Molded inductors manufacturing reject criteria

Introduction

Molded inductor is different than the other types of magnetic device in its construction. Molded inductors are manufactured by compressing the magnetic material in a mold around a conducting air coil using binder and or polymer to form a monolithic structure. Magnetic material used in this process is iron oxide powder. The compressed structure is cured in an oven to form a composite robust structure. The binder/polymer material acts as a distributed gap which enhances the magnetic performance. The propitiatory binder/polymer composition used on our products encapsulates the iron oxide powder, this help stop our parts from oxidizing in presence of moisture.

Purpose of this document is to help understand what kind of visual regularity may exist in the molded inductor products that TTelectronic has to offer. These cosmetic irregularities are inherent to special manufacturing process used to produce molded inductor.

This document will cover all types of surface irregularities that can be seen on the parts and the criteria that were used to reject the part in the quality inspection process. Tests were performed to validate the rejection criteria set in the document. The entire set of tests performed was according to AEC-Q200 standards involving operational life, mechanical shock and vibration tests. These tests results have shown that the visual imperfection that were present on the surface of the part and were accepted using our criteria does not affect functionality, reliability and performance of the molded inductors.

This document describes reject criteria and tests performed to verify electrically and visually that there was not change in the product after the tests. Products used for this study were HM72/HA72 series.

Reject criteria

Most cosmetic surface irregularity that may have occurred during manufacturing process and handling of the parts are broadly grouped in two categories namely chips and cracks.

Chips

Chips are regarded as surface irregularities that are caused by handling of parts in manufacturing process where piece of molded part detached from the main body. Figure 1 shows different location where chips can occur. Chips may occur on Top/Bottom surface area (TSA/BSA), on body side surface (BSS) and corner area (CA). Table 1 shows the chip acceptance criteria. Chips on all three area of the body are acceptable if they are less than 1/3rd of the length of the area where the chips are located. Figure 2 shows a part where it is divided into 1/3rd using blue grids. Blue circle shows chip that are acceptable and red circle shows a chip that is rejected during quality inspection process for all the figures shown as examples.

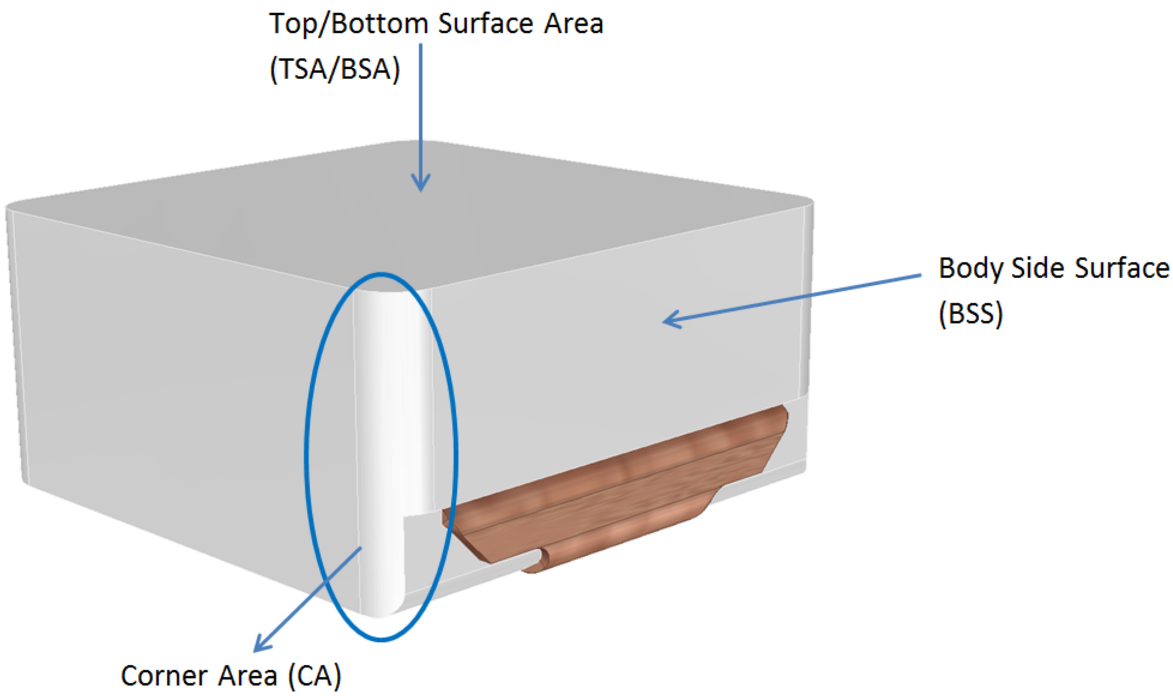


Figure 1: Different locations where chips can occur

Table 1: Chips acceptance criteria

Area on the part	**Acceptance criteria**
TSA/BSA	Less than 1/3 of length
BSS	Less than 1/3 of length
CA	Less than 1/3 of thickness

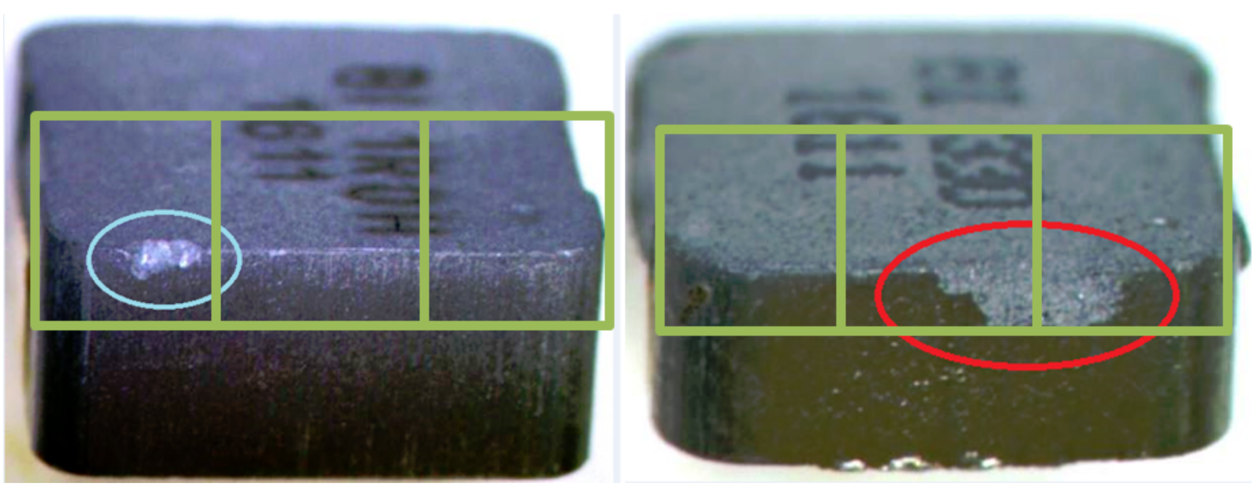


Figure 2: Accepted (blue circle) and rejected (red circle) part with green partition cubes covering 1/3 of the part.

Figure 3, 4 and 5 shows example of accepted and rejected parts for chips during final quality inspection for Top surface area, bottom surface area, body side surface area and corner area.

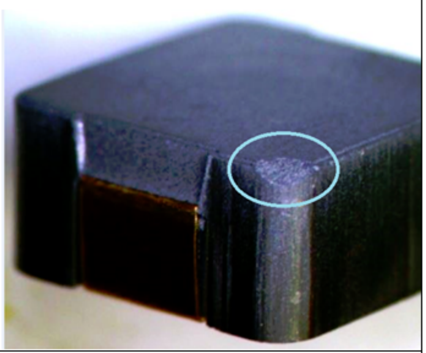
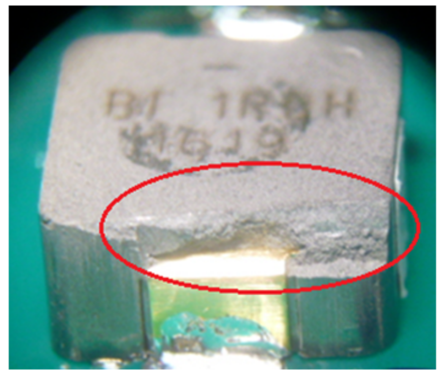
	ACCEPT	REJECT
Top Surface Area (TSA)	 	

Figure 3: Top/Bottom Surface Area (TSA/BSA) chips accept and reject example

	ACCEPT	REJECT
Body Side Surface (BSS)		

Figure 4: Body Side Surface Area (BSS) chips accept and rejects example

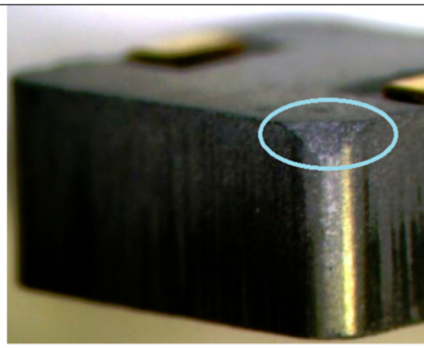
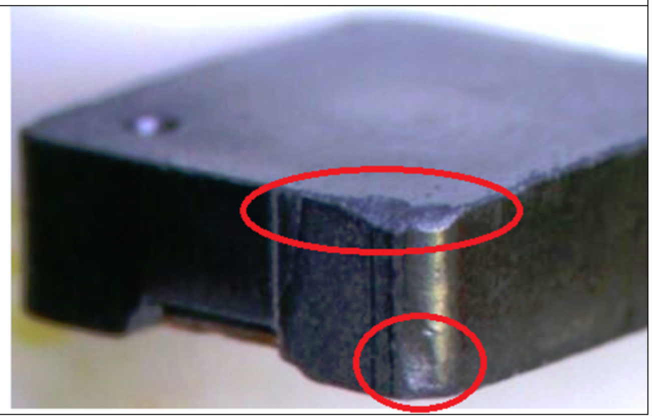
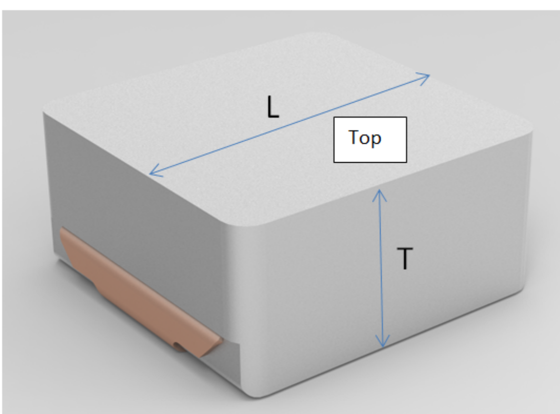
	ACCEPT	REJECT
Corner Area (CA)		

Figure 5: Corner Area (CA) chips accept and rejects example

Cracks

A crack on the outer surface of the part and around the terminal occurs when the parts are removed from the mold or during curing process. These minor and moderate cracks are measured to make sure that they fall within the acceptance criteria. Cracks may occur across the length or width of the part on the top and bottom surface or on the sides for the part, which is shown in Figure 6. Acceptance criteria for cracks are shown below in Table 2. Cracks on the top and bottom surface should be less than 50% of the length of the part for it to be acceptable. If cracks are diagonal same less than 50% of length rule applies. Cracks on the four sides should be less than 50% of the thickness of the part.



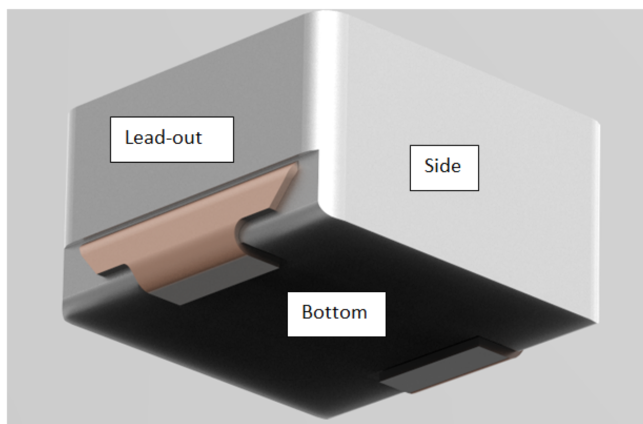


Figure 6: Different locations where cracks can occur

Table 2: Cracks acceptance criteria

Dimension	Acceptance criteria
L	Less than 50% of length, L
T	Less than 50% of thickness, T

Figure 7, 8 and 9 shows example of accepted and rejected parts for cracks during final quality inspection for Top surface area, bottom surface area, side and lead out area. Blue circle shows cracks that are acceptable and red circle shows cracks that are rejected during quality inspection process for all the figures shown as examples.

<table>
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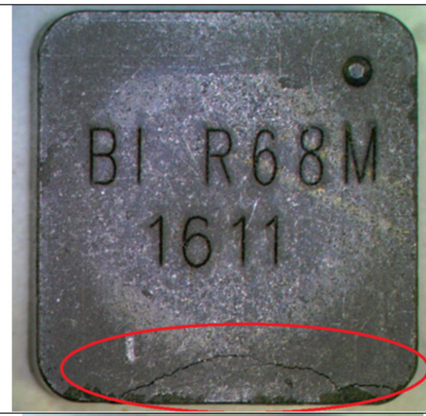
</td><td>
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Figure 7: Top area cracks accept and rejects examples

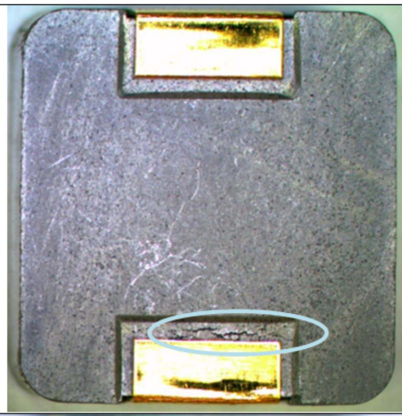
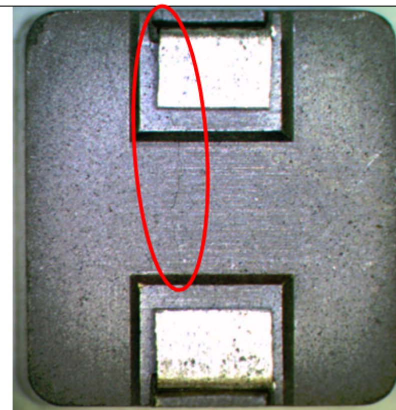
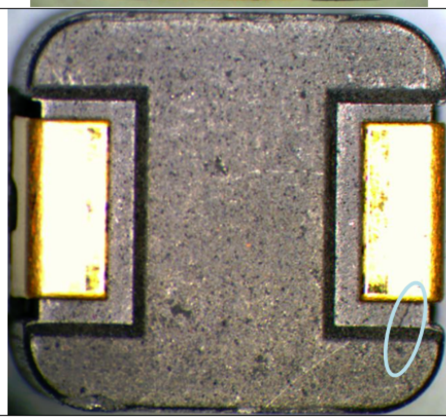
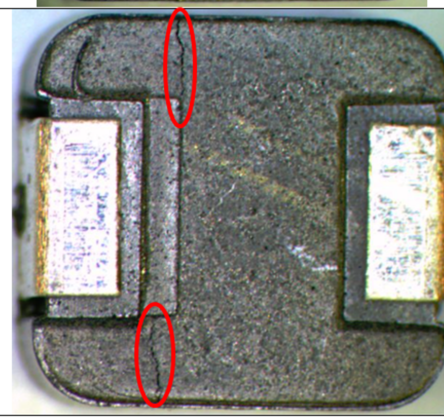
	ACCEPT	REJECT
Bottom		
		

Figure 8: Bottom area cracks accept and rejects examples

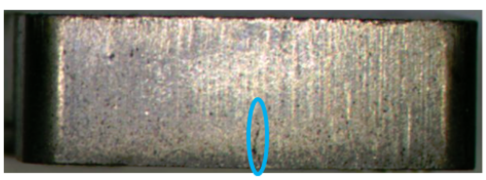
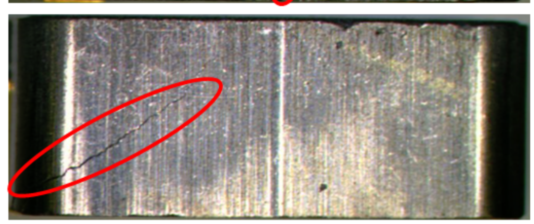
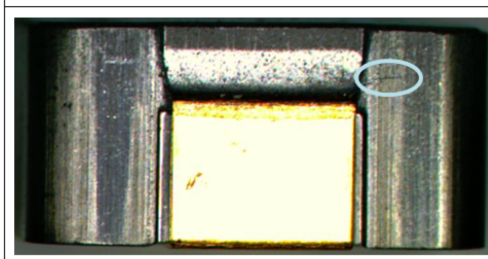
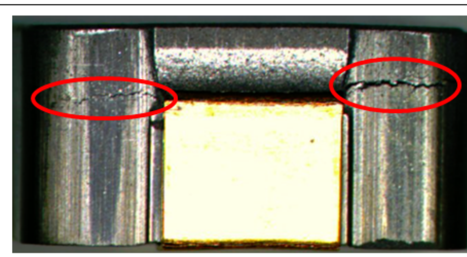
	ACCEPT	REJECT
Side Lead-out	 	 
		

Figure 9: Side and Lead-out area cracks accept and reject examples

Reliability Test

To evaluate the effect of continuous use on the products that had visual artifacts tests in table 3 were performed. Sample size for these tests was 77 for operational life test, 30 each for mechanical shock and vibration. Both size 06 (7.23mm x 6.8mm x 3mm) and 12 (13mm x 13.95mm x 6.5mm) parts were used for separate reliability tests to evaluate both package size. Test method and reference for the test are shown in the table 3. Before and after the tests were performed electrical data was collected and images were taken to see the effect of reliability test on the parts. Electrical measurements included inductance measured at 100 kHz, 0.1V and 25°C and DC resistance measured at 25°C.

Table 3: Tests performed

Test method for MAGNETICS (INDUCTORS/TRANSFORMERS)				
NO.	**Stress**	**Test Method/ Condition**	**References**	**Sample Size**
1	Operational Life	1000 hrs. Measurement at 24±4 hours after test conclusion.	MIL-PRF-27	77
2	Mechanical Shock	Figure 1 of method 213. Condition C	MIL-STD-202 Method 213	30
3	Vibration	5 G's for 20 minutes, 12 cycles each of 3 orientations. Test from 10-2000Hz.	MIL-STD-202 Method 204	30

On inductance measurement recorded before and after the operational life test there was decrease of 1.48% for the size 06 and decrease of 1.24% for size 12 parts. On resistance measurement recorded before and after the operational life test there was increase of 1.24% for the size 06 and increase of 3.12% for size 12 parts. This shows that there is very less migration of electrical parameters on the parts with acceptable amount of cosmetic artifacts and it is well with the tolerance of the part. After visual inspection of the parts it was observed that there was no propagation and widening of cracks and chips. Detailed report can be provided for reliability test upon request. Similar reliability tests were done to parts that marginally fell outside our acceptance criteria. These parts showed less than 1.78% variation in electrical parameter and no propagation and widening of crack and chips. This indicates that acceptance criteria we have set forth in this document will make sure that the product that we deliver to our customers are reliable and will be no different that the parts with no visible artifacts in terms of functionality, reliability and performance.