MULTILAYER CHIP INDUCTORS
LK SERIES

OPERATING TEMP.	−40～85℃

WAVE REFLOW

FEATURES

・Internal printed coil structure creates a closed magnetic circuit which acts as a magnetic shield eliminating crosstalk, thus permitting higher mounting densities.
・Multilayer block structure yields higher reliability.

APPLICATIONS

Any general circuit of portable equipment in which compact size and high mounting densities are required.

ORDERING CODE

L K 3 2 1 6 R 1 0 M – T ○
1 2 3 4 5 6

1

Type	
LK	Multilayer chip inductors

2

External Dimensions (LXW) (mm)	
1608(0603)	1.6×0.8
2125(0805)	2.0×1.25
3216(1206)	3.2×1.6

3

Nominal Inductance (μH)	
example	
47N	0.047
R10	0.1
1R0	1
100	10

*R=decimal point
*N=0.0(nH type)

4

Inductance Tolerances (%)	
K	±10
M	±20

5

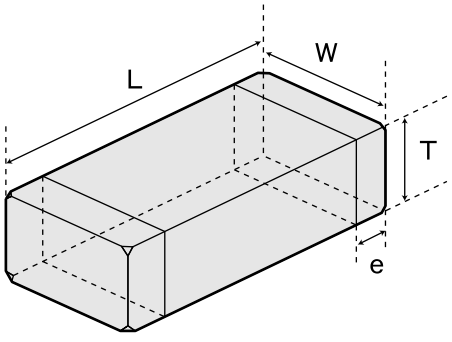
Packaging	
−T	Tape & Reel

6

Internal code	
△	Standard Products

△=Blank space

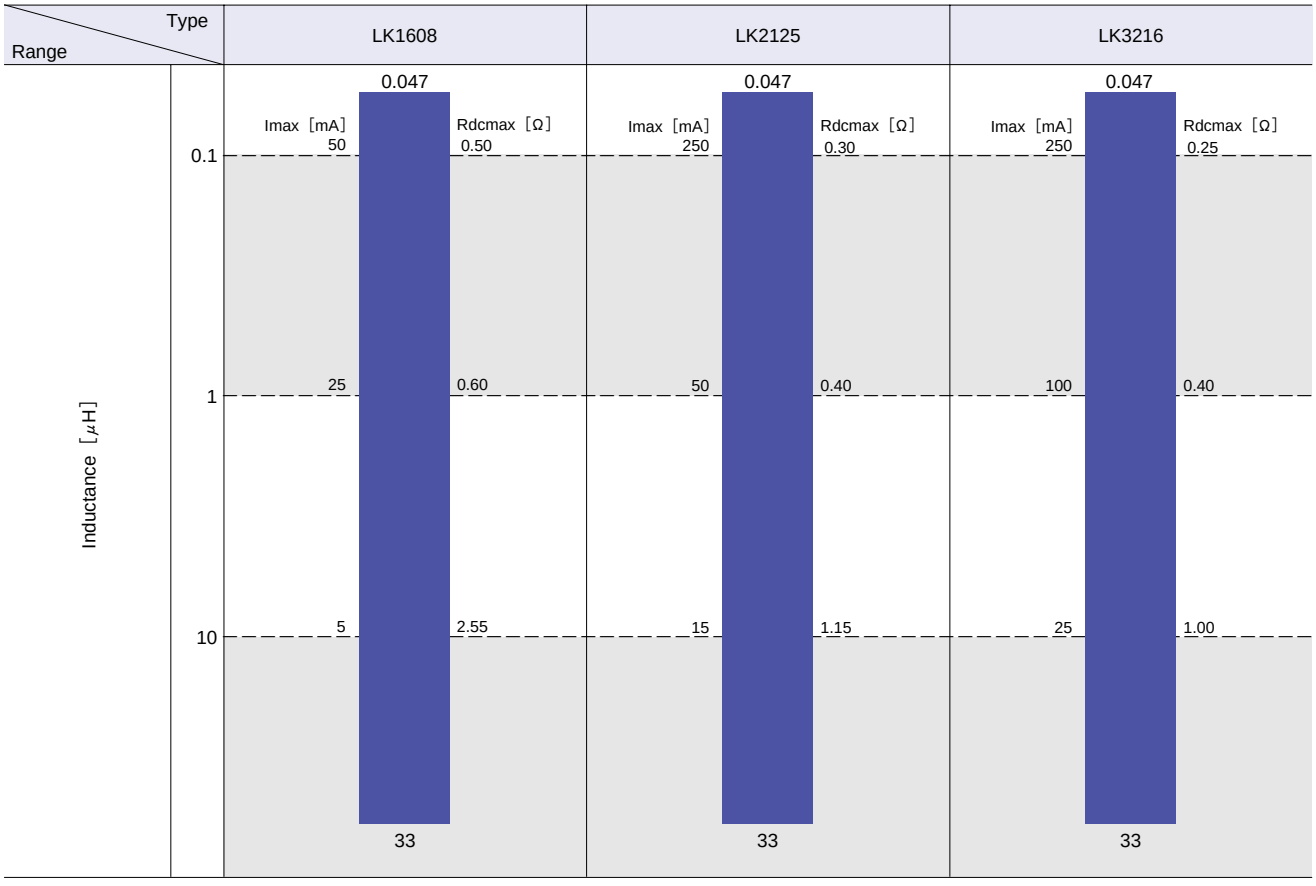
EXTERNAL DIMENSIONS



Type	L	W	T	e
LK1608 (0603)	1.6±0.15 (0.063±0.006)	0.8±0.15 (0.031±0.006)	0.8±0.15 (0.031±0.006)	0.3±0.2 (0.012±0.008)
LK2125 (0805)	$2.0^{+0.3}_{-0.1}$ ($0.079^{+0.012}_{-0.004}$)	1.25±0.2 (0.049±0.008)	0.85±0.2 1.25±0.2 (0.033±0.008) (0.049±0.008)	0.5±0.3 (0.020±0.012)
LK3216 (1206)	3.2±0.2 (0.126±0.008)	1.6±0.2 (0.063±0.008)	0.6±0.2 1.1±0.3 (0.024±0.008) (0.043±0.012)	0.5±0.3 (0.020±0.012)

Unit : mm(inch)

AVAILABLE INDUCTANCE RANGE



Examples	Inductance	Imax [mA]	Rdcmax [Ω]	Imax [mA]	Rdcmax [Ω]	Imax [mA]	Rdcmax [Ω]
	0.1μH	50	0.50	250	0.30	250	0.25
	1μH	25	0.60	50	0.40	100	0.40
	10μH	5	2.55	15	1.15	25	1.00

Selection Guide ◀ P.8 etc
Part Numbers P.234 ▶
Electrical Characteristics P.236 ▶
Packaging P.260 ▶
Reliability Data P.262 ▶
Precautions P.270 ▶

LK1608

Ordering code		Inductance (μH)	Inductance tolerance	(min.)	Self resonant frequency (MHz) (min.)	DC Resistance (Ω)(max.)	Rated current (mA) (max.)	Measuring frequency (MHz)	Thickness (mm) (inch)
LK 1608 47NM		0.047	±20%	10	260	0.30	50	50	0.8±0.15 (0.031±0.006)
LK 1608 68NM		0.068		10	250	0.30	50	50	
LK 1608 82NM		0.082		10	245	0.30	50	50	
LK 1608 R10□		0.10	±10% ±20%	15	240	0.50	50	25	
LK 1608 R12□		0.12		15	205	0.50	50	25	
LK 1608 R15□		0.15		15	180	0.60	50	25	
LK 1608 R18□		0.18		15	165	0.60	50	25	
LK 1608 R22□		0.22		15	150	0.80	50	25	
LK 1608 R27□		0.27		15	136	0.80	50	25	
LK 1608 R33□		0.33		15	125	0.85	35	25	
LK 1608 R39□		0.39		15	110	1.00	35	25	
LK 1608 R47□		0.47		15	105	1.35	35	25	
LK 1608 R56□		0.56		15	95	1.55	35	25	
LK 1608 R68□		0.68		15	80	1.70	35	25	
LK 1608 R82□		0.82		15	75	2.10	35	25	
LK 1608 1R0□		1.0		35	70	0.60	25	10	
LK 1608 1R2□		1.2		35	60	0.80	25	10	
LK 1608 1R5□		1.5		35	55	0.80	25	10	
LK 1608 1R8□		1.8		35	50	0.95	25	10	
LK 1608 2R2□		2.2		35	45	1.15	15	10	
LK 1608 2R7□		2.7		35	40	1.35	15	10	
LK 1608 3R3□		3.3		35	38	1.55	15	10	
LK 1608 3R9□		3.9		35	36	1.70	15	10	
LK 1608 4R7□		4.7		35	33	2.10	15	10	
LK 1608 5R6□		5.6		35	22	1.55	5	4	
LK 1608 6R8□		6.8		35	20	1.70	5	4	
LK 1608 8R2□		8.2		35	18	2.10	5	4	
LK 1608 100□		10		35	17	2.55	5	2	
LK 1608 120□		12		35	15	2.75	5	2	
LK 1608 150M		15	±20%	20	14	1.70	1	1	
LK 1608 180M		18		20	13	1.85	1	1	
LK 1608 220M		22		20	11	2.10	1	1	
LK 1608 270M		27		20	10	2.75	1	1	
LK 1608 330M		33		20	9	2.95	1	1	

・□ Please specify the Inductance tolerance code (K or M).

LK2125

Ordering code		Inductance (μH)	Inductance tolerance	(min.)	Self resonant frequency (MHz) (min.)	DC Resistance (Ω)(max.)	Rated current (mA) (max.)	Measuring frequency (MHz)	Thickness (mm) (inch)
LK 2125 47NM		0.047	±20%	15	320	0.20	300	50	0.85±0.2 (0.033±0.008)
LK 2125 68NM		0.068		15	280	0.20	300	50	
LK 2125 82NM		0.082		15	255	0.20	300	50	
LK 2125 R10□		0.10	±10% ±20%	20	235	0.30	250	25	
LK 2125 R12□		0.12		20	220	0.30	250	25	
LK 2125 R15□		0.15		20	200	0.40	250	25	
LK 2125 R18□		0.18		20	185	0.40	250	25	
LK 2125 R22□		0.22		20	170	0.50	250	25	
LK 2125 R27□		0.27		20	150	0.50	250	25	
LK 2125 R33□		0.33		20	145	0.55	250	25	
LK 2125 R39□		0.39		25	135	0.65	200	25	
LK 2125 R47□		0.47		25	125	0.65	200	25	1.25±0.2 (0.049±0.008)
LK 2125 R56□		0.56		25	115	0.75	150	25	
LK 2125 R68□		0.68		25	105	0.80	150	25	
LK 2125 R82□		0.82		25	100	1.00	150	25	
LK 2125 1R0□		1.0		45	75	0.40	50	10	0.85±0.2 (0.033±0.008)
LK 2125 1R2□		1.2		45	65	0.50	50	10	
LK 2125 1R5□		1.5		45	60	0.50	50	10	
LK 2125 1R8□		1.8		45	55	0.60	50	10	
LK 2125 2R2□		2.2		45	50	0.65	30	10	
LK 2125 2R7□		2.7		45	45	0.75	30	10	1.25±0.2 (0.049±0.008)
LK 2125 3R3□		3.3		45	41	0.80	30	10	
LK 2125 3R9□		3.9		45	38	0.90	30	10	
LK 2125 4R7□		4.7		45	35	1.00	30	10	
LK 2125 5R6□		5.6		50	32	0.90	15	4	
LK 2125 6R8□		6.8		50	29	1.00	15	4	
LK 2125 8R2□		8.2		50	26	1.10	15	4	
LK 2125 100□		10		50	24	1.15	15	2	
LK 2125 120□		12		50	22	1.25	15	2	
LK 2125 150M		15	±20%	30	19	0.80	5	1	
LK 2125 180M		18		30	18	0.90	5	1	
LK 2125 220M		22		30	16	1.10	5	1	
LK 2125 270M		27		30	14	1.15	5	1	
LK 2125 330M		33		30	13	1.25	5	0.4	

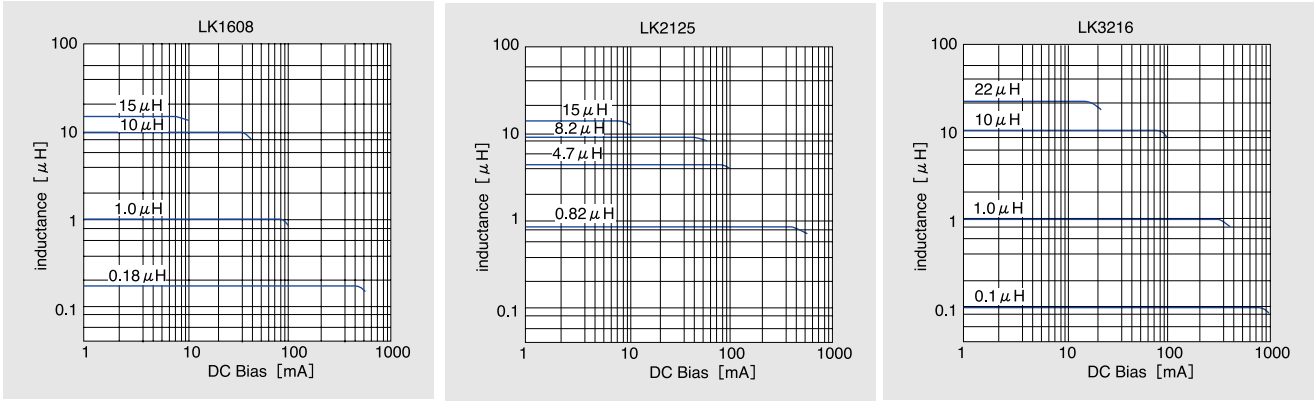
・□ Please specify the Inductance tolerance code (K or M).

LK3216

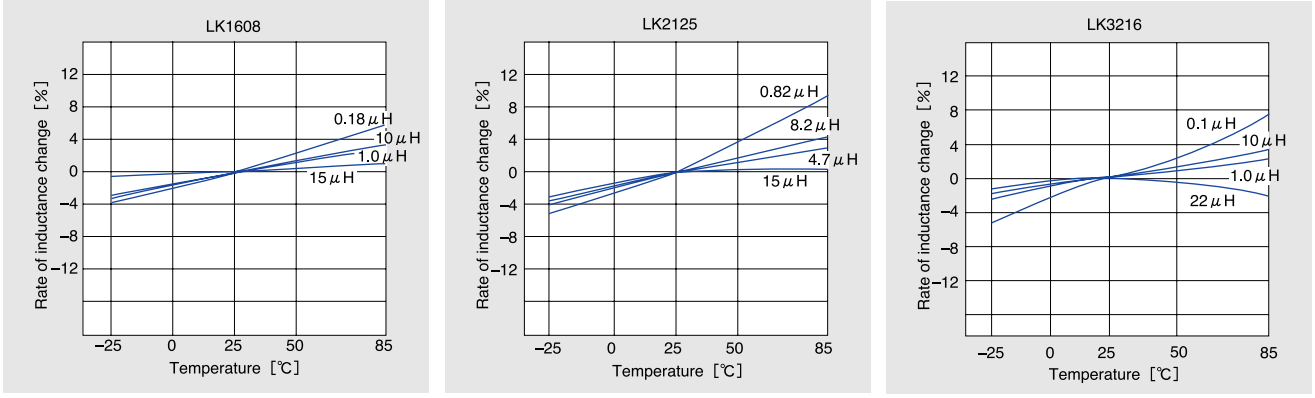
Ordering code		Inductance (μH)	Inductance tolerance	(min.)	Self resonant frequency (MHz) (min.)	DC Resistance (Ω) (max.)	Rated current (mA) (max.)	Measuring frequency (MHz)	Thickness (mm) (inch)
LK 3216 47NM		0.047	±20%	20	320	0.15	300	50	0.6±0.2 (0.024±0.008)
LK 3216 68NM		0.068		20	280	0.25	300	50	
LK 3216 R10□		0.10		20	235	0.25	250	25	
LK 3216 R12□		0.12		20	220	0.30	250	25	
LK 3216 R15□		0.15		20	200	0.30	250	25	
LK 3216 R18□		0.18		20	185	0.40	250	25	
LK 3216 R22□		0.22		20	170	0.40	250	25	
LK 3216 R27□		0.27		20	150	0.50	250	25	
LK 3216 R33□		0.33		20	145	0.60	250	25	
LK 3216 R39□		0.39		25	135	0.50	200	25	1.1±0.3 (0.043±0.012)
LK 3216 R47□		0.47		25	125	0.60	200	25	
LK 3216 R56□		0.56		25	115	0.70	150	25	
LK 3216 R68□		0.68		25	105	0.80	150	25	
LK 3216 R82□		0.82		25	100	0.90	150	25	
LK 3216 1R0□		1.0	±10%	45	75	0.40	100	10	0.6±0.2 (0.024±0.008)
LK 3216 1R2□		1.2	±20%	45	65	0.50	100	10	
LK 3216 1R5□		1.5		45	60	0.50	50	10	1.1±0.3 (0.043±0.012)
LK 3216 1R8□		1.8		45	55	0.50	50	10	
LK 3216 2R2□		2.2		45	50	0.60	50	10	
LK 3216 2R7□		2.7		45	45	0.60	50	10	
LK 3216 3R3□		3.3		45	41	0.70	50	10	
LK 3216 3R9□		3.9		45	38	0.80	50	10	
LK 3216 4R7□		4.7		45	35	0.90	50	10	
LK 3216 5R6□		5.6		50	32	0.70	25	4	
LK 3216 6R8□		6.8		50	29	0.80	25	4	
LK 3216 8R2□		8.2		50	26	0.90	25	4	
LK 3216 100□		10		50	24	1.00	25	2	
LK 3216 120□		12		50	22	1.05	15	2	
LK 3216 150M		15	±20%	35	19	0.70	5	1	
LK 3216 180M		18		35	18	0.70	5	1	
LK 3216 220M		22		35	16	0.90	5	1	
LK 3216 270M		27		35	14	0.90	5	1	
LK 3216 330M		33		35	13	1.05	5	0.4	

・□ Please specify the Inductance tolerance code (K or M).

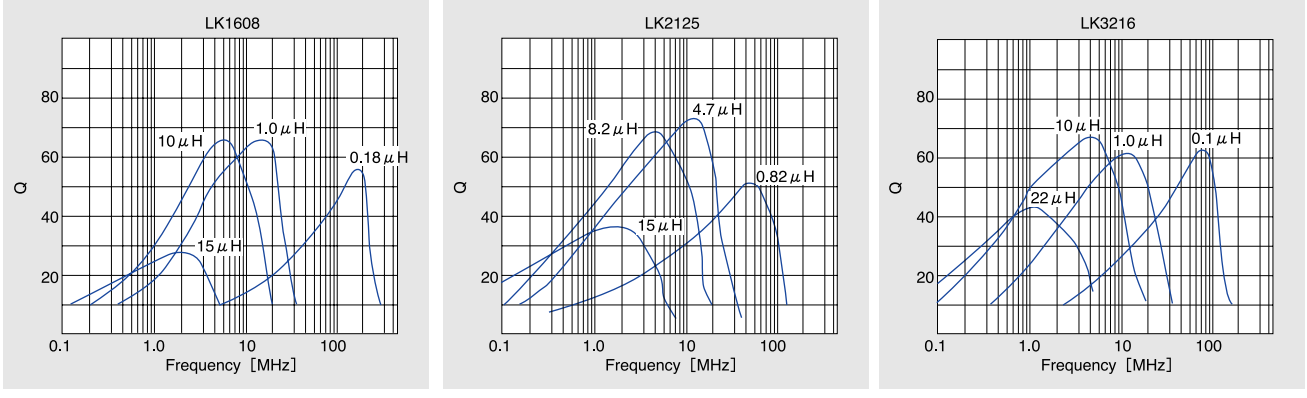
DC Bias characteristics(Measured by HP4194A)



Temperature characteristics(Measured by HP4275A)



Q-vs-Frequency characteristics(Measured by HP4195A+41951A)



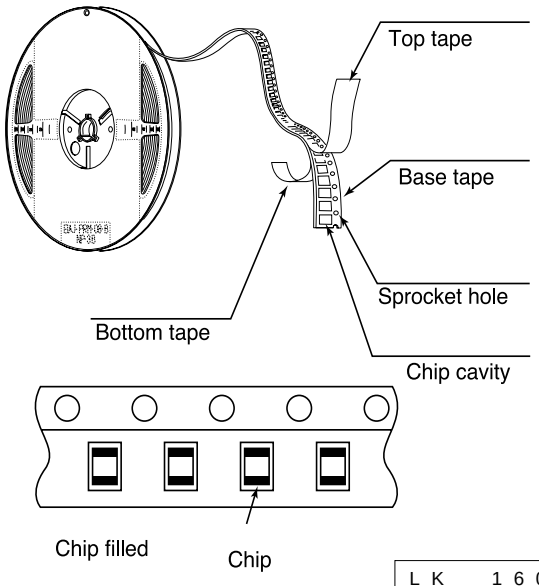
① Standard Quantity

■ Tape & Reel Packaging

Type	Thickness [mm] (inch)	[pcs] Standard Quantity	
		Paper Tape	Embossed Tape
LK1608(0603)	0.8 (0.031)	4000	—
LK2125(0805)	0.85 (0.033)	—	4000
	1.25 (0.049)	—	2000
LK3216(1206)	0.6 (0.024)	4000	—
	1.1 (0.043)	—	2000
HK1005(0402)	0.5 (0.020)	10000	—
HK1608(0603)	0.8 (0.031)	4000	—
HK2125(0805)	0.85 (0.033)	—	4000
	1.0 (0.039)	—	3000
BK1005(0402)	0.5 (0.020)	10000	—
BK1608(0603)	0.8 (0.031)	4000	—
BK2125(0805)	0.85 (0.033)	—	4000
	1.25 (0.049)	—	2000
BK3216(1206)	0.8 (0.031)	—	4000

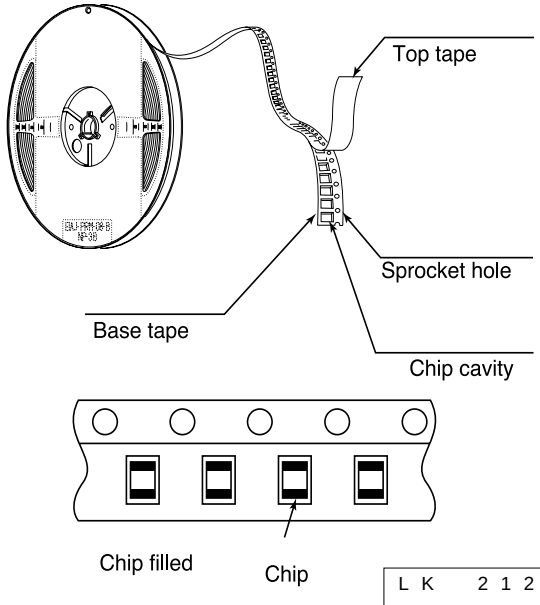
② Taping material

Card board carrier tape



L K	1 6 0 8
L K	3 2 1 6
B K	1 0 0 5
B K	1 6 0 8
H K	1 0 0 5
H K	1 6 0 8

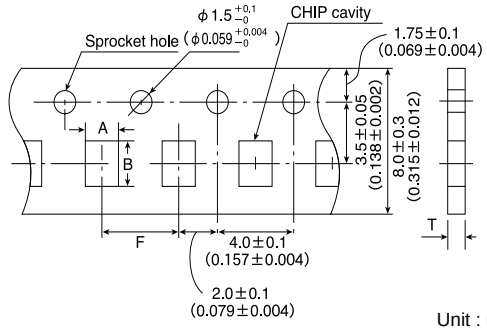
Embossed Tape



L K	2 1 2 5
L K	3 2 1 6
B K	2 1 2 5
B K	3 2 1 6
H K	2 1 2 5

③ Taping Dimensions

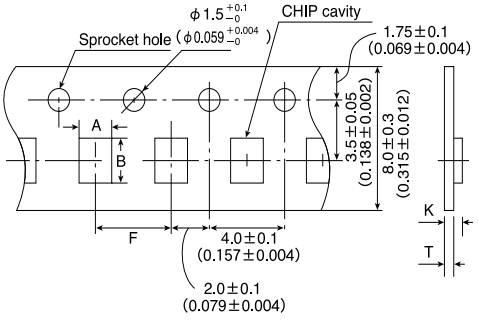
・ Paper tape (0.312 inches wide)



Unit : mm (inch)

Type	Chip Thickness	Chip cavity A	Chip cavity B	Insertion Pitch F	Tape Thickness T
LK1608(0603)	0.8 (0.031)	1.0±0.2 (0.039±0.008)	1.8±0.2 (0.071±0.008)	4.0±0.1 (0.157±0.004)	1.1max (0.043max)
LK3216(1206)	0.6 (0.024)	2.0±0.2 (0.079±0.008)	3.6±0.2 (0.142±0.008)		
HK1005(0402)	0.5 (0.020)	0.65±0.1 (0.026±0.004)	1.15±0.1 (0.045±0.004)	2.0±0.05 (0.079±0.002)	0.8max (0.031max)
HK1608(0603)	0.8 (0.031)	1.0±0.2 (0.039±0.008)	1.8±0.2 (0.071±0.008)	4.0±0.1 (0.157±0.004)	1.1max (0.043max)
BK1005(0402)	0.5 (0.020)	0.65±0.1 (0.026±0.004)	1.15±0.1 (0.045±0.004)	2.0±0.05 (0.079±0.002)	0.8max (0.031max)
BK1608(0603)	0.8 (0.031)	1.0±0.2 (0.039±0.008)	1.8±0.2 (0.071±0.008)	4.0±0.1 (0.157±0.004)	1.1max (0.043max)

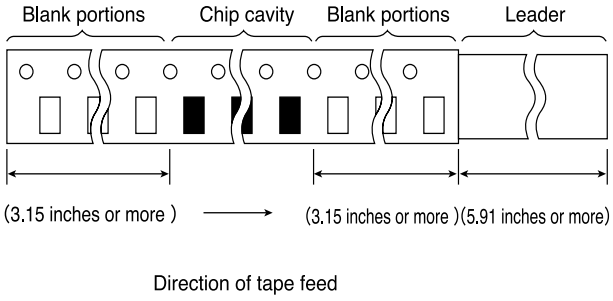
・ Embossed Tape (0.312 inches wide)



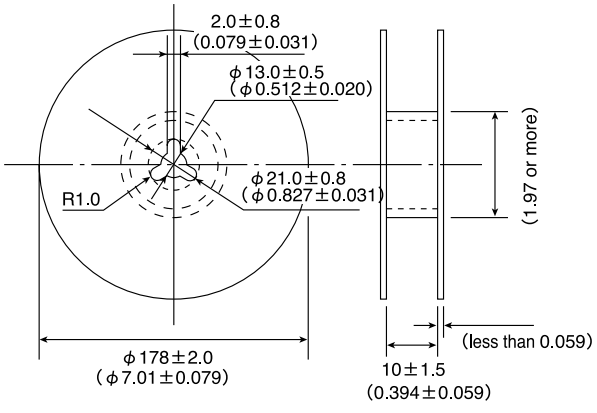
Unit : mm (inch)

Type	Chip Thickness	Chip cavity A	Chip cavity B	Insertion Pitch F	max. Tape Thickness K	T
LK2125(0805)	0.85 (0.033)	1.5±0.2 (0.059±0.008)	2.3±0.2 (0.091±0.008)	4.0±0.1 (0.157±0.004)	1.5 (0.059)	0.3 (0.012)
	1.25 (0.049)				2.0 (0.079)	
LK3216(1206)	1.1 (0.043)	2.0±0.2 (0.079±0.008)	3.6±0.2 (0.142±0.008)	4.0±0.1 (0.157±0.004)	2.0 (0.079)	0.3 (0.012)
HK2125(0805)	0.85 (0.033)	1.5±0.2 (0.059±0.008)	2.3±0.2 (0.091±0.008)	4.0±0.1 (0.157±0.004)	1.5 (0.059)	0.3 (0.012)
	1.0 (0.039)				2.0 (0.079)	
BK2125(0805)	0.85 (0.033)	1.5±0.2 (0.059±0.008)	2.3±0.2 (0.091±0.008)	4.0±0.1 (0.157±0.004)	1.5 (0.059)	0.3 (0.012)
	1.25 (0.049)				2.0 (0.079)	
BK3216(1206)	0.8 (0.031)	1.9±0.1 (0.075±0.004)	3.5±0.1 (0.138±0.004)	4.0±0.1 (0.157±0.004)	1.4 (0.055)	0.3 (0.012)

④ LEADER AND BLANK PORTION

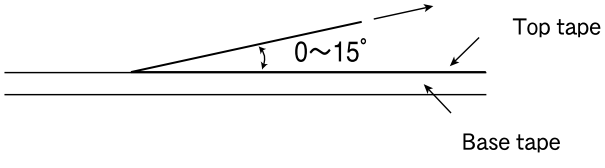


⑤ Reel Size



⑥ Top tape strength

The top tape requires a peel-off force of 0.1～0.7N in the direction of the arrow as illustrated below.

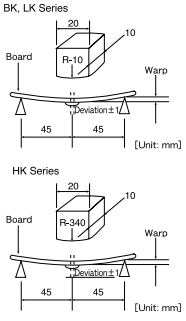


Multilayer chip inductors and beads

Item	Specified Value										Test Methods and Remarks
	BK1005	BK1608	BK2125	BK3216	LK1608	LK2125	LK3216	HK1005	HK1608	HK2125	
1.Operating Temperature Range	−55 to +125℃				−40 to +85℃			−55 to +125℃	−40 to +85℃		
2.Storage Temperature Range	−55 to +125℃				−40 to +85℃			−55 to +125℃	−40 to +85℃		
3.Rated Current	50 ,100mA DC	100 to 1000mA DC	150 to 1000mA DC	50 to 200mA DC	1 to 50mA DC	5 to 300mA DC	5 to 300mA DC	100 to 300mA DC	300mA DC		
4.Impedance	68 to 1000Ω ±25%	22 to 2500Ω ±25%	15 to 2500Ω ±25%	60 to 1000Ω ±25%	—	—	—	—		—	BK1005 Series: Measuring frequency: 100±1MHz Measuring equipment: HP4291A Measuring jig: 16192A BK1608, 2125 Series: Measuring frequency: 100±1MHz Measuring equipment: HP4291A, 4195A Measuring jig: 16092A or 16192A (HW) BK3216 Series: Measuring frequency: 100±1MHz Measuring equipment: HP4291A,4195A Measuring jig: 16192A
5. Inductance	—		—	—	0.047 to 33.0μH: ±20% 0.10 to 12.0μH: ±10%	0.047 to 33.0μH: ±20% 0.10 to 12.0μH: ±10%	0.047 to 33.0μH: ±20% 0.10 to 12.0μH: ±10%	1.0 to 5.6nH: ±0.3nH, 6.8 to 120nH: ±5%, 3.3 to 120nH:±10%	1.0 to 5.6nH: ±0.3nH 6.8 to 220nH: ±5% 3.3 to 220nH: ±10%	1.5 to 5.6nH: ±0.3nH 6.8 to 470nH: ±5% 3.3 to 470nH: ±10%	LK Series: Measuring frequency: 1 to 50 MHz (LK1608) Measuring frequency: 0.4 to 50MHz (LK2125,3216) Measuring equipment, jig: HP4194A + 16085B + 16092A (or its equivalent) HP4195A + 41951 -61001 + 16092A (or its equivalent) Measuring current: 1mA rms (0.047 to 4.7μH) 0.1mA rms (5.6 to 33μH) HK Series: Measuring frequency: 100MHz (HK1005) Measuring frequency: 50 / 100MHz (HK1608, 2125) Measuring equipment, jig: HP4291A + 16193A (HK1005) HP4195A + 16092A + in-house made jig (HK1608, 2125)
6.Q	—		—	—	10 to 35 min.	15 to 50 min.	20 to 50 min.	8 min.	8 to 12 min.	10 to 18 min.	LK Series: Measuring frequency: 1 to 50 MHz (LK1608) Measuring frequency: 0.4 to 50MHz (LK2125,3216) Measuring equipment, jig: HP4194A + 16085B + 16092A (or its equivalent) HP4195A + 41951 -61001 + 16092A (or its equivalent) Measuring current: 1mA rms (0.047 to 4.7μH) 0.1mA rms (5.6 to 33μH) HK Series: Measuring frequency: 100MHz (HK1005) Measuring frequency: 50 / 100MHz (HK1608, 2125) Measuring equipment, jig: HP4291A + 16193A(HK1005) HP4195A + 16092A + in-house made jig (HK1608, 2125)

* Definition of rated current : In the BK Series, the rated current is the value of current at which the temperature of the element is increased by 20℃.
In the LK and HK Series, the rated current is either the DC value at which the initial L value is decreased by 5% with the application of DC bias, or the value of current at which the temperature of the element is increased by 20℃.

Multilayer chip inductors and beads

Item	Specified Value										Test Methods and RemarKs
	BK1005	BK1608	BK2125	BK3216	LK1608	LK2125	LK3216	HK1005	HK1608	HK2125	
7.DC Resistance	0.25 to 1.5Ω max.	0.05 to 1.8Ω max.	0.05 to 0.8Ω max.	0.15 to 0.85Ω max.	0.3 to 2.95Ω max.	0.2 to 1.25Ω max.	0.15 to 1.05Ω max.	0.12 to 1.60Ω max.	0.05 to 1.5Ω max.	0.10 to 1.5Ω max.	BK Series: DC resistance between electrodes LK, HK Series: Measuring equipment: VOAC-7412 (made by Iwasaki Tsushinki) ・VOAC−7512(HK1608, 2125)
8.Self Resonance Frequency(SRF)	——		——	——	9 to 260MHz min.	13 to 320MHz min.	13 to 320MHz min.	600 to 10000 MHz min.	400 to 10000 MHz min.	200 to 4000 MHz min.	LK Series: Measuring equipment: HP4195A Measuring jig: 41951 - 69001 + 16092A (or its equivalent) HK Series: Measuring equipment: HP8719C ・HP8753D(HK2125)
9.Temperature Characteristic	——		——	——	——	——	——	Inductance change: Within ±10%	Inductance change: Within ±10%	Inductance change: Within ±10%	HK Series: Temperature range: -30 to +85℃ Reference temperature: +20℃
10. Resistance to Flexure of Substrate	No mechanical damage.	——	——	——	No mechanical damage.	No mechanical damage.	No mechanical damage.	No mechanical damage.	No mechanical damage.	No mechanical damage.	Warp: 2mm Testing board: glass epoxy-resin substrate Thickness: 0.8mm 

Multilayer chip inductors and beads

Item	Specified Value										Test Methods and Remarks
	BK1005	BK1608	BK2125	BK3216	LK1608	LK2125	LK3216	HK1005	HK1608	HK2125	
11.Solderability	At least 75% of terminal electrode is covered by new solder.				At least 75% of terminal electrode is covered by new solder.			At least 75% of terminal electrode is covered by new solder.			BK Series: Solder temperature: 230±5℃ Duration: 4±1 sec. Immersion speed: 25mm/sec. LK, HK Series: Solder temperature: 230±5℃ Duration: 4±1 sec. Preheating temperature: 150 to 180℃ Preheating time: 2 to 3 min. Flux: Immersion into methanol solution with colophony for 3 to 5 sec.
12.Resistance to Soldering	Appearance: No significant abnormality Impedance change: Within ±30%				No mechanical damage. Remaining terminal electrode: 70% min.			No mechanical damage. Remaining terminal electrode: 70% min.			BK Series: Solder temperature: 260±5℃ Duration: 10±0.5 sec. Preheating temperature: 150℃ Preheating time: 3 min. Immersion speed: 25 mm/sec. Recovery: 2 to 3 hrs of recovery under the standard condition after the test. (See Note 1) LK, HK Series: Solder temperature: 260±5℃ Duration: 10±0.5 sec. Preheating temperature: 150 to 180℃ Preheating time: 2 to 3 min. Flux: Immersion into methanol solution with colophony for 3 to 5 sec.
13.Thermal Shock	Appearance: No significant abnormality Impedance change: Within ±30%				No mechanical damage. Inductance change: Within ±10% Q change: Within ±30%			No mechanical damage. Inductance change: Within ±10% Q change: Within ±20%			BK Series: Conditions for 1 cycle step 1: -55 $^{+0}_{-3}$ ℃ 30±3 min. step 2: Room temperature 10 to 15 min. step 3: +125 $^{+3}_{-0}$ ℃ 30±3 min. step 4: Room temperature 10 to 15 min. Number of cycles: 5 Recovery: 2 to 3 hrs of recovery under the standard condition after the test. (See Note 1) LK Series: Conditions for 1 cycle / step 1: -25℃, 60 min. step 2: +85℃, 60 min. HK1608, 2125 Series: Conditions for 1 cycle / step 1: -40℃, 60 min. step 2: +85℃, 60 min. HK1005 Series: Conditions for 1 cycle / step 1: -55℃, 60 min. step 2: +125℃, 60 min. Number of cycles: 100

(Note 1) When there are questions concerning mesurement result : measurement shall be made after 48±2 hrs of recovery under the standard condition.

Multilayer chip inductors and beads

Item	Specified Value										Test Methods and RemarKs
	BK1005	BK1608	BK2125	BK3216	LK1608	LK2125	LK3216	HK1005	HK1608	HK2125	
14. Damp Heat (Steady state)	Appearance: No significant abnormality Impedance change: Within ±30%				No mechanical damage. Inductance change: Within ±10% Q change: Within ±30%			No mechanical damage. Inductance change: Within ±10% Q change: Within ±20%			BK Series: Temperature: 40±2℃ Humidity: 90 to 95%RH Duration: 500 $^{+24}_{0}$ hrs Recovery: 2 to 3 hrs of recovery under the standard condition after the removal from test chamber.(See Note1) LK, HK Series: Temperature: 40±2℃ (LK Series) 60±2℃ (HK Series) Humidity: 90 to 95%RH Duration: 500±12 hours Recovery: 1 to 2 hrs of recovery under the standard condition after the removal from test chamber.
15.Loading under Damp Heat	No mechanical damage, Inductance change：within±30%	——			No mechanical damage. Inductance change: 0.047 to 12.0μH: Within ±10% 15.0 to 33.0 μH: Within ±15% Q change: Within ±30%	No mechanical damage. Inductance change: Within ±10% Q change: Within ±30%		No mechanical damage. Inductance change: Within ±10% Q change: Within ±20%			BK1005 Series: Temperature: 40±2℃ (LK Series) Humidity: 90 to 95%RH Duration: 500 $^{+24}_{0}$ hrs Applied current: Rated current Recovery: 2 to 3 hrs of recovery under the standard condition after the removal from test chamber.(See Note1) LK, HK Series: Temperature: 40±2℃ (LK Series) 60±2℃ (HK Series) Humidity: 90 to 95%RH Duration: 500±12 hrs Applied current: Rated current Recovery: 1 to 2 hrs of recovery under the standard condition after the removal from test chamber.
16.Loading at High Temperature	Appearance: No significant abnormality Impedance change: Within ±30%				No mechanical damage. Inductance change: 0.047 to 12.0 μH: Within ±10% 15.0 to 33.0 μH: Within ±15% Q change: Within ±30%	No mechanical damage. Inductance change: Within ±10% Q change: Within ±30%		No mechanical damage. Inductance change: Within ±10% Q change: Within ±20%			BK Series: Temperature: 125±3℃ Applied current: Rated current Duration: 500 $^{+24}_{0}$ hrs Recovery: 2 to 3 hrs of recovery under the standard condition after the removal from test chamber.(See Note 1) LK, HK Series: Temperature: 85±2℃ (LK, HK Series) : 125±2℃ (HK 1005) Applied current: Rated current Duration: 500±12 hrs Recovery: 1 to 2 hrs of recovery under the standard condition after the removal from test chamber.

Note on standard condition: "standard condition" referred to herein is defined as follows:
5 to 35℃ of temperature, 45 to 85% relative humidity, and 86 to 106kPa of air pressure.
When there are questions concerning measurement results:
In order to provide correlation data, the test shall be conducted under condition of 20±2℃ of temperature, 65 to 70% relative humidity, and 86 to 106kPa of air pressure. Unless otherwise specified, all the tests are conducted under the "standard condition."

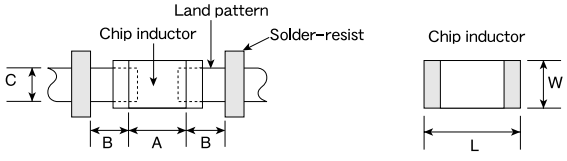
(Note 1)
measurement shall be made after 48±2 hrs of recovery under the standard condition.

Precautions on the use of Multilayer chip Inductors, Multilayer chip inductors for high frequency, Multilayer ferrite chip beads

<table>
<tr><th>Stages</th><th>Precautions</th><th>Technical considerations</th></tr>
<tr><td>1.1. Circuit Design</td><td>◆Verification of operating environment, electrical rating and performance
1. A malfunction in medical equipment, spacecraft, nuclear reactors, etc. may cause serious harm to human life or have severe social ramifications. As such, any inductors to be used in such equipment may require higher safety and/or reliability considerations and should be clearly differentiated from components used in general purpose applications.

◆Operating Current (Verification of Rated current)
1. The operating current for inductors must always be lower than their rated values.
2. Do not apply current in excess of the rated value because the inductance may be reduced due to the magnetic saturation effect.</td><td></td></tr>
<tr><td>2. PCB Design</td><td>◆Pattern configurations
(Design of Land-patterns)
1. When inductors are mounted on a PCB, the amount of solder used (size of fillet) can directly affect inductor performance. Therefore, the following items must be carefully considered in the design of solder land patterns:

(1) The amount of solder applied can affect the ability of chips to withstand mechanical stresses which may lead to breaking or cracking. Therefore, when designing land-patterns it is necessary to consider the appropriate size and configuration of the solder pads which in turn determines the amount of solder necessary to form the fillets.
(2) When more than one part is jointly soldered onto the same land or pad, the pad must be designed so that each component's soldering point is separated by solder-resist.</td><td>1. The following diagrams and tables show some examples of recommended patterns to prevent excessive solder amounts (larger fillets which extend above the component end terminations). Examples of improper pattern designs are also shown.

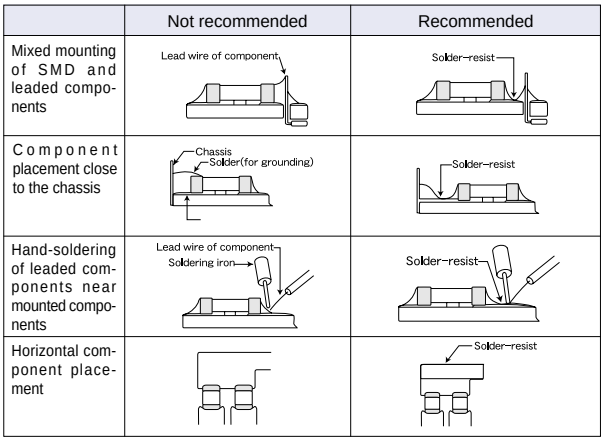
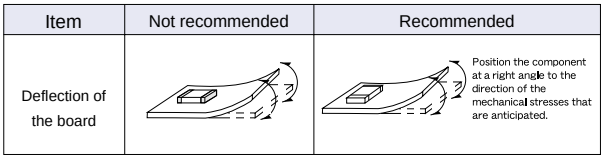
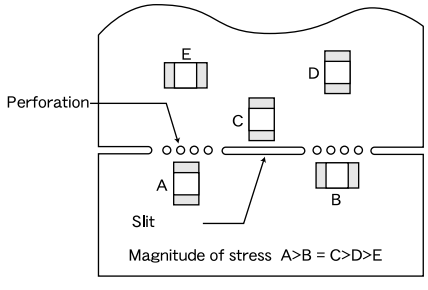
(1) Recommended land dimensions for a typical chip inductor land patterns for PCBs
 

Recommended land dimensions for wave-soldering (unit: mm)
<table>
<tr><th colspan="2">Type</th><th>1608</th><th>2125</th><th>3216</th></tr>
<tr><td rowspan="2">Size</td><td>L</td><td>1.6</td><td>2.0</td><td>3.2</td></tr>
<tr><td>W</td><td>0.8</td><td>1.25</td><td>1.6</td></tr>
<tr><td colspan="2">A</td><td>0.8～1.0</td><td>1.0～1.4</td><td>1.8～2.5</td></tr>
<tr><td colspan="2">B</td><td>0.5～0.8</td><td>0.8～1.5</td><td>0.8～1.7</td></tr>
<tr><td colspan="2">C</td><td>0.6～0.8</td><td>0.9～1.2</td><td>1.2～1.6</td></tr>
</table>

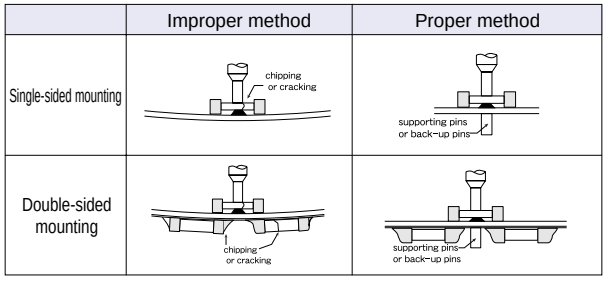
Recommended land dimensions for reflow-soldering (unit: mm)
<table>
<tr><th colspan="2">Type</th><th>1005</th><th>1608</th><th>2125</th><th>3216</th></tr>
<tr><td rowspan="2">Size</td><td>L</td><td>1.0</td><td>1.6</td><td>2.0</td><td>3.2</td></tr>
<tr><td>W</td><td>0.5</td><td>0.8</td><td>1.25</td><td>1.6</td></tr>
<tr><td colspan="2">A</td><td>0.45～0.55</td><td>0.6～0.8</td><td>0.8～1.2</td><td>1.8～2.5</td></tr>
<tr><td colspan="2">B</td><td>0.40～0.50</td><td>0.6～0.8</td><td>0.6～1.2</td><td>0.6～1.5</td></tr>
<tr><td colspan="2">C</td><td>0.45～0.55</td><td>0.6～0.8</td><td>0.9～1.6</td><td>1.2～2.0</td></tr>
</table>

Excess solder can affect the ability of chips to withstand mechanical stresses. Therefore, please take proper precautions when designing land-patterns.</td></tr>
</table>

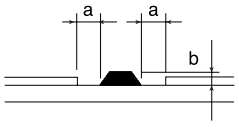
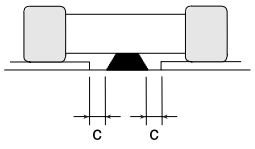
Precautions on the use of Multilayer chip Inductors, Multilayer chip inductors for high frequency, Multilayer ferrite chip beads

Stages	Precautions	Technical considerations
2.PCB Design	◆Pattern configurations (Inductor layout on panelized [breakaway] PC boards) 1. After inductors have been mounted on the boards, chips can be subjected to mechanical stresses in subsequent manufacturing processes (PCB cutting, board inspection, mounting of additional parts, assembly into the chassis, wave soldering the reflow soldered boards etc.) For this reason, planning pattern configurations and the position of SMD inductors should be carefully performed to minimize stress.	(2) Examples of good and bad solder application  1-1. The following are examples of good and bad inductor layout; SMD inductors should be located to minimize any possible mechanical stresses from board warp or deflection.  1-2. To layout the inductors for the breakaway PC board, it should be noted that the amount of mechanical stresses given will vary depending on inductor layout. An example below should be counted for better design.  1-3. When breaking PC boards along their perforations, the amount of mechanical stress on the inductors can vary according to the method used. The following methods are listed in order from least stressful to most stressful: push-back, slit, V-grooving, and perforation. Thus, any ideal SMD inductor layout must also consider the PCB splitting procedure.

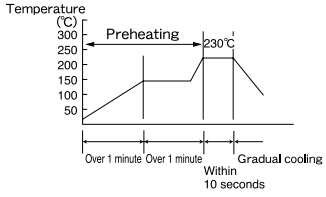
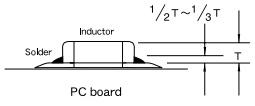
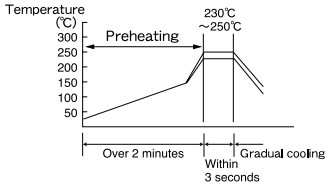
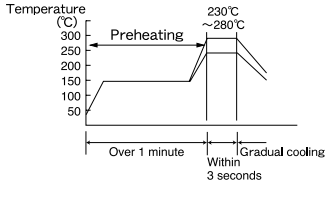
Precautions on the use of Multilayer chip Inductors, Multilayer chip inductors for high frequency, Multilayer ferrite chip beads

Stages	Precautions	Technical considerations
3.Considerations for automatic placement	◆Adjustment of mounting machine 1. Excessive impact load should not be imposed on the inductors when mounting onto the PC boards. 2. The maintenance and inspection of the mounter should be conducted periodically.	1. If the lower limit of the pick-up nozzle is low, too much force may be imposed on the inductors, causing damage. To avoid this, the following points should be considered before lowering the pick-up nozzle: (1)The lower limit of the pick-up nozzle should be adjusted to the surface level of the PC board after correcting for deflection of the board. (2)The pick-up pressure should be adjusted between 1 and 3 N static loads. (3)To reduce the amount of deflection of the board caused by impact of the pick-up nozzle, supporting pins or back-up pins should be used under the PC board. The following diagrams show some typical examples of good pick-up nozzle placement:  2. As the alignment pin wears out, adjustment of the nozzle height can cause chipping or cracking of the inductors because of mechanical impact on the inductors. To avoid this, the monitoring of the width between the alignment pin in the stopped position, and maintenance, inspection and replacement of the pin should be conducted periodically.
	◆Selection of Adhesives 1. Mounting inductors with adhesives in preliminary assembly, before the soldering stage, may lead to degraded inductor characteristics unless the following factors are appropriately checked; the size of land patterns, type of adhesive, amount applied, hardening temperature and hardening period. Therefore, it is imperative to consult the manufacturer of the adhesives on proper usage and amounts of adhesive to use.	1. Some adhesives may cause reduced insulation resistance. The difference between the shrinkage percentage of the adhesive and that of the inductors may result in stresses on the inductors and lead to cracking. Moreover, too little or too much adhesive applied to the board may adversely affect component placement, so the following precautions should be noted in the application of adhesives. (1)Required adhesive characteristics a. The adhesive should be strong enough to hold parts on the board during the mounting & solder process. b. The adhesive should have sufficient strength at high temperatures. c. The adhesive should have good coating and thickness consistency. d. The adhesive should be used during its prescribed shelf life. e. The adhesive should harden rapidly f. The adhesive must not be contaminated. g. The adhesive should have excellent insulation characteristics. h. The adhesive should not be toxic and have no emission of toxic gasses.

Precautions on the use of Multilayer chip Inductors, Multilayer chip inductors for high frequency, Multilayer ferrite chip beads

Stages	Precaution	Technical considerations
3.Considerations for automatic placement		When using adhesives to mount inductors on a PCB, inappropriate amounts of adhesive on the board may adversely affect component placement. Too little adhesive may cause the inductors to fall off the board during the solder process. Too much adhesive may cause defective soldering due excessive flow of adhesive on to the land or solder pad. [Recommended conditions] Figure / 2125/3216 case sizes as examples a / 0.3mm min b / 100 ～120 μm c / Area with no adhesive Amount of adhesives  After inductors are bonded 
4.Soldering	◆Selection of Flux 1. Since flux may have a significant effect on the performance of inductors, it is necessary to verify the following conditions prior to use; (1)Flux used should be with less than or equal to 0.1 wt% (Chlorine conversion method) of halogenated content. Flux having a strong acidity content should not be applied. (2)When soldering inductors on the board, the amount of flux applied should be controlled at the optimum level. (3)When using water-soluble flux, special care should be taken to properly clean the boards. ◆Soldering Temperature, time, amount of solder, etc. are specified in accordance with the following recommended conditions.	1-1. When too much halogenated substance (Chlorine, etc.) content is used to activate the flux, or highly acidic flux is used, an excessive amount of residue after soldering may lead to corrosion of the terminal electrodes or degradation of insulation resistance on the surface of the Inductor. 1-2. Flux is used to increase solderability in flow soldering, but if too much is applied, a large amount of flux gas may be emitted and may detrimentally affect solderability. To minimize the amount of flux applied, it is recommended to use a flux-bubbling system. 1-3. Since the residue of water-soluble flux is easily dissolved by water content in the air, the residue on the surface of Inductor in high humidity conditions may cause a degradation of insulation resistance and therefore affect the reliability of the components. The cleaning methods and the capability of the machines used should also be considered carefully when selecting water-soluble flux. 1-1. Preheating when soldering Heating: Chip inductor components should be preheated to within 100 to 130℃ of the soldering. Cooling: The temperature difference between the components and cleaning process should not be greater than 100 ℃. Chip inductors are susceptible to thermal shock when exposed to rapid or concentrated heating or rapid cooling. Therefore, the soldering process must be conducted with a great care so as to prevent malfunction of the components due to excessive thermal shock.

Precautions on the use of Multilayer chip Inductors, Multilayer chip inductors for high frequency, Multilayer ferrite chip beads

Stages	Precautions	Technical considerations
4.Soldering		Recommended conditions for soldering [Reflow soldering] Temperature profile  Caution 1. The ideal condition is to have solder mass (fillet) controlled to 1/2 to 1/3 of the thickness of the inductor, as shown below:  2. Because excessive dwell times can detrimentally affect solderability, soldering duration should be kept as close to recommended times as possible. [Wave soldering] Temperature profile  Caution 1. Make sure the inductors are preheated sufficiently. 2. The temperature difference between the inductor and melted solder should not be greater than 100 to 130℃ 3. Cooling after soldering should be as gradual as possible. 4. Wave soldering must not be applied to the inductors designated as for reflow soldering only. [Hand soldering] Temperature profile  Caution 1. Use a 20W soldering iron with a maximum tip diameter of 1.0 mm. 2. The soldering iron should not directly touch the inductor.
5.Cleaning	◆Cleaning conditions 1. When cleaning the PC board after the Inductors are all mounted, select the appropriate cleaning solution according to the type of flux used and purpose of the cleaning (e.g. to remove soldering flux or other materials from the production process.)	1. The use of inappropriate solutions can cause foreign substances such as flux residue to adhere to the inductor, resulting in a degradation of the inductor's electrical properties (especially insulation resistance).

Precautions on the use of Multilayer chip Inductors, Multilayer chip inductors for high frequency, Multilayer ferrite chip beads

Stages	Precautions	Technical considerations
5.Cleaning	2. Cleaning conditions should be determined after verifying, through a test run, that the cleaning process does not affect the inductor's characteristics.	2. Inappropriate cleaning conditions (insufficient or excessive cleaning) may detrimentally affect the performance of the inductors. (1)Excessive cleaning In the case of ultrasonic cleaning, too much power output can cause excessive vibration of the PC board which may lead to the cracking of the inductor or the soldered portion, or decrease the terminal electrodes' strength. Thus the following conditions should be carefully checked; Ultrasonic output Below 20 w/ℓ Ultrasonic frequency Below 40 kHz Ultrasonic washing period 5 min. or less
6. Post cleaning processes	◆Application of resin coatings, moldings, etc. to the PCB and components. 1. With some type of resins a decomposition gas or chemical reaction vapor may remain inside the resin during the hardening period or while left under normal storage conditions resulting in the deterioration of the inductor's performance. 2. When a resin's hardening temperature is higher than the inductor's operating temperature, the stresses generated by the excess heat may lead to inductor damage or destruction. 3. Stress caused by a resin's temperature generated expansion and contraction may damage inductors. The use of such resins, molding materials etc. is not recommended.	
7. Handling	◆Breakaway PC boards (splitting along perforations) 1. When splitting the PC board after mounting inductors and other components, care is required so as not to give any stresses of deflection or twisting to the board. 2. Board separation should not be done manually, but by using the appropriate devices. ◆General handling precautions 1. Always wear static control bands to protect against ESD. 2. Keep the inductors away from all magnets and magnetic objects. 3. Use non-magnetic tweezers when handling inductors. 4. Any devices used with the inductors (soldering irons, measuring instruments) should be properly grounded. 5. Keep bare hands and metal products (i.e., metal desk) away from chip electrodes or conductive areas that lead to chip electrodes. 6. Keep inductors away from items that generate magnetic fields such as speakers or coils. ◆Mechanical considerations 1. Be careful not to subject the inductors to excessive mechanical shocks. (1) If inductors are dropped on the floor or a hard surface they should not be used. (2)When handling the mounted boards, be careful that the mounted components do not come in contact with or bump against other boards or components.	

Precautions on the use of Multilayer chip Inductors, Multilayer chip inductors for high frequency, Multilayer ferrite chip beads

Stages	Precautions	Technical considerations
8. Storage conditions	◆Storage 1. To maintain the solderability of terminal electrodes and to keep the packaging material in good condition, care must be taken to control temperature and humidity in the storage area. Humidity should especially be kept as low as possible. Recommended conditions Ambient temperature Below 40 ℃ Humidity Below 70% RH The ambient temperature must be kept below 30 ℃. Even under ideal storage conditions inductor electrode solderability decreases as time passes, so inductors should be used within 6 months from the time of delivery. *The packaging material should be kept where no chlorine or sulfur exists in the air.	1. If the parts are stocked in a high temperature and humidity environment, problems such as reduced solderability caused by oxidation of terminal electrodes and deterioration of taping/packaging materials may take place. For this reason, components should be used within 6 months from the time of delivery. If exceeding the above period, please check solderability before using the inductors