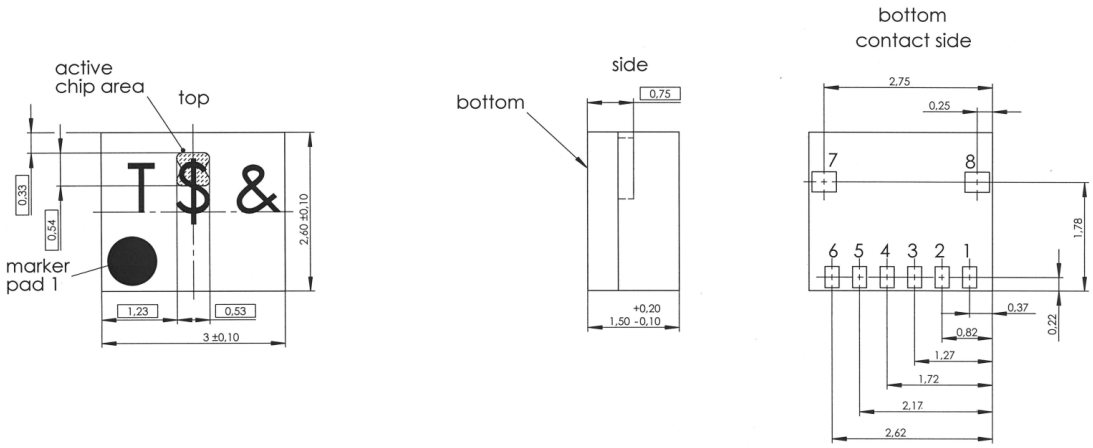


Fig. 6: Pinout of the GF708AMA LGA6S Package

Dimensions



Sensor marking:

T: Sensor GF708
$: Week (A:1/2, B: 3/4, …)
&: Year (A: 2009, B: 2010, …)

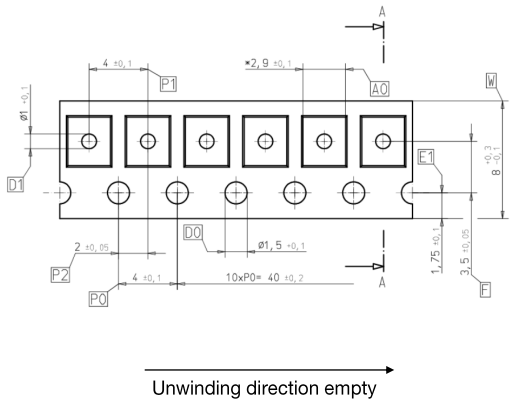
Notes:
- All Dimensions in mm
- Pad dimensioning correlates to pad center.
- Pad dimensions (1-6): 0.23 mm x 0.35 mm
- Pad dimensions (7-8): 0.40 mm x 0.33 mm
- The green shaded area denotes the active chip area.

Tolerances:
- Pads: ± 0.025 mm
- Pads to housing edge: ± 0.1 mm
- Chip to housing edge: ± 0.1 mm

Fig. 7: LGA6S outline for GF708AMA.

GF708AMA LGA6S Package

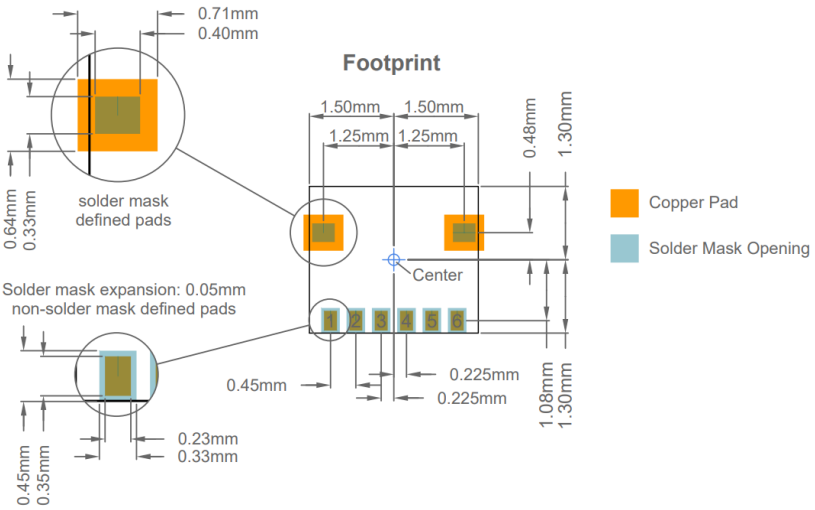
Reel layout



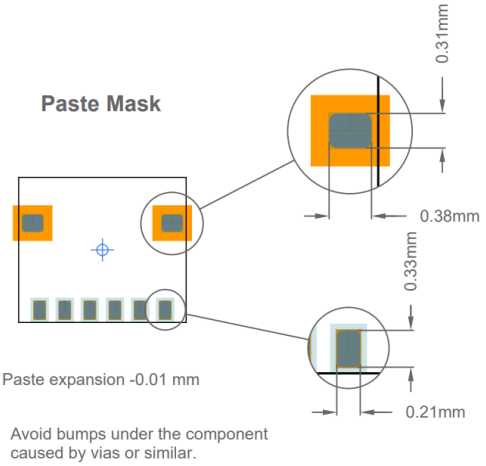
Notes:
- Type: RC 3689
- Material: PS (conductive)
- Conductivity: 10^3 - 10^6 Ω/sq
- All cavity dimensions measured at the end of radius
- All Dimensions in mm
- Surface resistivity can break
- Marking for pin 1 towards sprocket hole (IEC60286-3)
- Shelf life: 24 months after seal date (dry-packed sensors), non-condensing atmosphere, max. 40 °C, max. 90 % relative humidity
- moisture sensitivity level 2 classified (JEDEC J-STD-020)
- after dry pack opening: floor conditions und floor times as defined in JEDEC J-STD-033
- bake out times and conditions after the allowed floor time refer to JEDEC J-STD-033
- Sensors in tape & reel are not allowed to bake out at temperatures > 45 °C

Fig. 8: LGA6S tape & reel for GF708AMA-AE.

Land pattern layout



Notes:
- Solder mask of 125 µm thickness recommanded.
- Solder paste with grain size of type 5 recommanded.



NOTE: Avoid bumps under the component caused by vias or similar.

Reflow-Profile Recommendation:

Temperature	Time
40 - 170 °C	110 - 150 sec.
170 - 217 °C	100 - 140 sec.
To reach peak	240 - 310 sec.
> 217 °C	30 - 90 sec.

Fig. 9: LGA6S land pattern and reflow recommendation.

Evalboard with GF708APA-AE

Pinout

Pad	Symbol	Parameter
1	GND	Ground
2	nc	Not connected
3	$+V_{out}$	Positive output voltage
4	V_{CC}	Supply voltage
5	nc	Not connected
6	$-V_{out}$	Negative output voltage

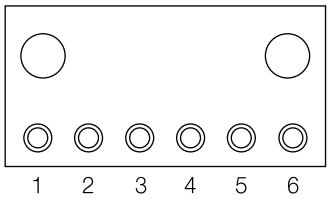
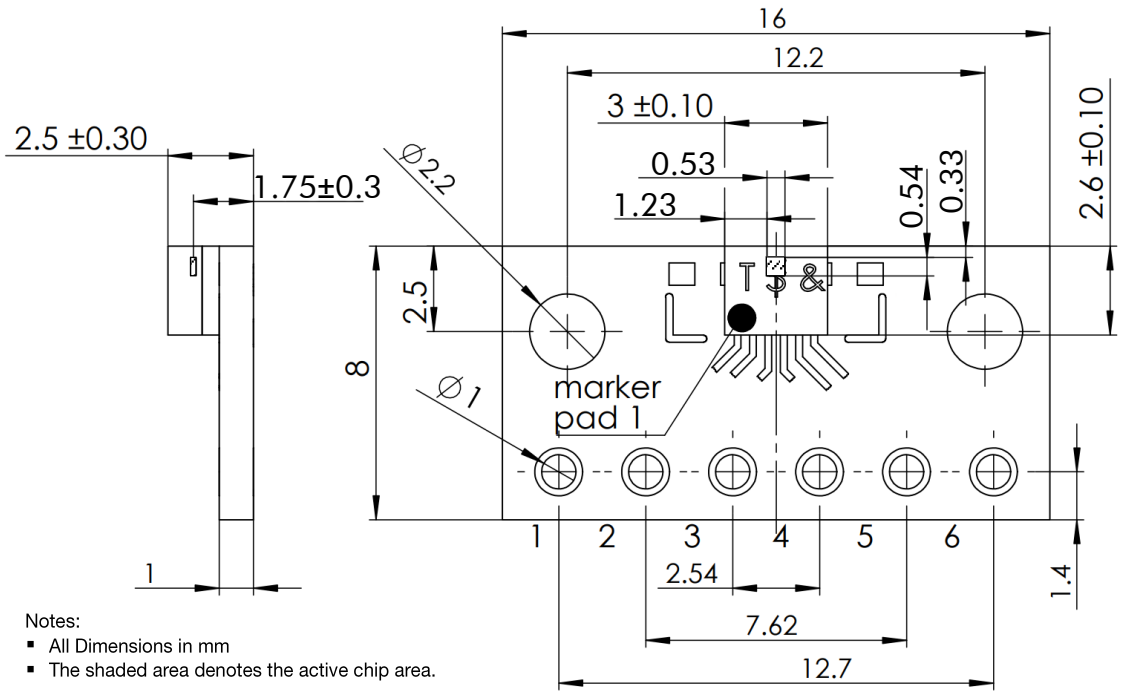


Fig. 18: Pinout of the evalboard

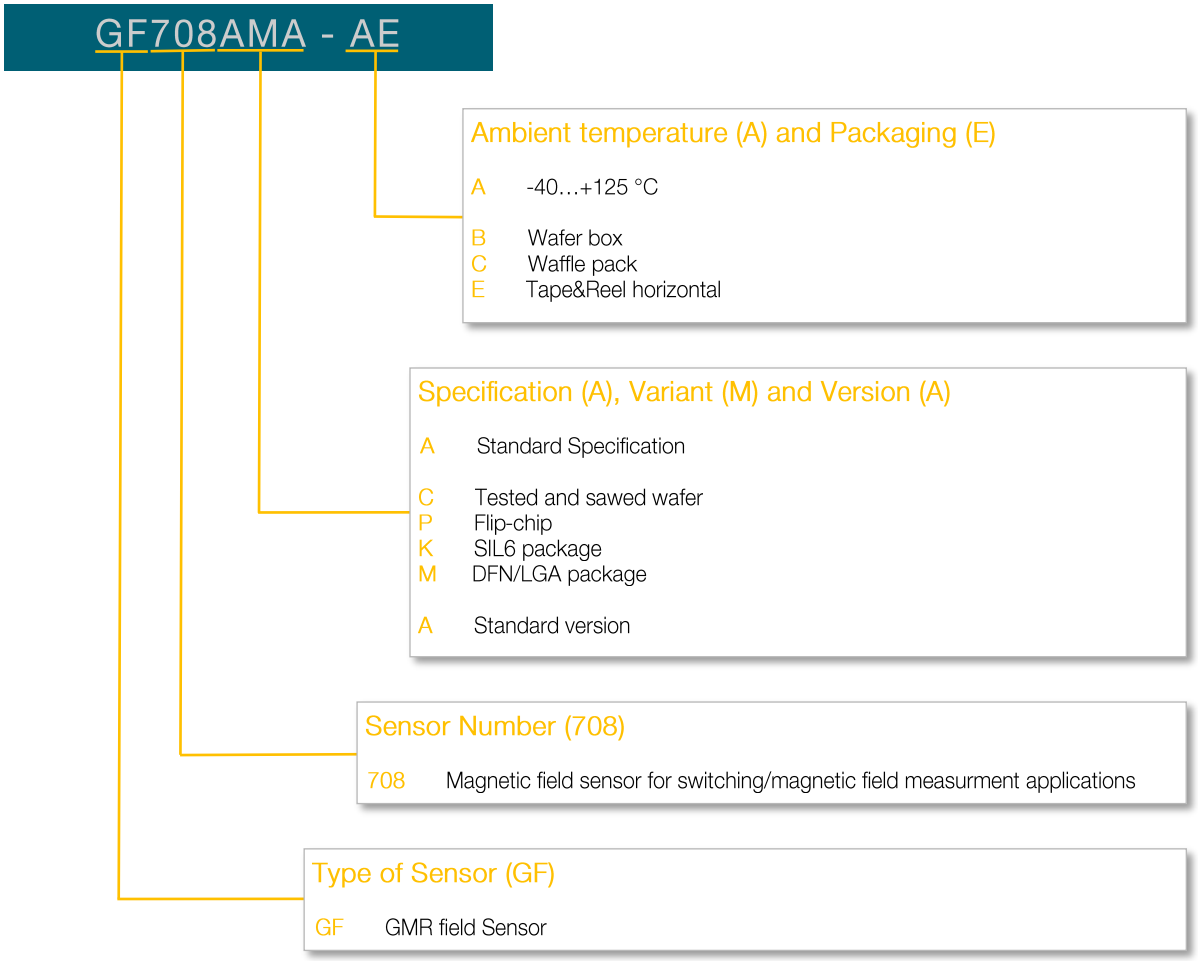
Dimensions



Notes:
- All Dimensions in mm
- The shaded area denotes the active chip area.

Fig. 19: Outline of evalboard with GF708APA-AE.

Additional Information on Ordering Code



General Information

Product Status

Article	Status
GF708APA-AE	The product is in series production.
GF708ACA-AB	The product is in series production.
GF708AKA-AC	The product is in series production.
GF708AMA-AE	The product is in series production.
GF708 Evalboard	This product is for evaluation of the GF708APA-AE sensor.
Note	The status of the product may have changed since this data sheet was published. The latest information is available on the internet at www.sensitec.com.

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Life Critical Applications

These products are not qualified for use in life support appliances, aeronautical applications or devices or systems where malfunction of these products can reasonably be expected to result in personal injury.

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Changelist

Version	Description of the Change	Date
GF708.DSE.08	Add evalboard information (pp. 8)	12/2024
GF708.DSE.07	Logo and adress updated (pp. 1-9)	03/2024
GF708.DSE.00	Original (pp. 1-9)	03/2011

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