



# Tin Whisker Monitoring Final Report



# Tin Whisker Monitoring

## ➤ REFERENCE SPECIFICATION

- External Specifications: JESDA121 and JESD201
- SCS PECN: QR090023WI and QR090030QP

## ➤ METHOD

- Measuring technique
- Measuring point



## ➤ TEST CONDITIONS

REL TEST	Precond	Sample Size	Test Conditions	Readout Point
Ambient Storage	Per JEDEC	6	30(+/-2) °C, 60(+/-3) %RH (L3)	0, 1000, 3000hrs
Temp Cycling (TC)	Specs	6	-55(+0/-10) °C, 85(+10/-0) °C Soak Mode 2 (5min-10min): ~ 2 to 3 cycles per hour	0, 1000x
Temperature/Humidity		6	60(+/-5) °C, 87(+3/-2) %RH(*)	0, 1000, 3000hrs

### FOR LQFP (Leaded):

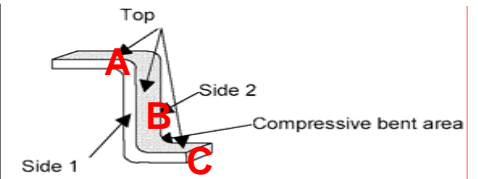
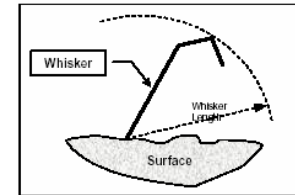
Top-A / Top-B / Top-C / Side-1 / Side-2 / Compressive Bend3

### FOR QFNp (Leadless):

Top-A / Top-B (Front)

### FOR PLCC (Gull Wing):

Top-A / Top-B (Front) / Side-1 / Side-2



Measuring technique & TH used per JESDA121 (more stringent). Measuring technique & TH per JESD201 shall be used for subsequent monitoring.

Underplate Process or Post Bake Process			A (no precondition)
			C (SnPb reflow)
			D (Pb-free reflow)
Condition	Preconditioning Temperature Exposure	Thermal Profile Exposure	Use Guidelines
A	None	Normal ambient exposure	Intended to test for whisker growth under ambient temperature/humidity storage.
B	Room temperature storage for a minimum of 4 weeks after the finish is applied	15 -30 °C 30 – 80% RH	Intended for samples without under-plating or post bake mitigation before exposure to high temperature/humidity storage, temperature cycling or preconditioning per conditions C or D.
C	Sn-Pb Temperature Preconditioning	Sn-Pb profile per clause 5.1.2.1	Intended to test for whisker growth after thermal exposure to Sn-Pb SMT assembly temperatures (backward compatibility).
D	Pb-free Temperature Preconditioning	Pb-free profile per clause 5.1.2.1	Intended to test for whisker growth after thermal exposure to Pb-free SMT assembly temperatures (Pb-free compatibility).

- ✓ A/R Criteria: <50um max whisker length (Generic); Subjected to specific customer requirements
- ✓ Yearly Monitoring on 3 packages. Half yearly monitoring upon request.
- ✓ Completed Tin Whisker monitor for 2006
  - MQFP 14x14x1.4 100L
  - LQFP-EP 20x20x1.4 164L
  - TSSOP 9.7x4.4x0.9 28L
  - QFNp 9x9x0.85 64L



# Tin Whisker Monitoring Schedule

Pkg	pre-con type	pre-inspection	TC			TH			Amb		
			500x	1000x	1500x	1000	3000	4000	1000	3000	4000
			Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned
<b>MQFP</b> (14x14x1.4 100L)	No reflow	<b>Completed</b>	11-Jan-06	11-Apr-06	18-May-06	28-Jan-06	23-Jun-06	28-Sep-06	5-Mar-06	31-Jul-06	27-Nov-06
	Sn-Pb		28-Feb-06	14-May-06	2-Jun-06	9-Feb-06	26-Jul-06	12-Nov-06	17-Mar-06	30-Aug-06	17-Dec-06
	Pb free		17-Mar-06	5-May-06	11-Jun-06	21-Feb-06	23-Jul-06	7-Nov-06	29-Mar-06	28-Sep-06	6-Jan-07
<b>LQFP-EP</b> (20x20x1.4 164L)	No reflow		14-Jan-06	14-Apr-06	21-May-06	31-Jan-06	26-Jun-06	3-Oct-06	8-Mar-06	5-Aug-06	2-Dec-06
	Sn-Pb		5-Mar-06	26-Apr-06	24-May-06	12-Feb-06	8-Jul-06	23-Oct-06	20-Mar-06	25-Aug-06	22-Dec-06
	Pb free		15-Mar-06	8-May-06	14-Jun-06	24-Feb-06	20-Jul-06	8-Oct-06	1-Apr-06	14-Sep-06	11-Jan-07
<b>TSSOP</b> (9.7x4.4x0.9 28L)	No reflow		17-Jan-06	17-Apr-06	30-May-06	3-Feb-06	29-Jun-06	8-Oct-06	11-Mar-06	10-Aug-06	7-Dec-06
	Sn-Pb		6-Mar-06	29-Apr-06	5-Jun-06	15-Feb-06	11-Jul-06	28-Oct-06	23-Mar-06	15-Aug-06	27-Dec-06
	Pb free		18-Mar-06	11-May-06	17-Jun-06	27-Feb-06	17-Jul-06	17-Nov-06	4-Apr-06	19-Sep-06	16-Jan-07
<b>QFNp</b> (9x9x0.85 64L)	No reflow	25-Feb-06	20-Apr-06	27-May-06	6-Feb-06	2-Jul-06	13-Oct-06	14-Mar-06	20-Aug-06	12-Dec-06	
	Sn-Pb	9-Mar-06	2-May-06	8-Jun-06	18-Feb-06	14-Jul-06	2-Nov-06	26-Mar-06	4-Sep-06	1-Jan-07	
	Pb free	21-Mar-06	23-Apr-06	20-Jun-06	2-Mar-06	5-Jul-06	22-Nov-06	7-Apr-06	9-Sep-06	21-Jan-07	

 : Completed



## Tin Whisker Monitoring Result

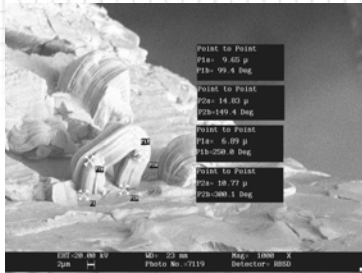
Pkg	pre-con type	MAX Whisker Length (um)								
		TC			TH			Amb		
		500x	1000x	1500x	1000hrs	3000hrs	4000hrs	1000hrs	3000hrs	4000hrs
<b>MQFP</b> (14x14x1.4 100L)	No reflow	24.57	26.70	42.14	No Whisker	No Whisker	26.50	No Whisker	7.00	No Whisker
	Sn-Pb	9.54	24.98	25.94	11.58		No Whisker		9.25	No Whisker
	Pb free	16.45	19.73	21.36	9.69		No Whisker		No Whisker	13.05
<b>LQFP-EP</b> (20x20x1.4 164L)	No reflow	15.82	36.89	34.33	No Whisker	No Whisker	No Whisker	No Whisker	No Whisker	No Whisker
	Sn-Pb	18.89	25.30	25.71						
	Pb free	16.66	20.98	16.19						
<b>TSSOP</b> (9.7x4.4x0.9 28L)	No reflow	16.27	32.48	32.04	17.61	27.59	18.88	No Whisker	No Whisker	No Whisker
	Sn-Pb	12.07	15.45	22.22	No Whisker	19.31	7.38		24.77	
	Pb free	14.24	24.98	16.46	No Whisker	No Whisker	No Whisker		12.05	
<b>QFNp</b> (9x9x0.85 64L)	No reflow	No Whisker	7.68	17.60	No Whisker	14.52	29.35	No Whisker	No Whisker	No Whisker
	Sn-Pb	9.51	15.58	14.90	9.14	29.39	44.13			11.69
	Pb free	7.46	10.41	14.47	No Whisker	29.30	44.06			17.43

### Equipment:

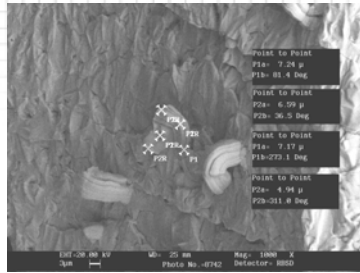
- ESPEC TSE-11-A Temp Cycle Chamber
- ESPEC Taibai LHL-113 Temp Humd Chamber



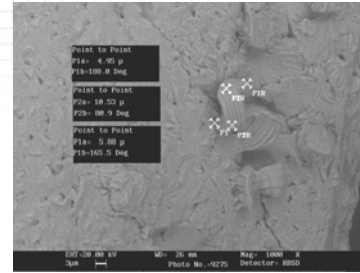
# Tin Whisker Monitoring Result (TC 1500x SEM Images)



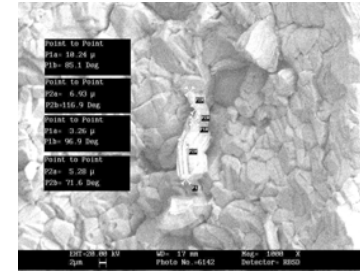
MQFP (No reflow)  
MAX Whisker : 42.14um



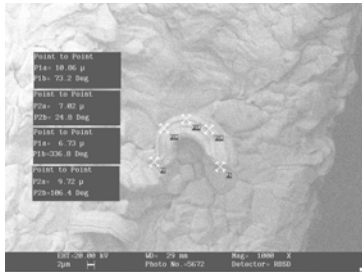
MQFP (Sn-Pb reflow)  
MAX Whisker : 25.94um



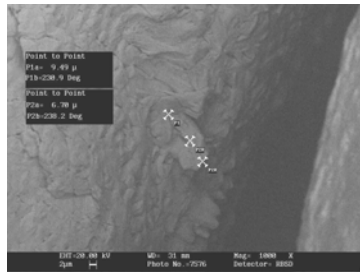
MQFP (PB-free reflow)  
MAX Whisker : 21.36um



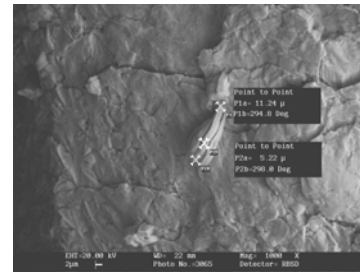
LQFP (Sn-PB reflow)  
MAX Whisker : 25.71um



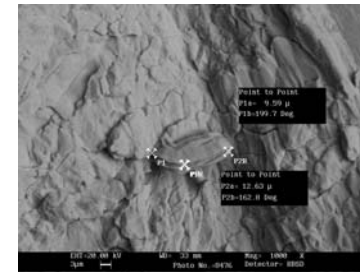
LQFP (No reflow)  
MAX Whisker : 34.33um



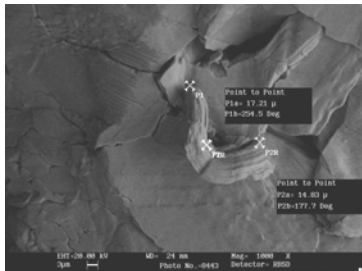
LQFP (Pb-free reflow)  
MAX Whisker : 16.19um



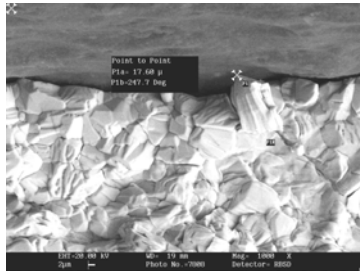
TSSOP (PB-free reflow)  
MAX Whisker : 16.46um



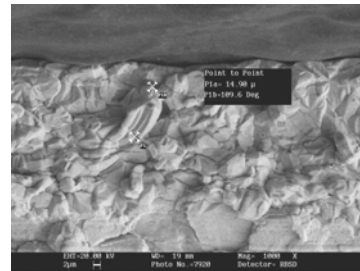
TSSOP (Sn-Pb reflow)  
MAX Whisker : 22.22um



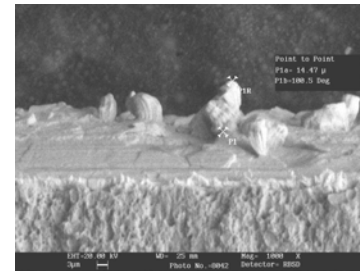
TSSOP (No reflow)  
MAX Whisker : 32.04um



QFNp (No reflow)  
MAX Whisker : 17.60um



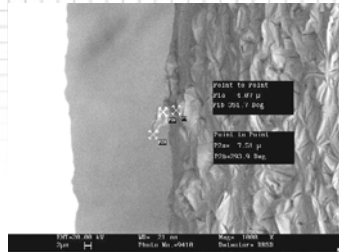
QFNp (Sn-Pb reflow)  
MAX Whisker : 14.90um



QFNp (Pb-free reflow)  
MAX Whisker : 14.47um

# Tin Whisker Monitoring Result (SEM Images)

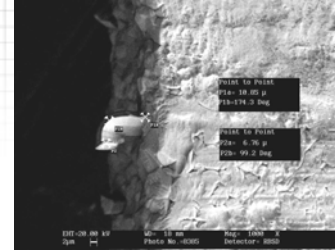
❖ TH1000hrs



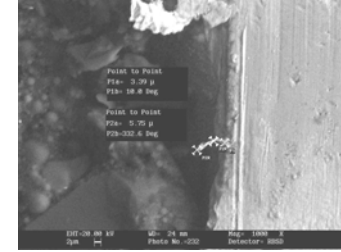
MQFP (Sn-Pb reflow)  
MAX Whisker : 11.58um



MQFP (PB-free reflow)  
MAX Whisker : 9.69um

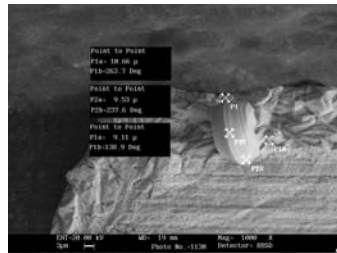


TSSOP (No reflow)  
MAX Whisker : 17.61um

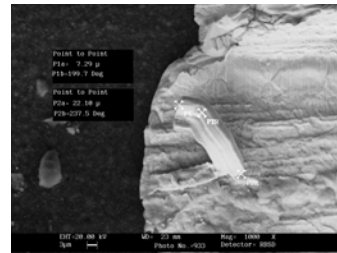


QFNp (Sn-Pb reflow)  
MAX Whisker : 9.14um

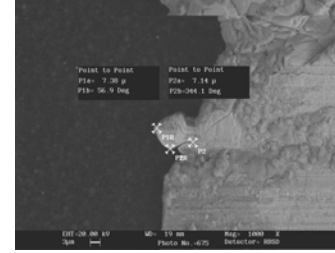
❖ TH3000hrs



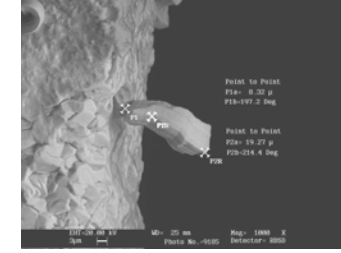
QFNp (Pb-free reflow)  
MAX Whisker : 29.30um



QFNp (Sn-PB reflow)  
MAX Whisker : 29.39um

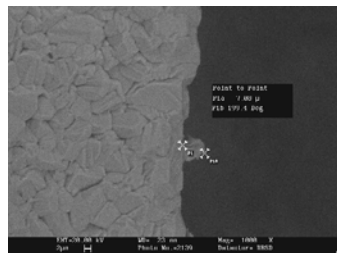


QFNp (No reflow)  
MAX Whisker : 14.52um

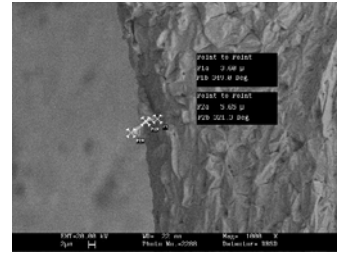


QFNp (No reflow)  
MAX Whisker : 27.59um

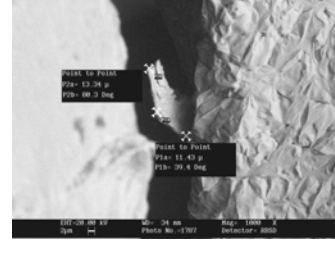
❖ AMB3000hrs



MQFP (No reflow)  
MAX Whisker : 7.00um



MQFP (Sn-Pb reflow)  
MAX Whisker : 9.25um



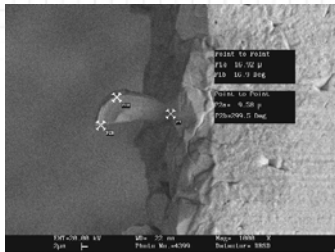
TSSOP (Sn-Pb reflow)  
MAX Whisker : 24.77um



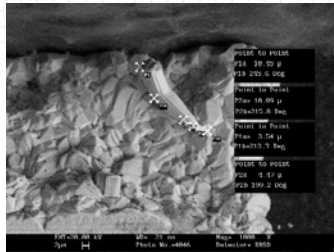
TSSOP (Pb-free reflow)  
MAX Whisker : 12.05um

# Tin Whisker Monitoring Result (SEM Images)

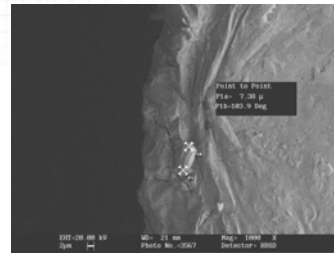
❖ TH4000hrs



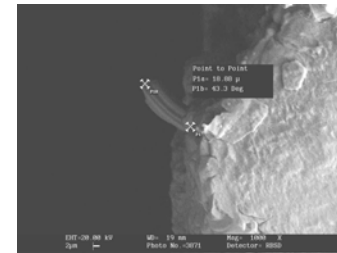
MQFP(No reflow)  
MAX Whisker : 26.50um



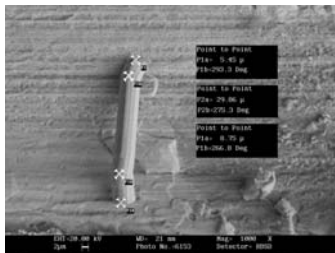
QFNp(No reflow)  
MAX Whisker : 29.35um



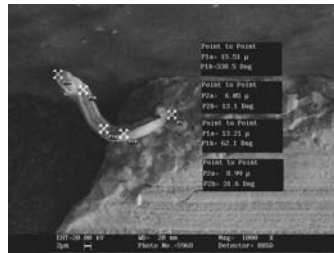
TSSOP(Sn-Pb reflow)  
MAX Whisker : 7.38um



TSSOP(No reflow)  
MAX Whisker : 18.88um

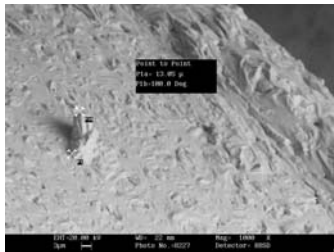


QFNp(Pb-free reflow)  
MAX Whisker : 44.06um

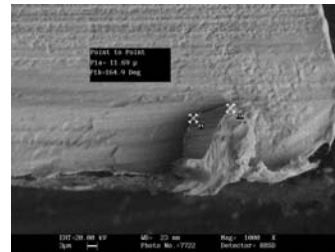


QFNp(SnPb reflow)  
MAX Whisker : 44.13um

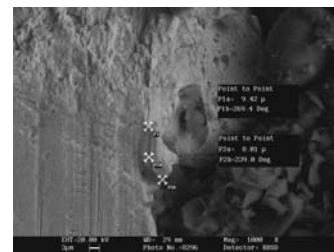
❖ Amb4000hrs



MQFP(Pb-free reflow)  
MAX Whisker : 13.05um



QFNp(SnPb reflow)  
MAX Whisker : 11.69um



QFNp(Pb-free reflow)  
MAX Whisker : 17.43um



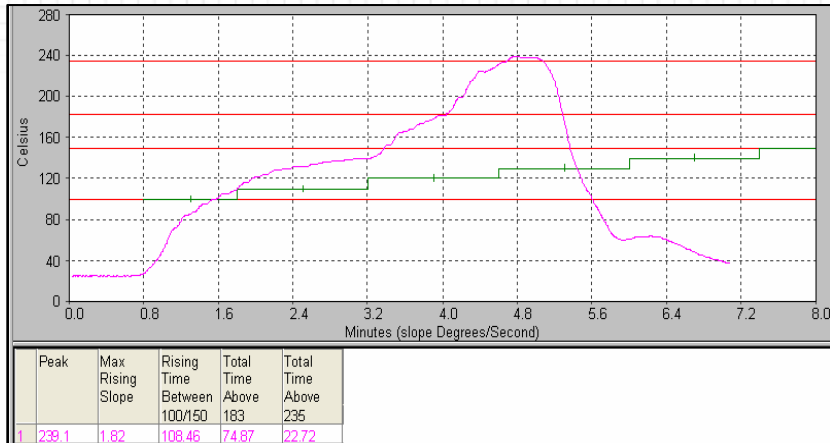
## Tin Whisker Monitoring Sample Size and Information

Sample Size											
Package	Preconditioning	TC			TH			Ambient			Total
		500x	1000x	1500x	1000hrs	3000hrs	4000hrs	1000hrs	3000hrs	4000hrs	
MQFP (14x14x1.4 100L)	No reflow	6	6	6	6	6	6	6	6	6	162
	Sn-Pb	6	6	6	6	6	6	6	6	6	
	Pb free	6	6	6	6	6	6	6	6	6	
LQFP-EP (20x20x1.4 164L)	No reflow	6	6	6	6	6	6	6	6	6	162
	Sn-Pb	6	6	6	6	6	6	6	6	6	
	Pb free	6	6	6	6	6	6	6	6	6	
TSSOP (9.7x4.4x0.9 28L)	No reflow	6	6	6	6	6	6	6	6	6	162
	Sn-Pb	6	6	6	6	6	6	6	6	6	
	Pb free	6	6	6	6	6	6	6	6	6	
QFNp (9x9x0.85 64L)	No reflow	6	6	6	6	6	6	6	6	6	162
	Sn-Pb	6	6	6	6	6	6	6	6	6	
	Pb free	6	6	6	6	6	6	6	6	6	

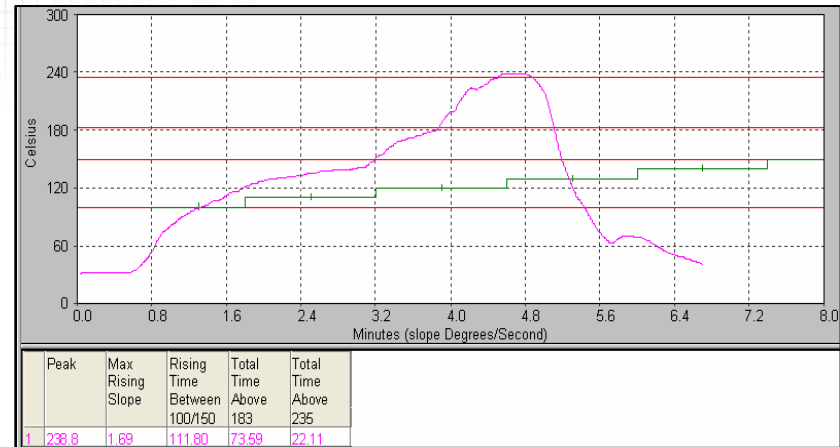
Pkg Type	Leaframe Type	Plating Type	Plating Line	Post Bake (Anneal)
MQFP	C7025 Cu Alloy	Pure Sn	SP05	150C/1hr
LQFP	C7025 Cu Alloy	Pure Sn	Meco #1	150C/1hr
TSSOP	C7025 Cu Alloy	Pure Sn	SP05	150C/1hr
QFNp	C194H Cu Alloy	Pure Sn	Meco #1	150C/1hr

# Tin Whisker Monitoring Reflow Profile (Sn-Pb)

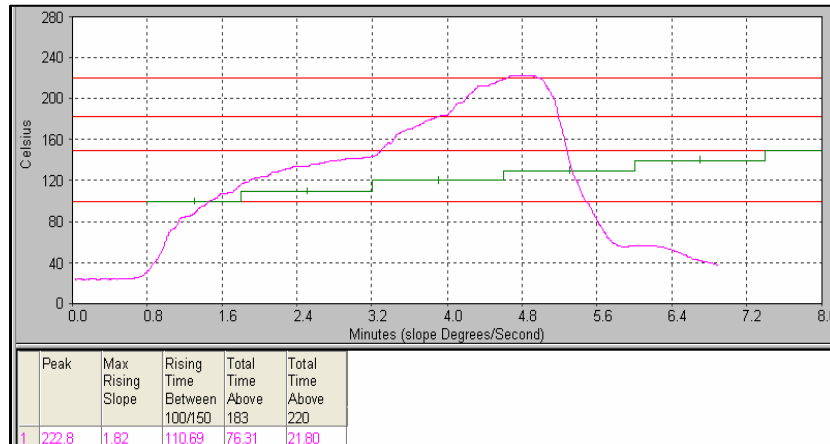
## MQFP 14x14x1.4 100L (235-240°C)



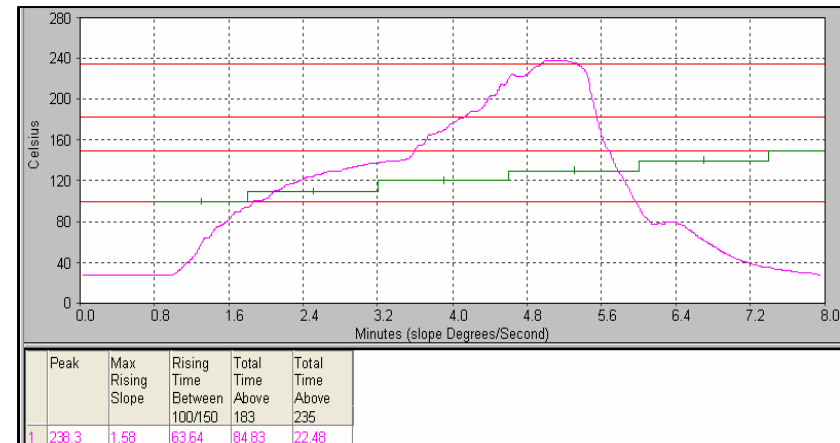
## TSSOP 9.7x4.4x0.9 28L (235-240°C)



## LQFP-EP 20x20x1.4 164L (220-225°C)



## QFNp 9x9x0.85 64L (235-240°C)



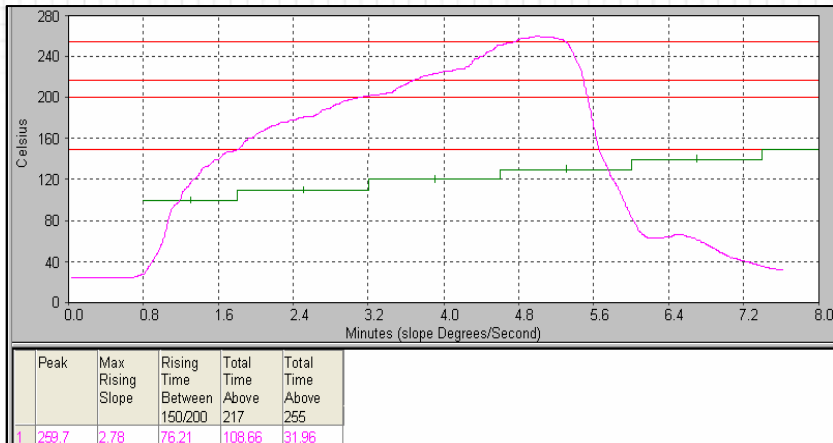
Specs: JEDEC J-STD-020C

Equipment: BTU VIP-70 5 Zones Full Convection Reflow Oven

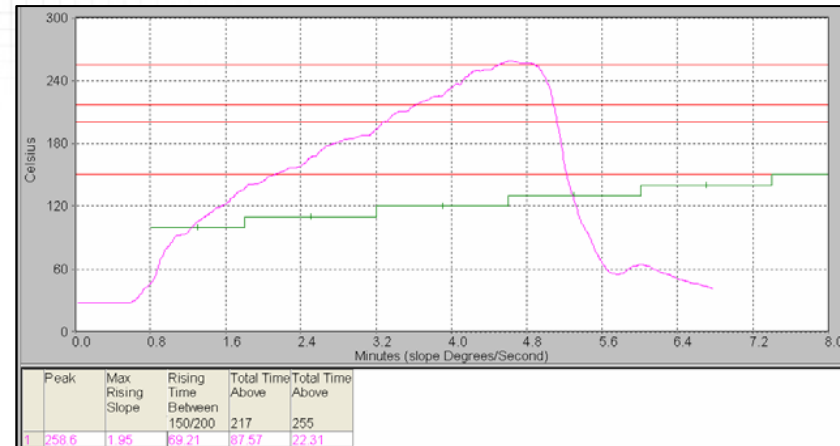


# Tin Whisker Monitoring Reflow Profile (Pb-Free)

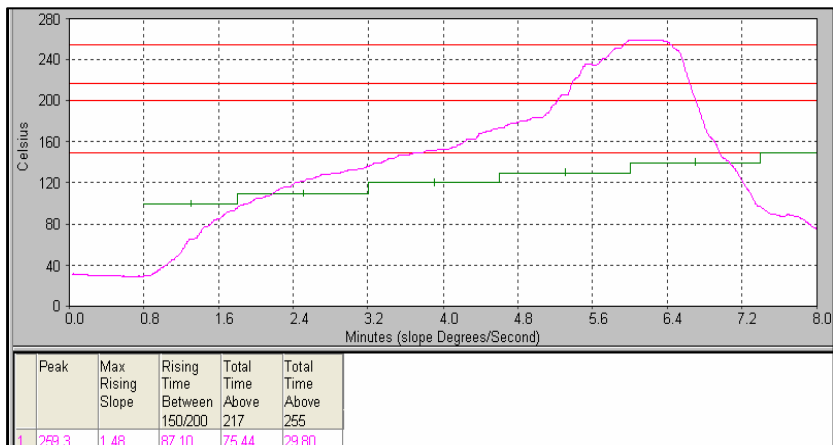
## MQFP 14x14x1.4 100L (255-260°C)



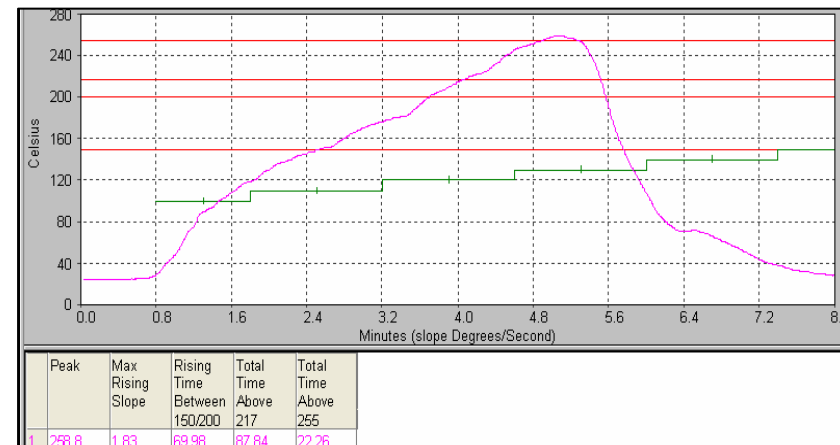
## TSSOP 9.7x4.4x0.9 28L (255-260°C)



## LQFP-EP 20x20x1.4 164L (255-260°C)



## QFNp 9x9x0.85 64L (255-260°C)

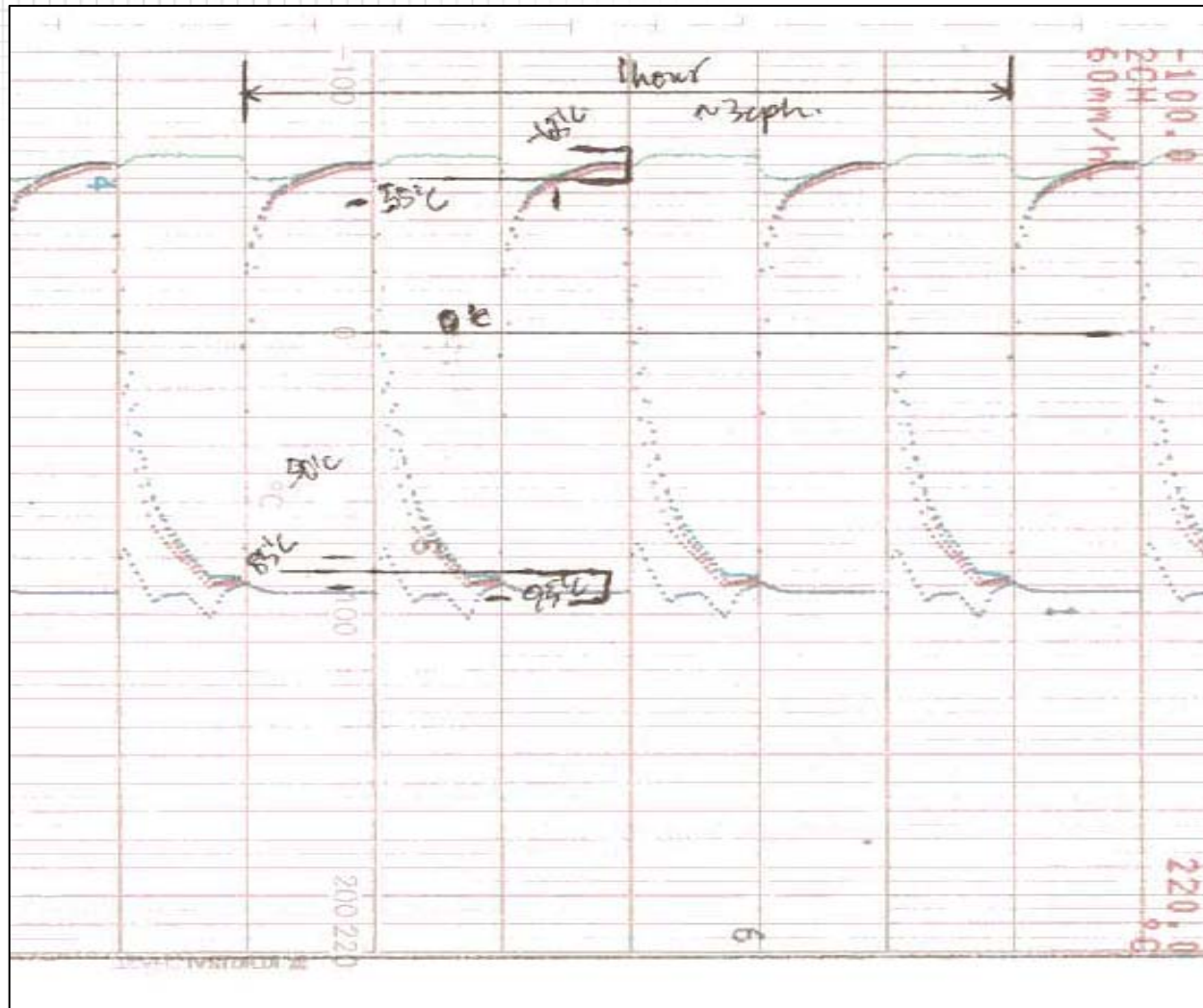


Specs: JEDEC J-STD-020C

Equipment: BTU Pyramax98A 7 Zones Full Convection Reflow Oven



## Tin Whisker Monitoring Temperature Cycling Profile



Min Temperature  
-55 to -40 (+0/-10) °C  
Max Temperature  
+85 (+10/-0) °C,  
air to air; 5 to 10 minute soak;  
~3 cycles/hour

Specs: JEDEC JESD22A121  
Equipment: ESPEC TSE-11-A Temp Cycle Chamber



## 2007 Tin Whisker Monitoring Sampling Proposal

Sample Size								
Package	Preconditioning	TC -55(+0/-10) oC, 85(+10/-0) oC			TH 60(+/-5) oC, 87(+3/-2) %RH			Total
		500x	1000x	1500x	1000hrs	1500hrs	4000hrs	
QFP	No reflow	6	6	6	6	6	6	72
	Pb free	6	6	6	6	6	6	
QFNp	No reflow	6	6	6	6	6	6	72
	Pb free	6	6	6	6	6	6	

**Note:**

1. Two different type of packages (lead types) are selected for 2007 monitoring
2. Ambient storage test is taken out , base on the current results product is less susceptible to TinW and is less stringent among the others two tests
3. Sn-Pb leg will be taken out for next year monitoring as industries is moving to Pb-Free.
4. Readout points are amended to be in line with JEDEC
5. Sample size and inspection point remains unchanged, compliance to JEDEC
6. Radial measuring method will be used (per JESD201)
7. The above will also be used as Generic Tin Whisker data for year 2007