X3G-OH047; X3T-OH047; X3G-OH048; X3T-OH048

Magnetic field sensor

Rev. 1 — 4 April 2011 Product specification

1. Product profile

1.1 General description

The X3G-OH047, X3G-OH048, X3T-OH047 and X3T-OH048 are sensitive magnetic field sensors, employing the magneto-resistive effect of thin film permalloy. The sensors contain two parallel supplied Wheatstone bridges at a relative angle of 45° to each other.

A rotating magnetic field in the surface parallel to the chip (x-y plane) will deliver two independent sinusoidal output signals, one following a cos(2α) and the other following a sin(2α) function, α being the angle between sensor and field direction (see Figure 5 and Figure 6).

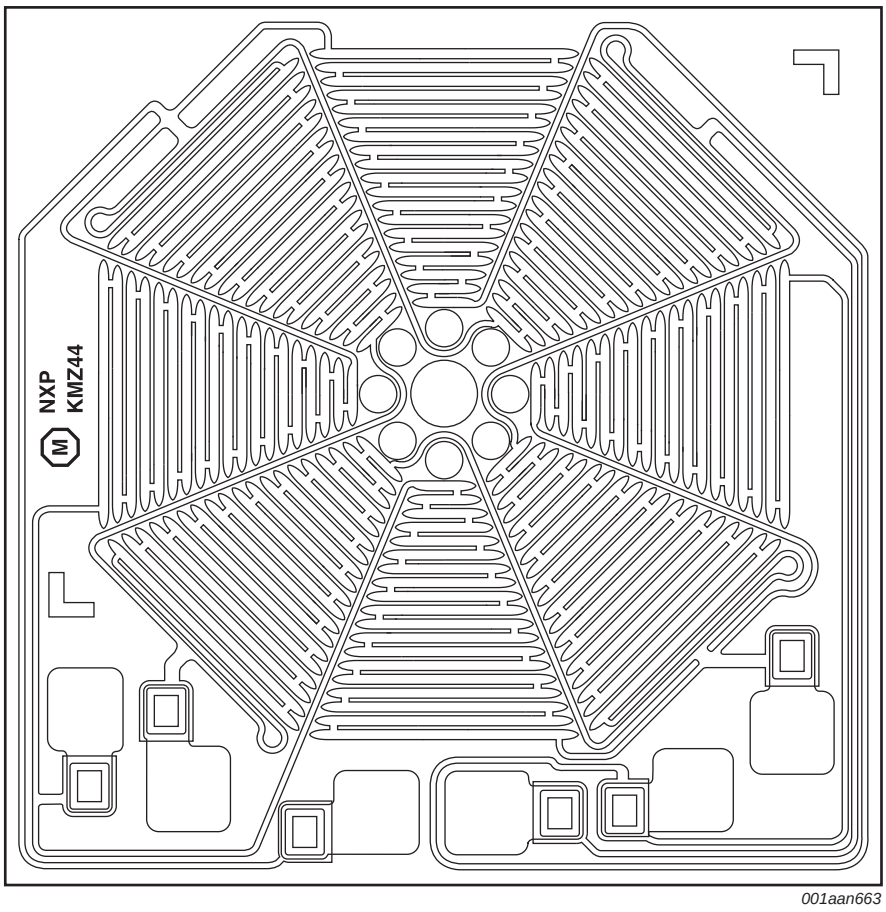
The X3G-OH047, X3G-OH048, X3T-OH047 and X3T-OH048 are suited for high precision angle measurement applications under low field conditions (saturation field strength 25 kA/m).

The sensors can be operated at any frequency between DC and 1 MHz.

All type numbers shown in this data sheet are valid for a single-die (single sensor). The double-die has two magnetic field sensors with electrical and magnetic parameters which fulfill the specified single-die values and do not correlate to each other.

Table 1. Product overview

Type number	Sensor	Packing
X3G-OH047	double-die	sawn wafer; on foil
X3G-OH048	single-die	sawn wafer; on foil
X3T-OH047	double-die	taped on reel
X3T-OH048	single-die	taped on reel



KMZ44 is an internal name which is visible on the die

Fig 1. Sensor die

1.2 Features and benefits

- Accurate and reliable angle measurement
- Mechanical robustness, contactless principle
- Wear-free operation
- Accuracy independent of mechanical tolerances
- Extended temperature range

1.3 Applications

- Steering angle and torsion
- Headlight adjustment
- Motor positioning
- Window wipers
- Fuel level
- Mirror positioning

1.4 Quick reference data

Table 2. Quick reference data

T_{amb} = 25 °C; H_{ext} = 25 kA/m; V_{CC} = 5 V; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{CC}	supply voltage			-	5	9	V
V_M	peak voltage	see Figure 3	[1][2]	60	67	75	mV
V_{offset}	offset voltage	per supply voltage; see Figure 3	[1]	–2	-	+2	mV/V
$TC_{V(offset)}$	offset voltage temperature coefficient	per supply voltage; T_{amb} = –40 °C to +150 °C; see Figure 3	[1][3]	–2	-	+2	(μV/V)/K
R_{bridge}	bridge resistance		[1][4]	2.7	3.2	3.7	kΩ

[1] Applicable for bridge 1 and bridge 2.

[2] $V_M = |V_{O(max)} - V_{offset}|$. Periodicity of V_M: sin(2α) and cos(2α), respectively.

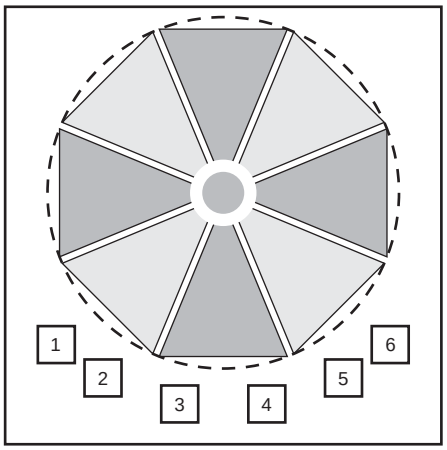
[3] $$TC_{V(offset)} = \frac{V_{offset}(at\ 150\ °C) - V_{offset}(at\ -40\ °C)}{150\ °C - (-40\ °C)}$$

[4] Bridge resistance between pad 5 to pad 1 and pad 4 to pad 2.

2. Pinning information

Table 3. Pinning

Pad	Symbol	Description	Simplified outline
1	ON1	output voltage bridge 1	
2	ON2	output voltage bridge 2	
3	GND	common ground	
4	OP2	output voltage bridge 2	
5	OP1	output voltage bridge 1	
6	V_{CC}	common bridge supply voltage	



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3. Ordering information

Table 4. Ordering information

Type number	Package		
	Name	Description	Version
X3G-OH047	bare die	double-die; sawn wafer; on foil	OL-X3G-OH047
X3G-OH048	bare die	single-die; sawn wafer; on foil	OL-X3G-OH048
X3T-OH047	bare die	double-die; taped on reel	OL-X3T-OH047
X3T-OH048	bare die	single-die; taped on reel	OL-X3T-OH048

4. Circuit diagram

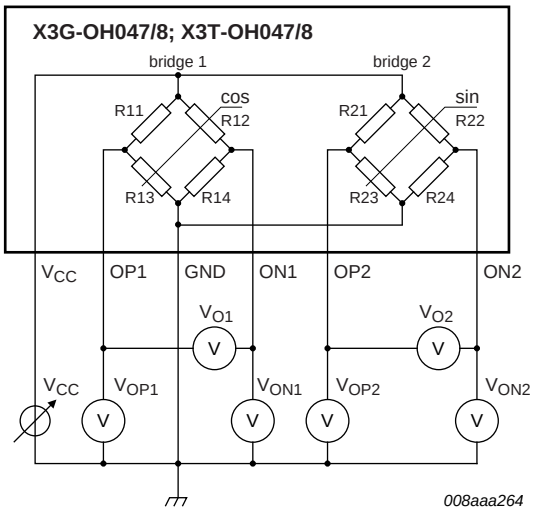

Fig 2. Device and test circuit diagram

5. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage		-	9	V
H_{ext}	external magnetic field strength	[1]	25	-	kA/m
T_{amb}	ambient temperature		–40	+150	°C

[1] Minimum stimulating magnetic field parallel to the chip surface (x-y plane) to achieve specified angular accuracy.

6. Characteristics

Table 6. Characteristics

T_{amb} = 25 °C; H_{ext} = 25 kA/m[1]; V_{CC} = 5 V; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{CC}	supply voltage			-	5	9	V
V_M	peak voltage	see Figure 3	[2][3]	60	67	75	mV
TC_{VM}	peak voltage temperature coefficient	T_{amb} = –40 °C to +150 °C	[2][4]	–0.30	–0.36	–0.42	%/K
R_{bridge}	bridge resistance		[2][5]	2.7	3.2	3.7	kΩ
$TC_{R(bridge)}$	bridge resistance temperature coefficient	T_{amb} = –40 °C to +150 °C	[2][6]	0.24	0.27	0.29	%/K
V_{offset}	offset voltage	per supply voltage; see Figure 3	[2]	–2	-	+2	mV/V
$TC_{V(offset)}$	offset voltage temperature coefficient	per supply voltage; T_{amb} = –40 °C to +150 °C; see Figure 3	[2][7]	–2	-	+2	(μV/V)/K
$V_{o(hys)}$	hysteresis output voltage	see Figure 4	[2][8]	0	0.05	0.18	%FS
ω	angular velocity			0	-	1	MHz
k	amplitude synchronism		[9]	98.9	100	101.1	%
TC_k	amplitude synchronism temperature coefficient	T_{amb} = –40 °C to +150 °C	[10]	–0.01	0	+0.01	%/K
Δα	angular inaccuracy		[11]	0	0.05	0.1	deg

[1] Minimum stimulating magnetic field parallel to the chip surface (x-y plane) to achieve angular inaccuracy.

[2] Applicable for bridge 1 and bridge 2.

[3] $V_M = |V_{O(max)} - V_{offset}|$. Periodicity of V_M: sin(2α) and cos(2α), respectively.

[4] $$TC_{VM} = \frac{V_M(at\ 150\ °C) - V_M(at\ –40\ °C)}{V_M(at\ 25\ °C) \times (150\ °C - (–40\ °C))}$$

[5] Bridge resistance between pad 5 to pad 1 and pad 4 to pad 2.

[6] $$TC_{R(bridge)} = \frac{R_{bridge}(at\ 150\ °C) - R_{bridge}(at\ –40\ °C)}{R_{bridge}(at\ 25\ °C) \times (150\ °C - (–40\ °C))}$$

[7] $$TC_{V(offset)} = \frac{V_{offset}(at\ 150\ °C) - V_{offset}(at\ –40\ °C)}{150\ °C - (–40\ °C)}$$

[8] $$V_{o(hys)1} = \left|\frac{V_{O1}(67.5°)135° \rightarrow 45° - V_{O1}(67.5°)45° \rightarrow 135°}{2 \times V_{M1}}\right|$$

$$V_{o(hys)2} = \left|\frac{V_{O2}(22.5°)90° \rightarrow 0° - V_{O2}(22.5°)0° \rightarrow 90°}{2 \times V_{M2}}\right|$$

[9] $$k = \frac{V_{M1}}{V_{M2}}$$

[10] $$TC_k = \frac{k(at\ 150\ °C) - k(at\ –40\ °C)}{k(at\ 25\ °C) \times (150\ °C - (–40\ °C))}$$

[11] $\Delta\alpha = |\alpha_{real} - \alpha_{meas}|$; V_{offset} = 0 V; inaccuracy of angular measurement due to deviations from ideal sinusoidal characteristics, calculated from the third and fifth harmonics of the spectrum V_O.

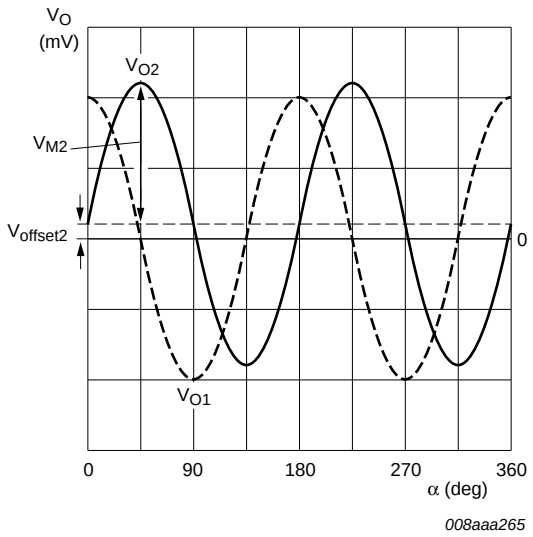

Fig 3. Output signals related to the direction of the magnetic field

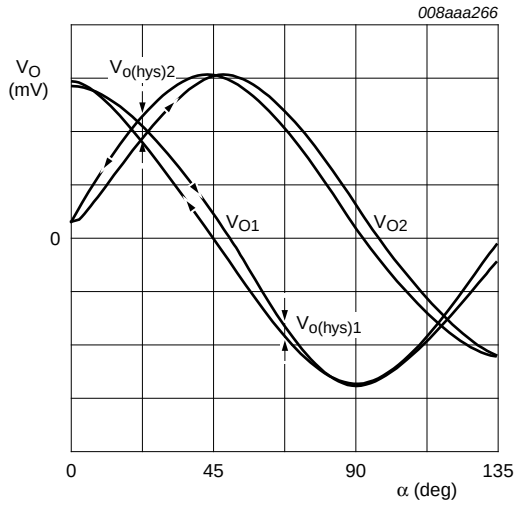

Fig 4. Definition of hysteresis

7. Bare die outline

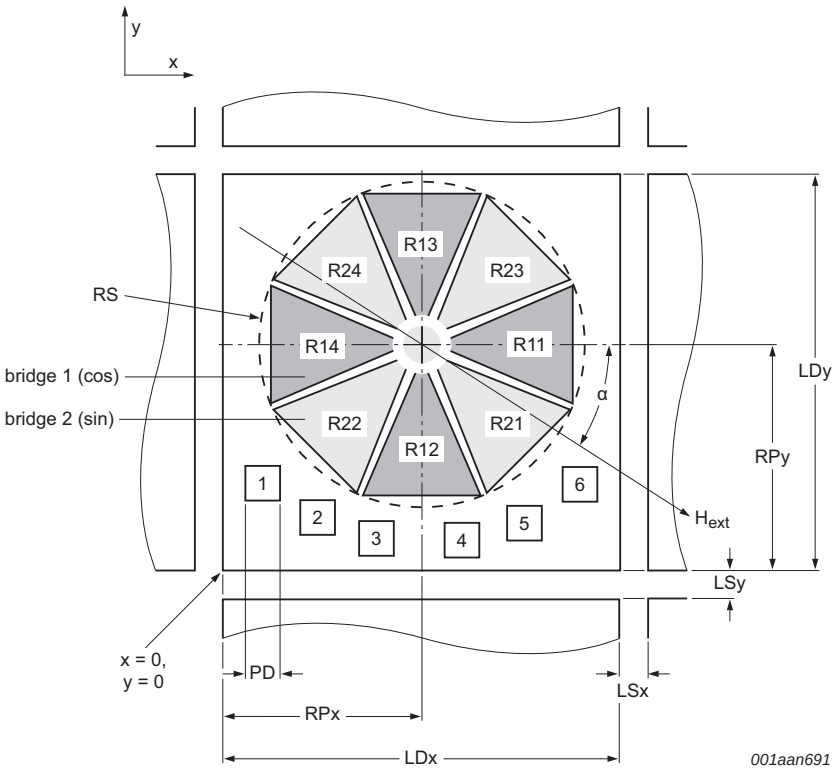

Fig 5. Bare die outline (single die)

Table 7. Mechanical dimensions for Figure 5

Symbol	Parameter	x	y	Radius/diameter	Unit
LD	die size	1150	1150	-	µm
LS	sawing lane width	60	60	-	µm
RP	reading point position	575	642	-	µm
RS	sensitive area radius	-	-	480	µm
PD	pad diameter	-	-	110	µm
1	position pad 1	108	230	-	µm
2	position pad 2	243	125	-	µm
3	position pad 3	489	95	-	µm
4	position pad 4	632	95	-	µm
5	position pad 5	900	125	-	µm
6	position pad 6	1032	200	-	µm

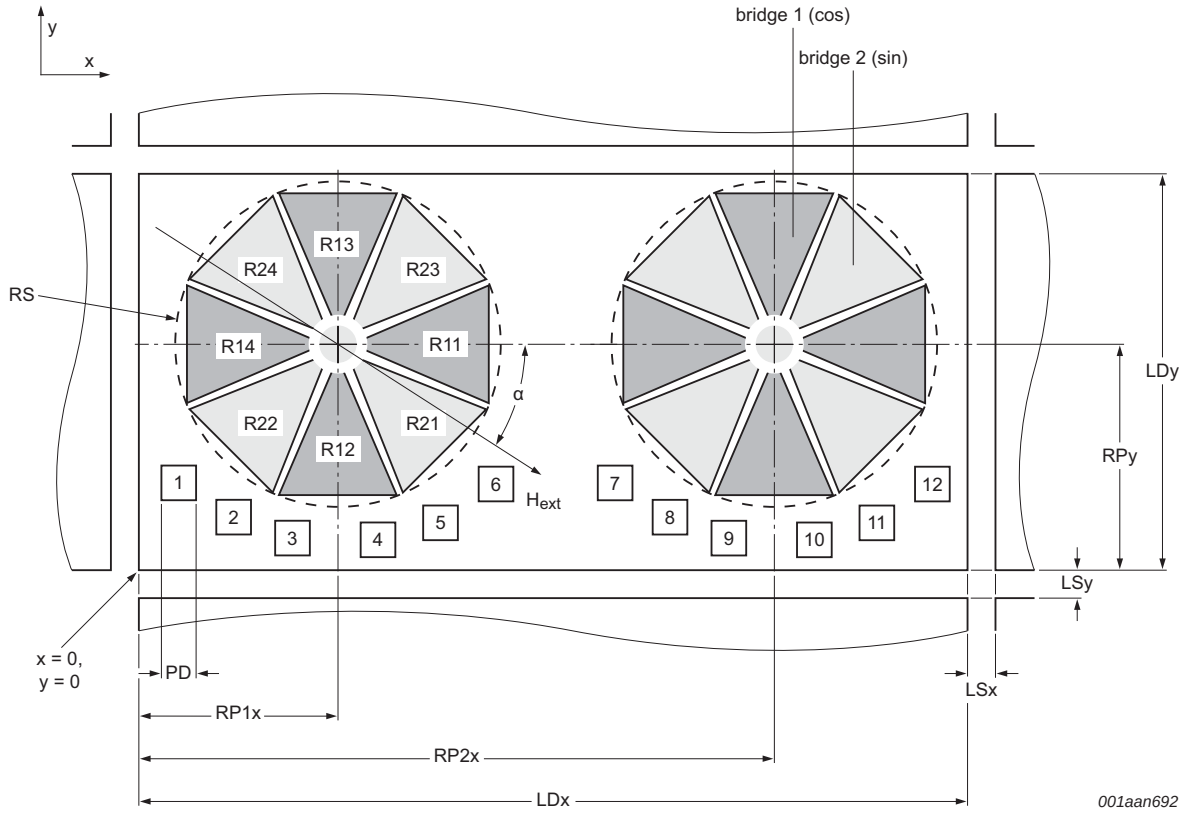

Fig 6. Bare die outline (double die)

Table 8. Mechanical dimensions for Figure 6

Symbol	Parameter	x	y	Radius/diameter	Unit
LD	die size	2360	1150		µm
LS	sawing lane width	60	60		µm
RP1	reading point position 1	575	642		µm
RP2	reading point position 2	1785	642		µm
RS	sensitive area radius	-	-	480	µm
PD	pad diameter	-	-	110	µm
1	position pad 1	108	230		µm
2	position pad 2	243	125		µm
3	position pad 3	489	95		µm
4	position pad 4	632	95		µm
5	position pad 5	900	125		µm
6	position pad 6	1032	200		µm
7	position pad 7	1318	230		µm
8	position pad 8	1453	125		µm
9	position pad 9	1699	95		µm

Table 8. Mechanical dimensions for Figure 6 *…continued*

Symbol	Parameter	x	y	Radius/diameter	Unit
10	position pad 10	1842	95		µm
11	position pad 11	2110	125		µm
12	position pad 12	2242	200		µm

Table 9. Wafer dimensions

Symbol	Parameter	Value	Unit
WD	wafer diameter	150	mm
WT	wafer thickness	380 ± 15	µm

8. Packing information

8.1 Tape construction for X3G-OH047 and X3G-OH048

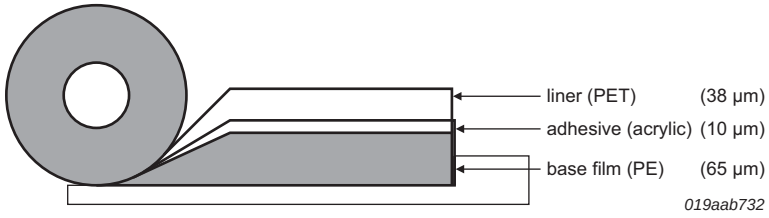

Fig 7. Tape construction

Table 10. Material composition

Parameter	Content	Typical value	Unit
Total thickness	-	75	µm
Adhesion	-	55 / 20	g/mm
Ionic impurity	Na^+	0.027	µg/ml
	K^+	< 0.004	µg/ml
	Cl	0.045	µg/ml

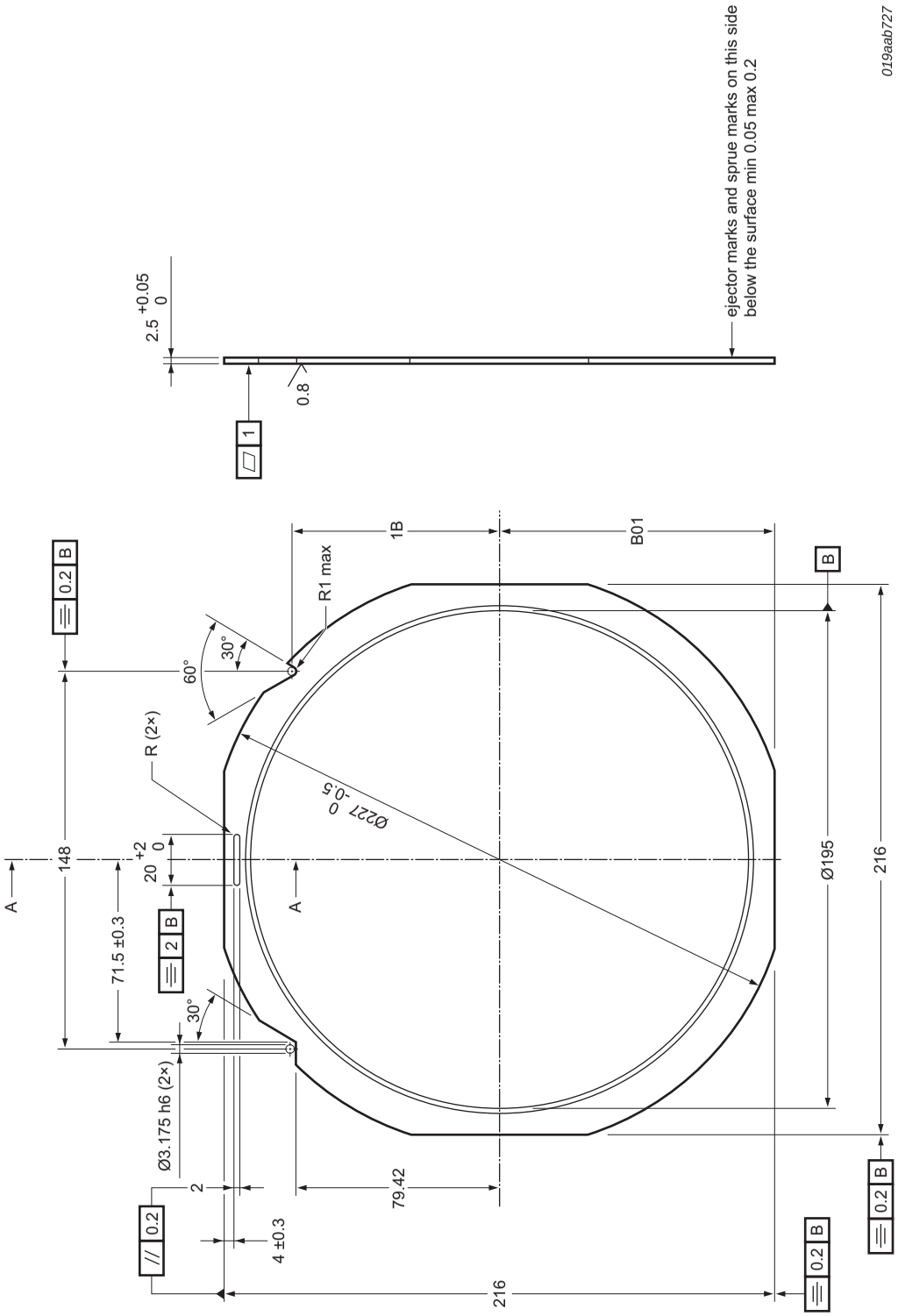

Fig 8. Geometrical dimensions of frame

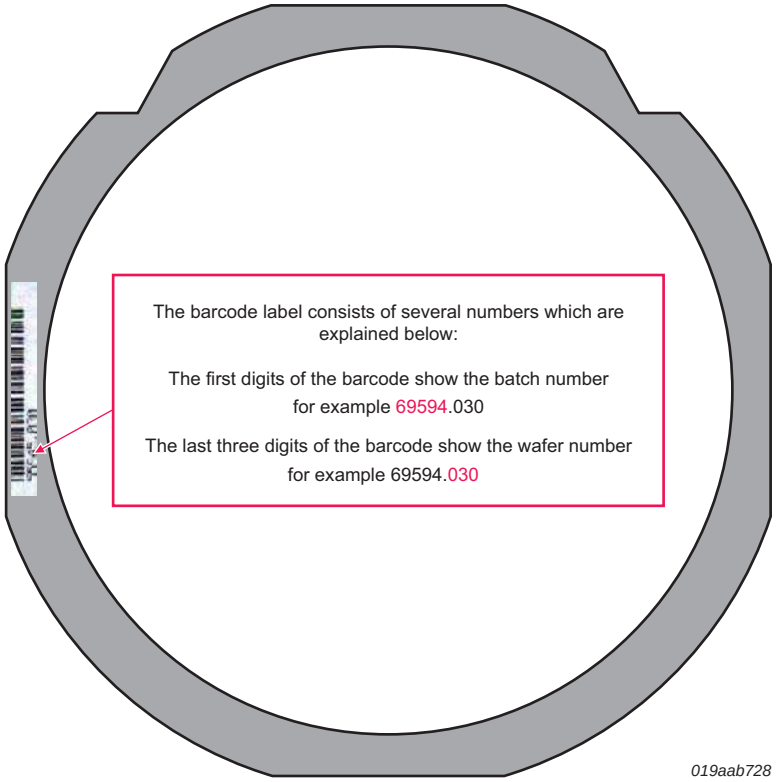

Fig 9. Film Frame Carrier (FFC) with barcode label

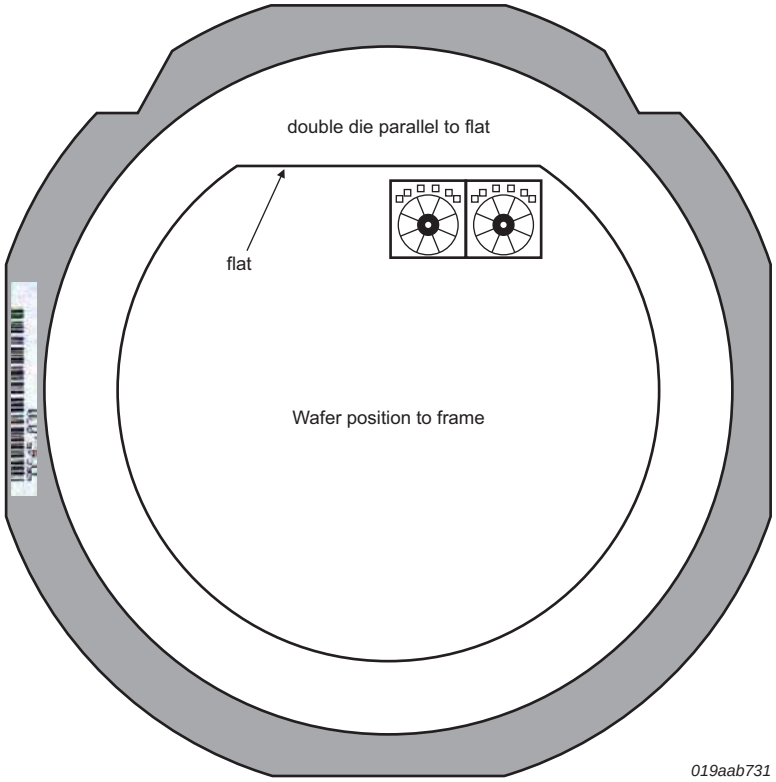

Fig 10. Wafer position to frame and double die position to wafer

8.2 Carrier tape for X3T-OH047 and X3T-OH048

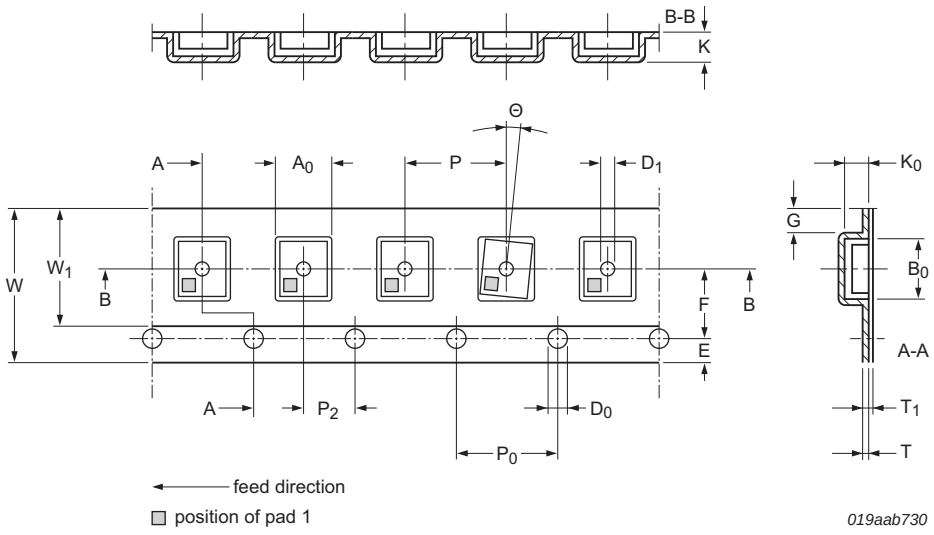

Fig 11. Tape outline, carrier tape X3T-OH048

Table 11. Dimensions for Figure 11 "Tape outline, carrier tape X3T-OH048"

Item	Symbol	Specification	
		Dimension [mm]	Tolerance
Overall dimensions			
Tape width	W	8	±0.1
Thickness	K	≤ 1.2	-
Distance	G	≥ 0.75	-
Sprocket holes			
Diameter	D_0	1.5	±0.1
Distance	E	1.75	±0.1
Pitch[1]	P_0	4	±0.1
Distance between center lines			
Length direction	P_2	2	±0.05
Width direction	F	3.5	±0.05
Compartments			
Length	A_0	1.4	±0.05
Width	B_0	1.4	±0.05
Depth	K_0	0.8	±0.05
Hole diameter	D_1	0.5	±0.1
Pitch	P	4	±0.1
Device			
Outline	X3T-OH048		
Rotation	Θ	≤ 20°	-
Carrier tape antistatic			
Film thickness[2]	T	0.25	±0.07

Table 11. Dimensions for Figure 11 "Tape outline, carrier tape X3T-OH048" *...continued*

Item	Symbol	Specification	
		Dimension [mm]	Tolerance
Cover tape			
Width	W_1	≤ 5.75	-
Film thickness	T_1	≤ 0.1	-
Bending radius			
In winding direction	R	≥ 30	-

[1] Cumulate pitch error ±0.2 over 10 pitch.

[2] Carbon loaded polystyrene 100 % recyclable.

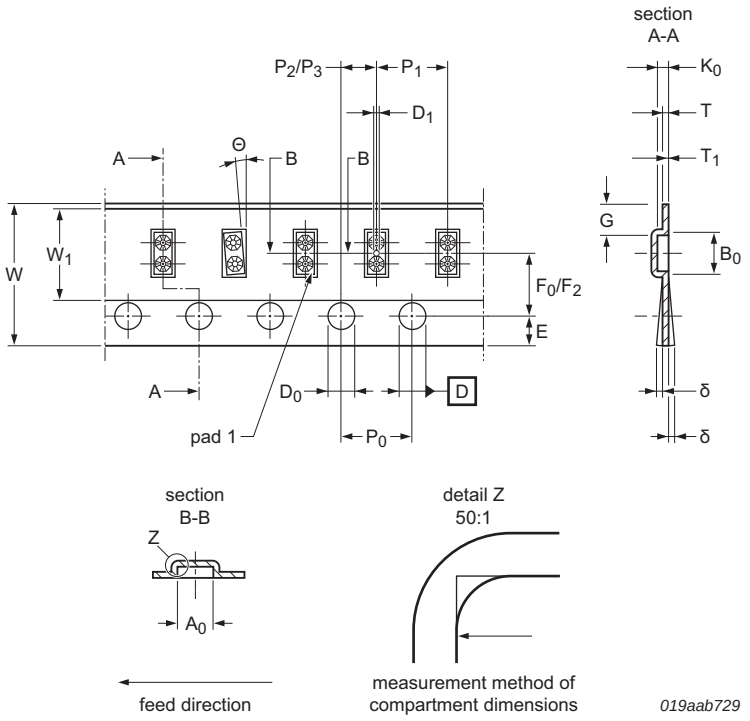

Fig 12. Tape outline, carrier tape X3T-OH047

Table 12. Dimensions for Figure 12 "Tape outline, carrier tape X3T-OH047"

Item	Symbol	Specification	
		Dimension [mm]	Tolerance
Overall dimensions			
Tape width	W	8	±0.1
Distance	G	≥ 0.75	-
Sprocket holes			
Diameter	D_0	1.5	±0.1
Distance	E	1.75	±0.1
Pitch[1]	P_0	4	±0.1

Table 12. Dimensions for Figure 12 "Tape outline, carrier tape X3T-OH047" *…continued*

Item	Symbol	Specification	
		Dimension [mm]	Tolerance
Distance between center lines			
Sprocket hole / cavity center	P_2	2	±0.05
Sprocket hole / cavity hole	P_3	2	±0.05
Sprocket hole / cavity center	F_0	3.5	±0.05
Sprocket hole / cavity hole	F_2	3.5	±0.05
Compartments			
Length	A_0	1.4	±0.05
Width overall	B_0	2.7	±0.05
Depth	K_0	0.5	±0.05
Hole diameter	D_1	0.5	±0.1
Pitch	P_1	4	±0.1
Device			
Outline	X3T-OH047		
Rotation	Θ	≤ 15°	-
Carrier tape antistatic			
Film thickness[2]	T	0.25	±0.07
Bend	δ	≤ 0.3	-
Cover tape			
Width	W_1	5.3	±0.1
Film thickness	T_1	0.05	±0.01
Bending radius			
In winding direction	R	≥ 30	-

[1] Cumulate pitch error ±0.2 over 10 pitch.

[2] Carbon loaded polystyrene 100 % recyclable.

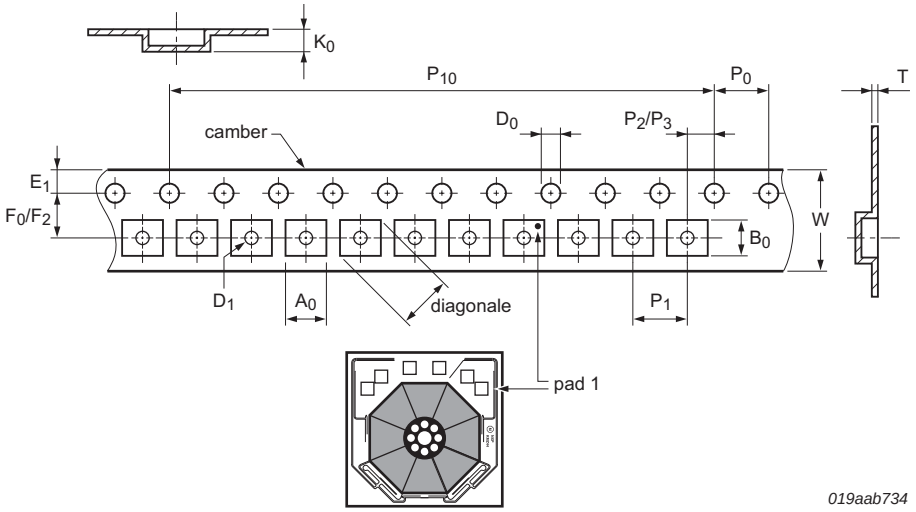

Fig 13. Chip position and pad 1 location for X3T-OH048

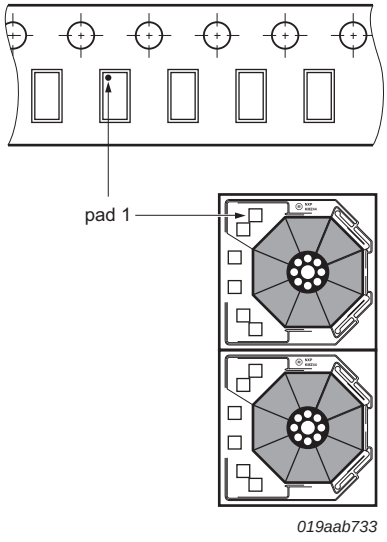

Fig 14. Chip position and pad 1 location for X3T-OH047

9. Revision history

Table 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
X3G_T_OH047_048 v.1	20110404	Product specification	-	-

10. Legal information

10.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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12. Contents

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