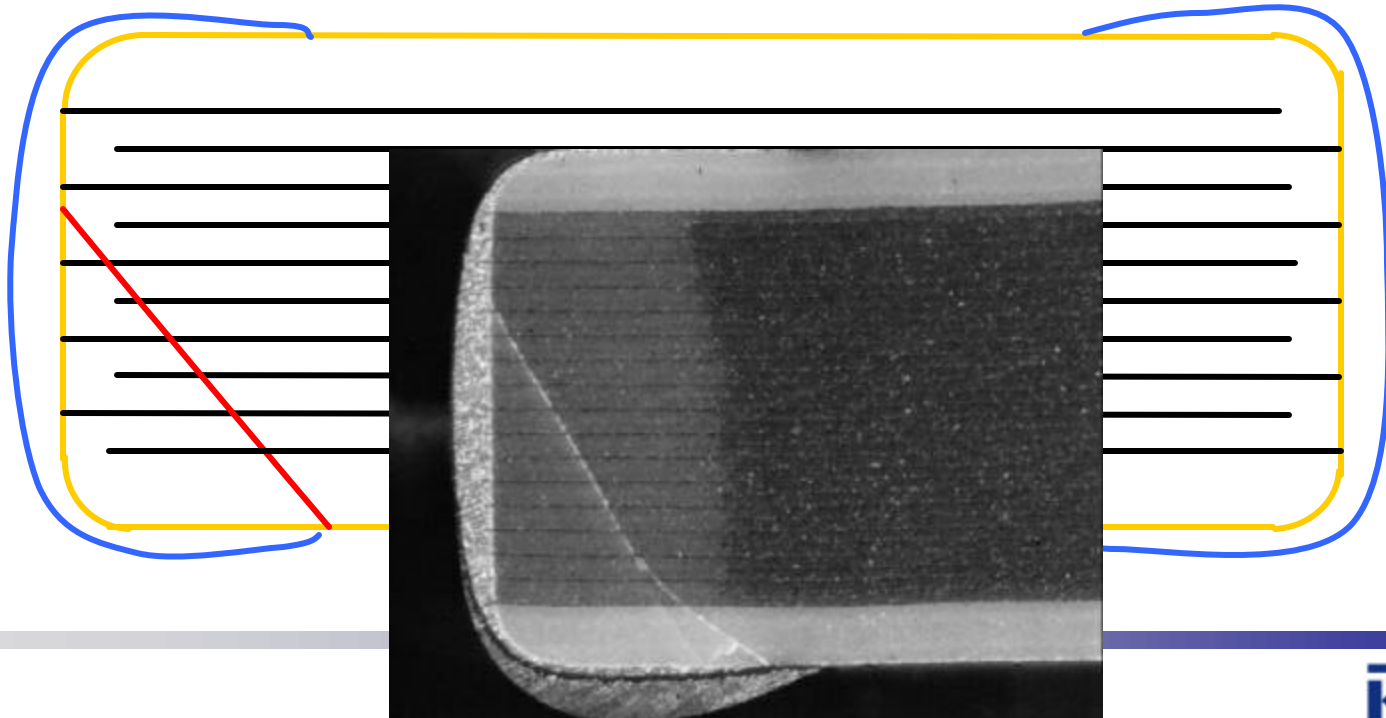


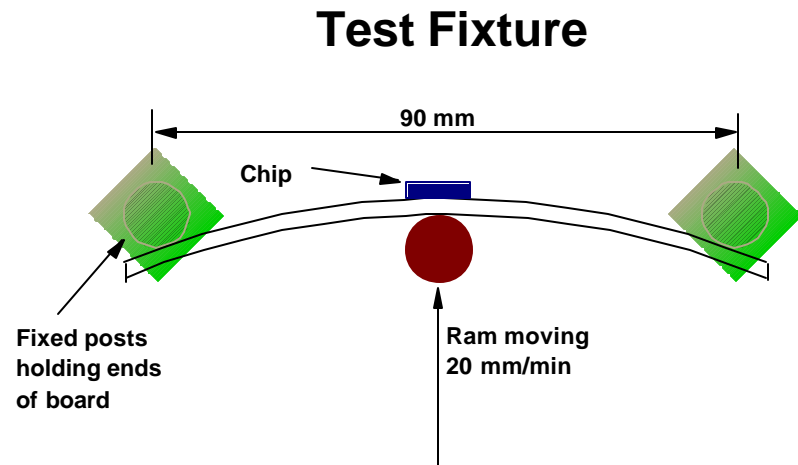
# Flex Performance

- Flex Cracks are created when a physical displacement generates sufficient stress within the ceramic body to fracture the ceramic material.
- Pb-Free soldering systems are less ductile resulting in industry concern about the effects on flex performance.



# Flex Test Procedure

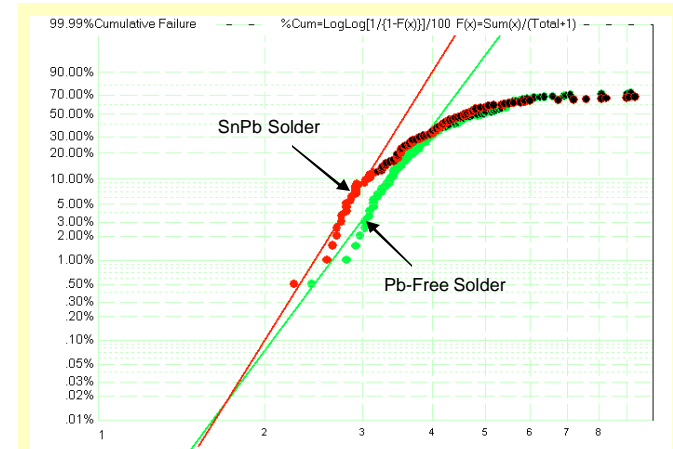
- Parts mounted on test boards
- Flex at a rate of 1 mm/Second, to a maximum of 10 mm.
- Capacitance continually monitored.
- Continue to crack detection, defined as a 2% capacitance change.



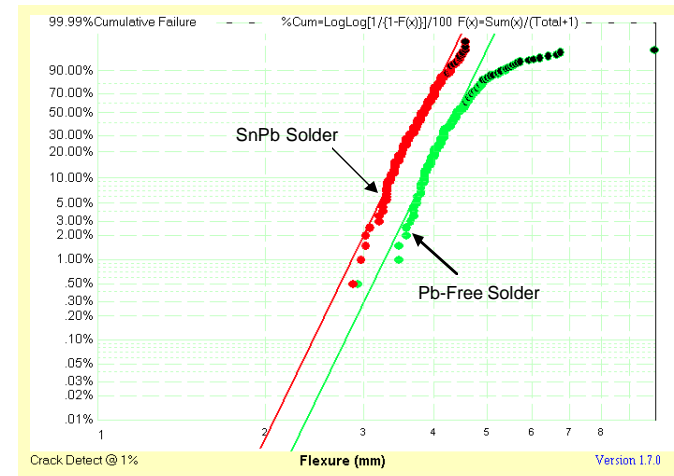
# Individual Part Results

- The calculated failure rate line is generated using the lower end of the Weibull distribution.
- This line is used to predict the expected failure rate at a given displacement.
- The calculated failure rate line is also used to calculate the amount of flex required for 1 PPM, 10 PPM, and 100 PPM failure rates.

0603C224K4RAC



0805C224J3RAB



# Comparative Flex Test Results



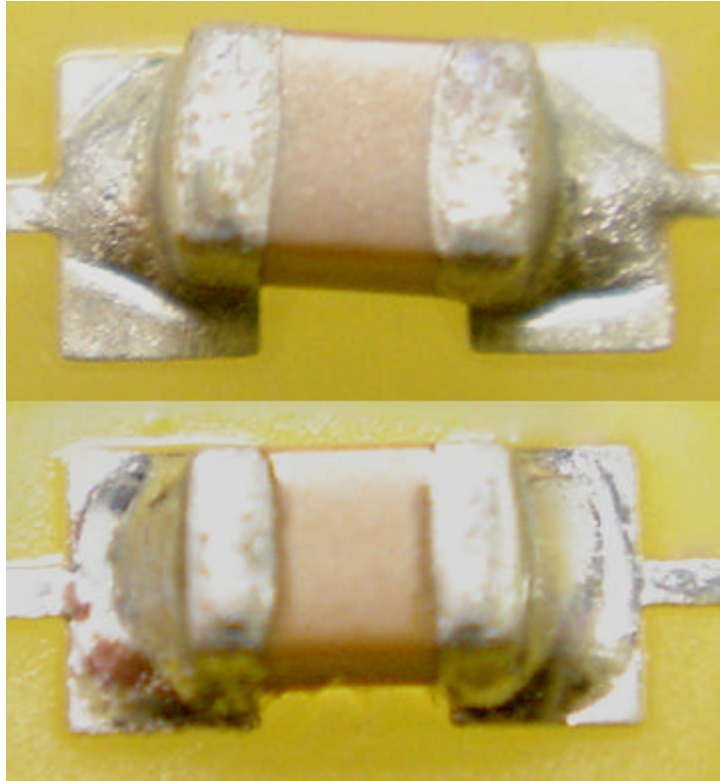
- Red arrows point to instances of one solder having a clear advantage over the other.
  - Findings don't support prediction that Pb-Free solders will always result in an increased failure rate at a given displacement.
  - Only in half the trials we see an improvement of one soldering system over another.

## Pb vs. Pb-Free (Flex)

PN	Solder	Pcs	Level	RR (%)	Flex @ 1mm FR	Flex @ 2mm FR	Flex @ 3mm FR
0603C224K5RAC	SnPb	193	0.5%	94.05	<1 PPM	0.1%	8.9%
	PbFree	194		97.11	1 PPM	755 PPM	3.6%
0805C224J3RAB	SnPb	200	1.0%	98.33	<1 PPM	61 PPM	2.0%
	PbFree	199		96.40	<1 PPM	→9 PPM	→0.3%
1206C822K1RAC	SnPb	198	1.0%	96.39	→<1 PPM	→0.19%	82%
	PbFree	197		97.13	16 PPM	0.90%	→31%
1206C104J4RAB	SnPb	200	1.0%	98.56	→16 PPM	43.6%	90%
	PbFree	200		97.89	37 PPM	→28.2%	92%
1812C474K5RAB	SnPb	200	1.0%	98.00	806 PPM	40.0%	93%
	PbFree	197		98.28	→2 PPM	→8.6%	93%

# Pb-Free Flex Test Conclusion

- Pad Size has a direct impact on flex performance.
- A smaller pad has better flex capability.
- Pb-Free solders do not flow as well as SnPb solders, reducing the effective pad size.
- The difference in fillets may have a larger impact on flex performance than the ductility of the solder.



Pb-Free

SnPb