

# IC Failure Analysis Lab

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## ***Failure Analysis Report***

ICFA Lab Reference Number:	ICFA-0003 – Final
Customer:	
Customer Reference Number:	N/A
Requester:	Paul G.
Device Number:	MC68194FJ
Quantity:	3 + 2 Ref
Report Date:	September 19, 2010
Analyst:	Fenimore C.
Report By:	Fenimore C.

## Description

Three (3) Motorola / On Semi Carrier Band Modem (MC68194FJ and two (2) reference samples were submitted to the IC Failure Analysis Lab for failure analysis. The customer reported failure is listed below. Samples were serialized by ICFA Lab.

### Device Information

Serial Number	Top Marking	Customer Reported Failure Description
F1	ON MC68194FJ ZRED0240 PHILIPPINES	<i>"Does not work – Replaced the chip and Module worked"</i>
F2	ON MC68194FJ ZRED0240 PHILIPPINES	<i>"Does not work – Replaced the chip and Module worked"</i>
F3	M MC68194FJ ZRAY0512 PHILIPPINES	<i>"Does not work – Replaced the chip and Module worked"</i>
G4 ~ G5 (Reference)	ON MC68194FJ ZRAY0512 PHILIPPINES	Good

## Summary

External visual inspection and real time 2D X-Ray of the failing samples revealed no anomaly. No wire bonds are visible on the X-Ray images because they are Aluminum. T-SAM (Through- Scanning Acoustic Microscopy) revealed anomaly on F3 sample.

I-V curve trace of samples revealed opens/shorts and anomaly to GND pins. All four 4 GND pins (Pins 1, 39, 43 and 48) were tied together and used as a single GND for our I-V curve testing. *This was done to minimize curve tracing costs and identify the suspected pins.*

The suspected pins identified from the above method were individually curve traced to each GND pin. The results of this analysis revealed shorts and leakage on suspected pins.

All 3 failing samples were decapsulated and no anomaly was observed on die surfaces. The samples were inspected under OBRICH microscope and emission sites were observed on all 3 failing samples.

F1 & F2 samples were randomly selected and mechanically delayered down to the Contact layer. An anomaly sites were observed in the Contact layers near pins 34 ~ 38 of F1 and pins 37 & 38 of F2 samples. The most likely cause of anomalies in the Contact planes is ESD (Electrostatic Discharge) in both samples.

F3 sample was also mechanically delayered down to substrate layer. An anomaly was observed in the substrate layer. The most likely cause of anomaly in the substrate layer is ESD (Electrostatic Discharge).

## **Analyses**

### **External Visual Examination:**

External visual inspections of the failing samples revealed no anomaly. (Figure 1 ~ 2)

### **2D X-ray inspection:**

Real time 2D X-Ray of samples revealed no anomaly. No wire bonds are visible because wire bonds are Aluminum. (Figures 3 ~ 4)

### **Scanning Acoustic Microscopy (SAM):**

T-SAM inspection revealed anomaly on F3 Sample. (Figure 5)

Electrical I-V Testing:

The electrical characteristics of failing samples were compared to the reference sample with a curve tracer.

The results are as below: (Figures 6 ~ 24)

Pin #	Pin name	GND	Results		
			F1	F2	F3
Pin4	RXCLK	To Pins (1+39+43+48)			
Pin5	SMIND				
Pin6	RXSYMO				
Pin7	RXSYMI				
Pin8	RXSYM2				
Pin10	VCC-TTL				
Pin11	GND-TTL				
Pin12	RESET				
Pin13	TXSYMO				
Pin14	TXSYM1				
Pin15	TXSYM2				
Pin16	SMREQ				
Pin17	TXCLK				High Resistance Open
Pin18	JAB				
Pin19	EOTDIS				
Pin20	VCC-OSC				
Pin21	XTAL2				
Pin22	XTAL1				
Pin23	GND-OSC				
Pin24	TXDIS		Leakage (curve unstable)	Leakage (curve unstable)	
Pin25	GND-LOGIC				
Pin26	TXOUT				

Table 1: **F1, F2 and F3** => I-V Curve Trace Results. Pins 1, 39, 43 and 48 were tied together and used as single GND point for the I-V test.

Electrical I-V Testing Results (Continued)

Pin #	Pin name	GND	Results		
			F1	F2	F3
Pin27	VCC-TXOUT	To Pins (1+39+43+48)	Leakage (curve unstable)		
Pin28	TXOUT				
Pin29	JAB-RC				
Pin30	GAIN		Leakage		
Pin31	CARDET		Leakage		
Pin32	VCC-RCV		Short		
Pin33	GND-RCV				
Pin34	THRESHOLD				
Pin35	FDBK		Short	Leakage	Leakage
Pin36	FDBK		Short	Leakage	Leakage
Pin37	RXIN		Short	Leakage	Leakage
Pin38	RXIN		Short	Leakage	Leakage
Pin40	SET-PW				
Pin41	RPW				
Pin42	CPW				
Pin44	VCX				Leakage
Pin45	VCM-C1				
Pin46	VCM-C2				
Pin47	VCC-VCM				
Pin50	DOWN				
Pin51	UP				
Pin52	VCC-LOGIC				

Table 2: **F1, F2 and F3** => I-V Curve Trace Results. Pins 1, 39, 43 and 48 were tied together and used as single GND point for the I-V test.

Pin #	Pin name	GND	Results of Suspected Pins to Individual GNDs		
			F1	F2	F3
Pin24	TXDIS	to Pin1	Leakage (curve unstable)	Leakage (curve unstable)	No analysis
Pin27	VCC-TXOUT		Leakage (curve unstable)	No analysis	No analysis
Pin30	GAIN		Slight Leakage	No analysis	No analysis
Pin31	CARDET		Leakage	No analysis	No analysis
Pin32	VCC-RCV		Short	No analysis	No analysis
Pin35	FDBK		Short	Leakage	Leakage
Pin36	FDBK		Short	Leakage	Leakage
Pin37	RXIN		Short	Leakage	Leakage
Pin38	RXIN		Short	Leakage	Leakage
Pin44	VCX		No analysis	No analysis	Leakage
Pin24	TXDIS	to Pin39			No analysis
Pin27	VCC-TXOUT			No analysis	No analysis
Pin30	GAIN			No analysis	No analysis
Pin31	CARDET			No analysis	No analysis
Pin32	VCC-RCV			No analysis	No analysis
Pin35	FDBK				
Pin36	FDBK				
Pin37	RXIN				
Pin38	RXIN				
Pin44	VCX		No analysis	No analysis	

Table 3: **F1, F2 and F3** => Re-do of I-V Curve Trace Results. Suspected pins are curve traced to individual GNDs (**Pin 1** and **Pin 39**).

Pin #	Pin name	GND	Results of Suspected Pins to Individual GNDs		
			F1	F2	F3
Pin24	TXDIS	to Pin43			No analysis
Pin27	VCC-TXOUT			No analysis	No analysis
Pin30	GAIN			No analysis	No analysis
Pin31	CARDDET			No analysis	No analysis
Pin32	VCC-RCV			No analysis	No analysis
Pin35	FDBK				
Pin36	FDBK				
Pin37	RXIN				
Pin38	RXIN				
Pin44	VCX		No analysis	No analysis	
Pin24	TXDIS	to Pin48	Leakage (curve unstable)	Leakage (curve unstable)	No analysis
Pin27	VCC-TXOUT		Leakage (curve unstable)	No analysis	No analysis
Pin30	GAIN		Slight leak	No analysis	No analysis
Pin31	CARDDET		Leakage	No analysis	No analysis
Pin32	VCC-RCV		Leakage	No analysis	No analysis
Pin35	FDBK		Leakage	Leakage	Leakage
Pin36	FDBK		Leakage	Leakage	Leakage
Pin37	RXIN		Leakage	Leakage	Leakage
Pin38	RXIN		Leakage	Leakage	Leakage
Pin44	VCX		No analysis	No analysis	Leakage

Table 4: **F1, F2 and F3** => Re-do of I-V Curve Trace Results. Suspected pins are curve traced to individual GNDs (**Pin 43** and **Pin 48**).

#### Decapsulation and Die Optical Inspection:

All 3 failing samples were mechanically decapped and no anomaly was observed on die surfaces. (Figure 25)

#### OBRICH and Photo Emission Inspection:

All decapped failing samples and a reference sample were powered under an OBRICH scope to look for photo emission (hot spots) sites. Hot spots were observed on all 3 failing samples. (Figures 26 ~ 28)

#### Mechanical Delayering and SEM Inspection:

F1 & F2 samples were randomly selected and mechanically delayered down to the Contact layer. An anomaly sites were observed in the Contact layers near pins 34 ~ 38 of F1 and pins 37 & 38 of F2 samples. The most likely cause of anomalies in the Contact planes is ESD (Electrostatic Discharge) in both samples. (Figures 29 ~ 38)

F3 sample was also mechanically delayered down to substrate layer. An anomaly was observed in the substrate layer. The most likely cause of anomaly in the substrate layer is ESD (Electrostatic Discharge). (Figures 39 ~ 44)

Photographs:



Figure 1: Photographs of **Failing** samples as received



Figure 2: Photographs of **Reference** samples as received



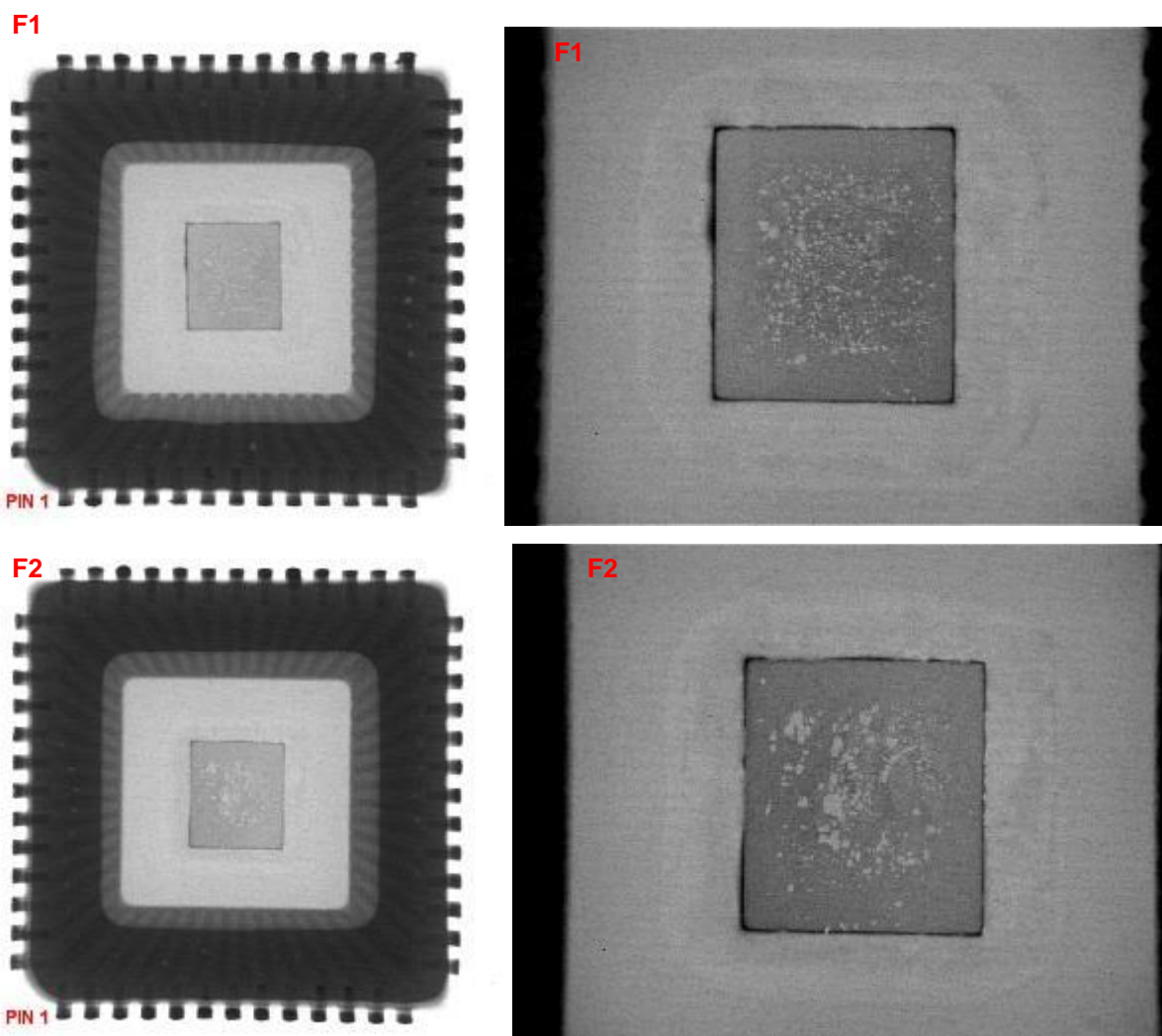
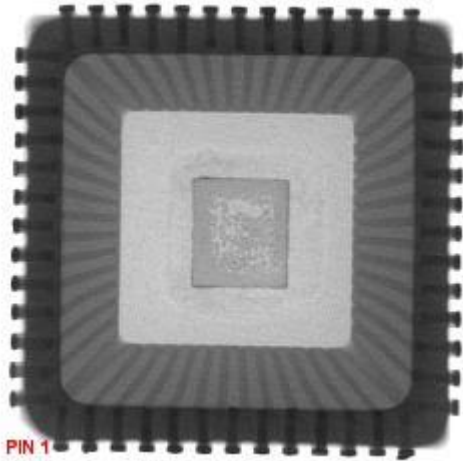
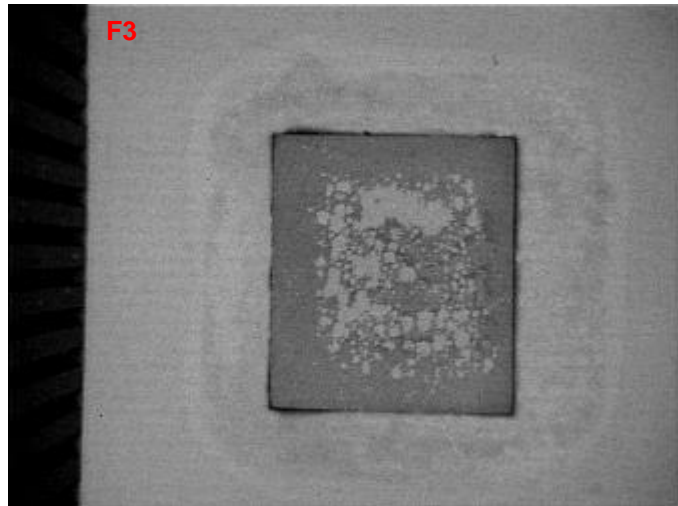


Figure 3: **F1 and F2** => 2D X-Ray of sample exhibit no anomaly.  
Close up image is on the right

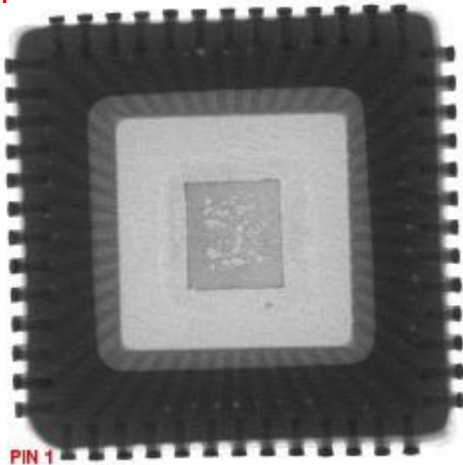
F3



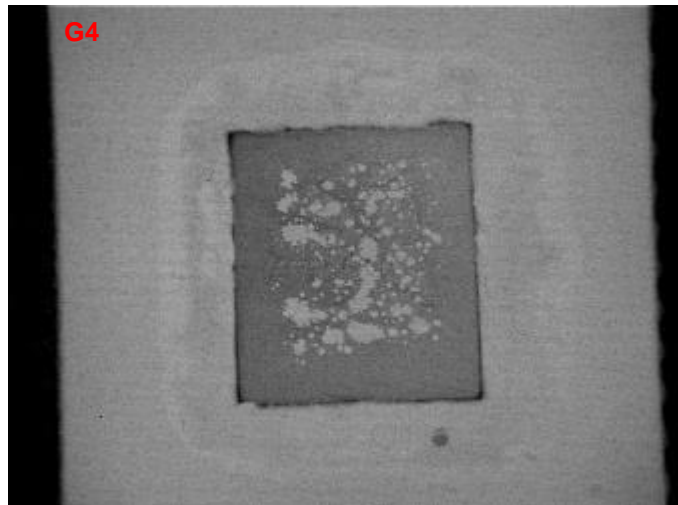
F3



G4



G4



Side View

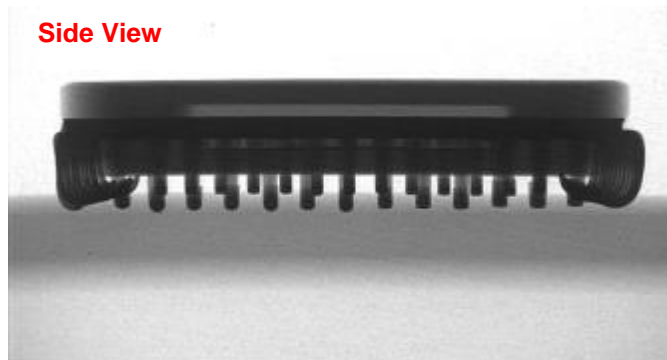


Figure 4:

**F3 and G4** => 2D X-Ray of sample exhibit no anomaly. Close images are on the right.

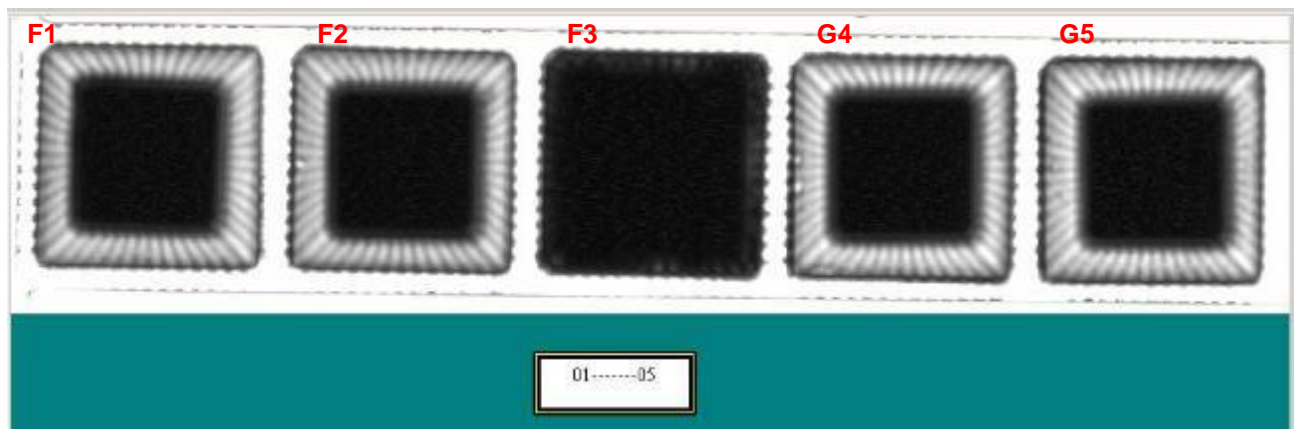


Figure 5: T-SAM results revealed anomaly on F3 sample. Anomaly is represented in dark color.

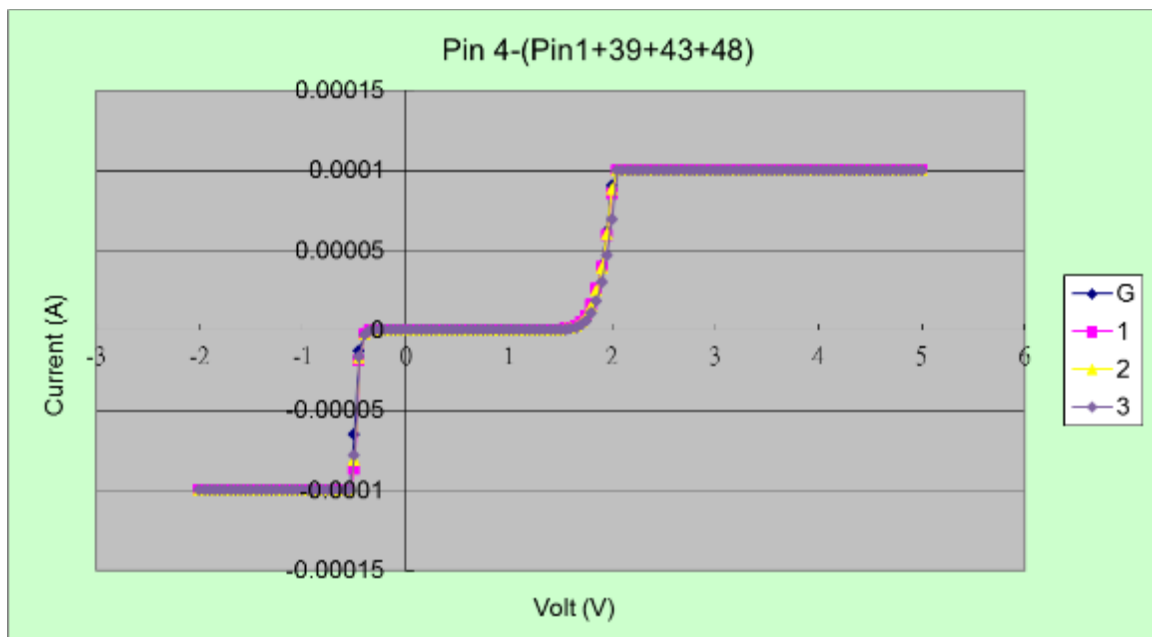


Figure 6: Typical I-V Curve of a good pin (Pin4) to GND (Pins 1+39+43+48). No anomaly was observed.

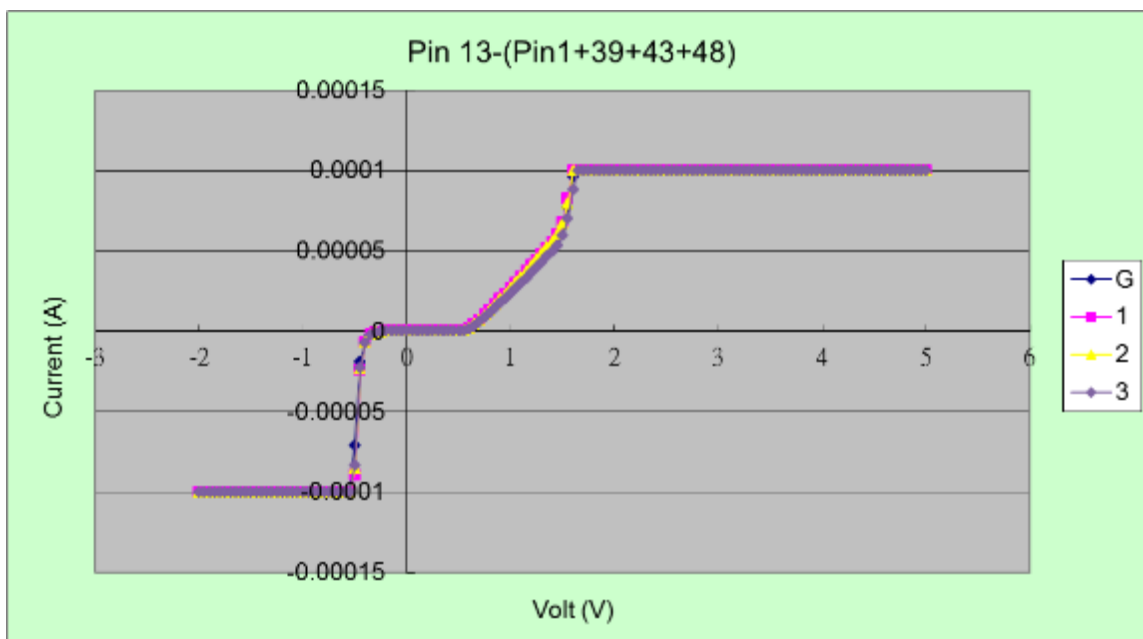


Figure 7: Typical I-V Curve of a good pin (Pin13) to GND (Pins 1+39+43+48). No anomaly was observed.

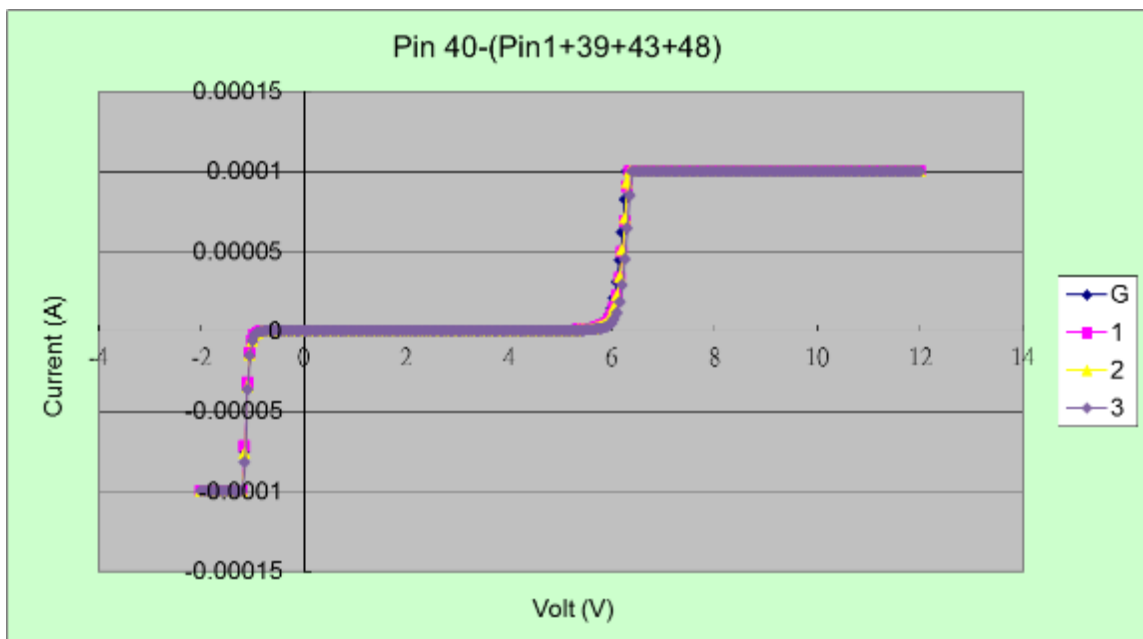


Figure 8: Typical I-V Curve of a good pin (Pin40) to GND (Pins 1+39+43+48). No anomaly was observed.

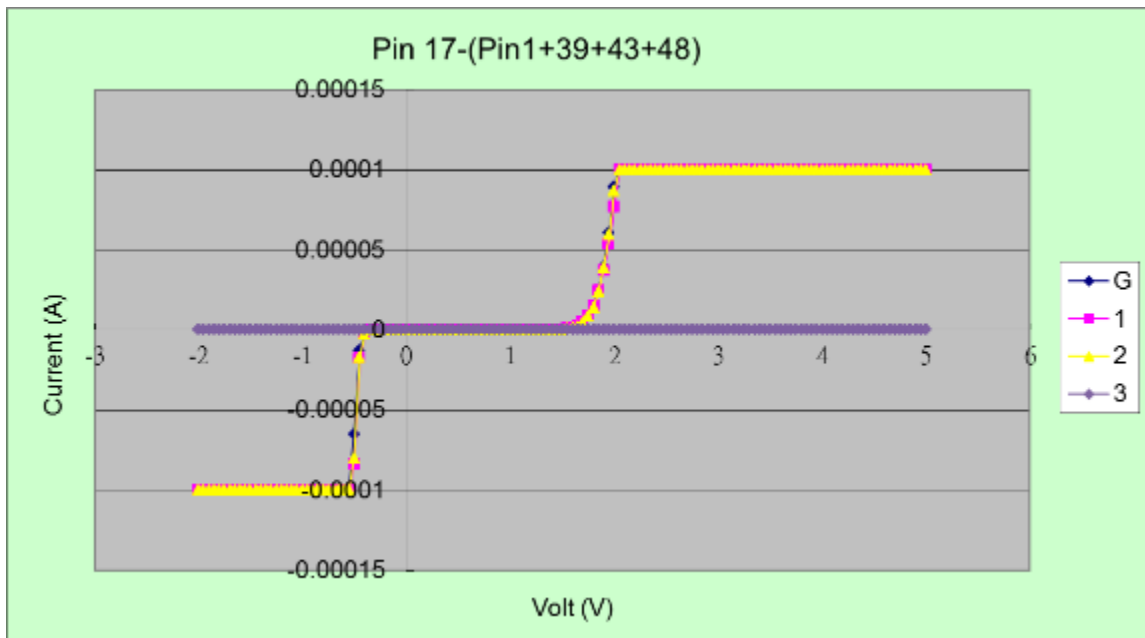


Figure 9: Typical I-V Curve of an abnormal pin (Pin 17) to GND (Pins 1+39+43+48). Open was observed on **F3** sample.

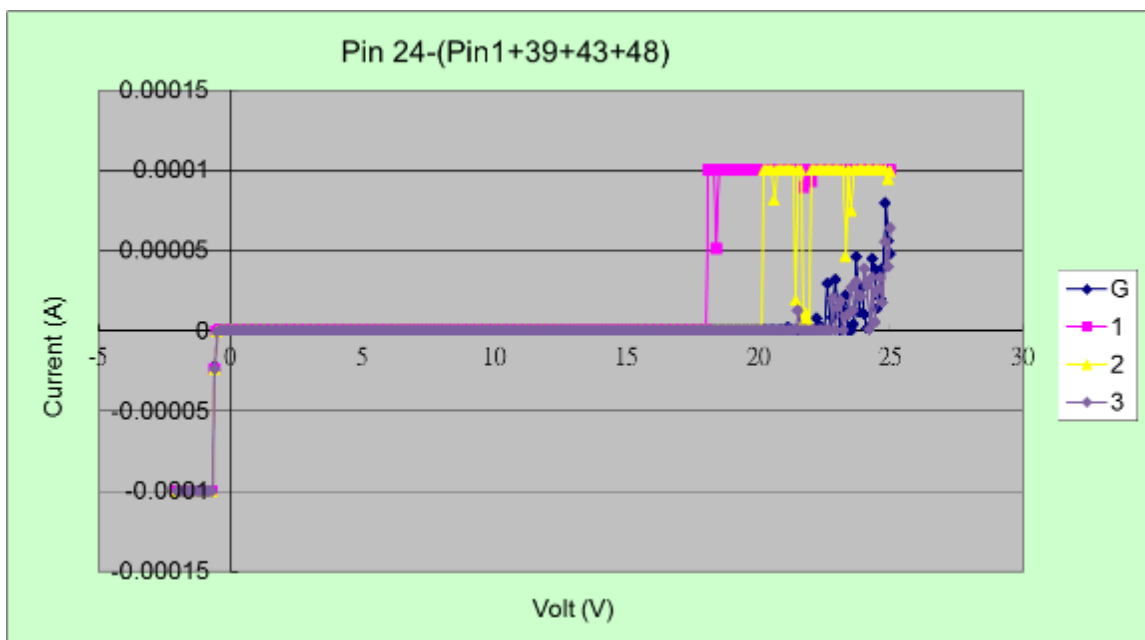


Figure 10: Typical I-V Curve of an unstable pin (Pin 24) to GND (Pins 1+39+43+48). Unstable condition was observed on **F1 & F2** samples.

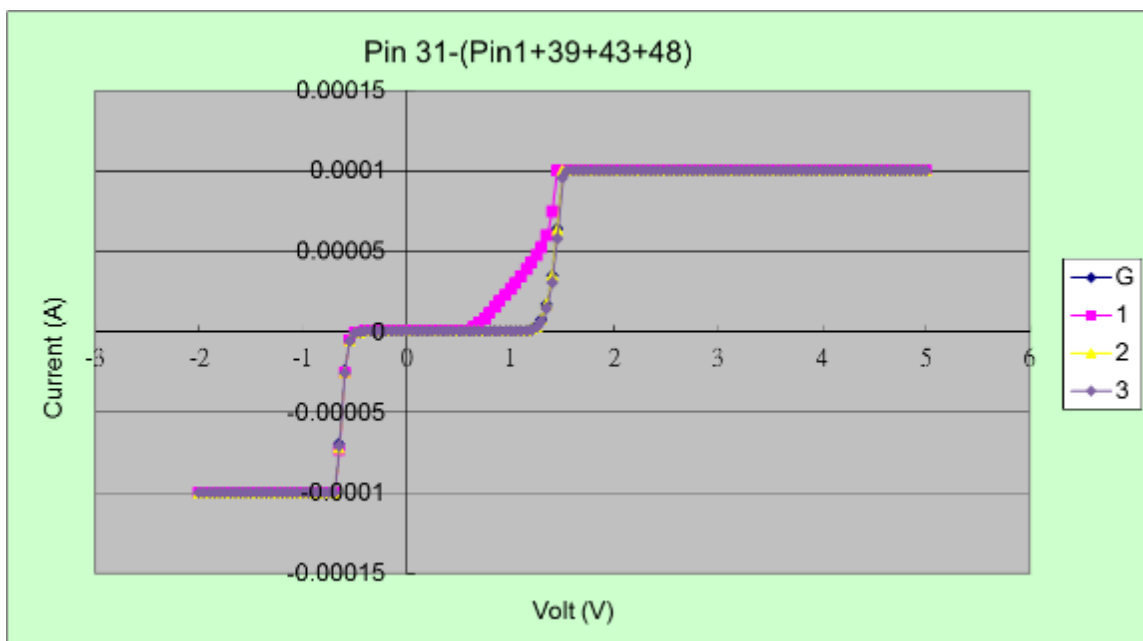


Figure 11: Typical I-V Curve of a leaking pin (Pin 31) to GND (Pins 1+39+43+48). Leakage was observed on **F1** sample.

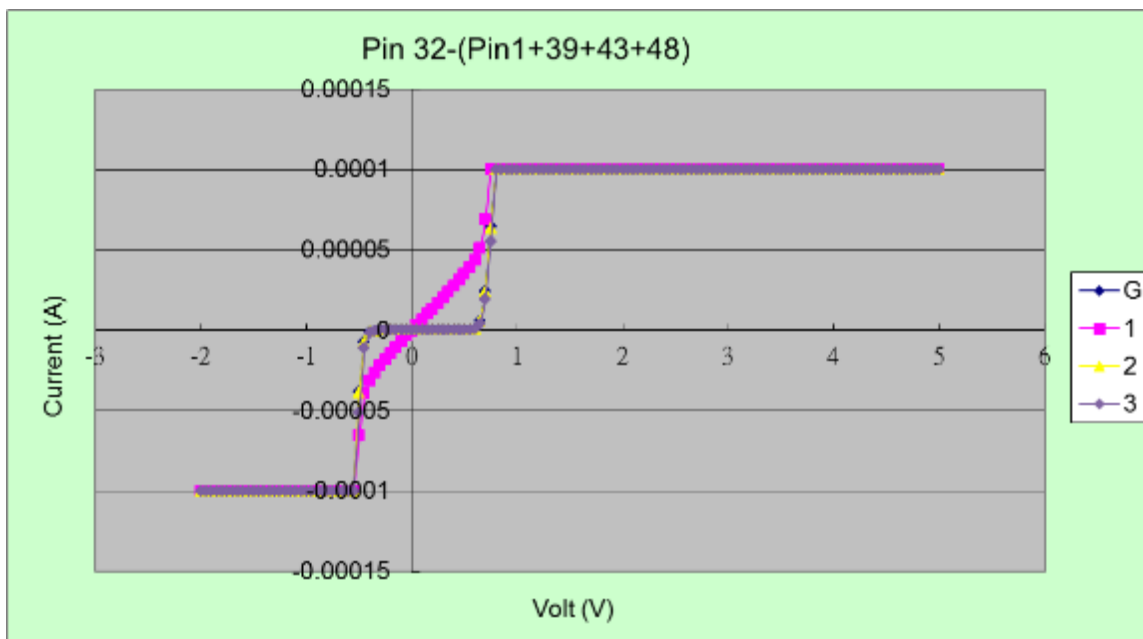


Figure 12: Typical I-V Curve of a shorted pin (Pin 32) to GND (Pins 1+39+43+48). Short was observed on **F1** sample.

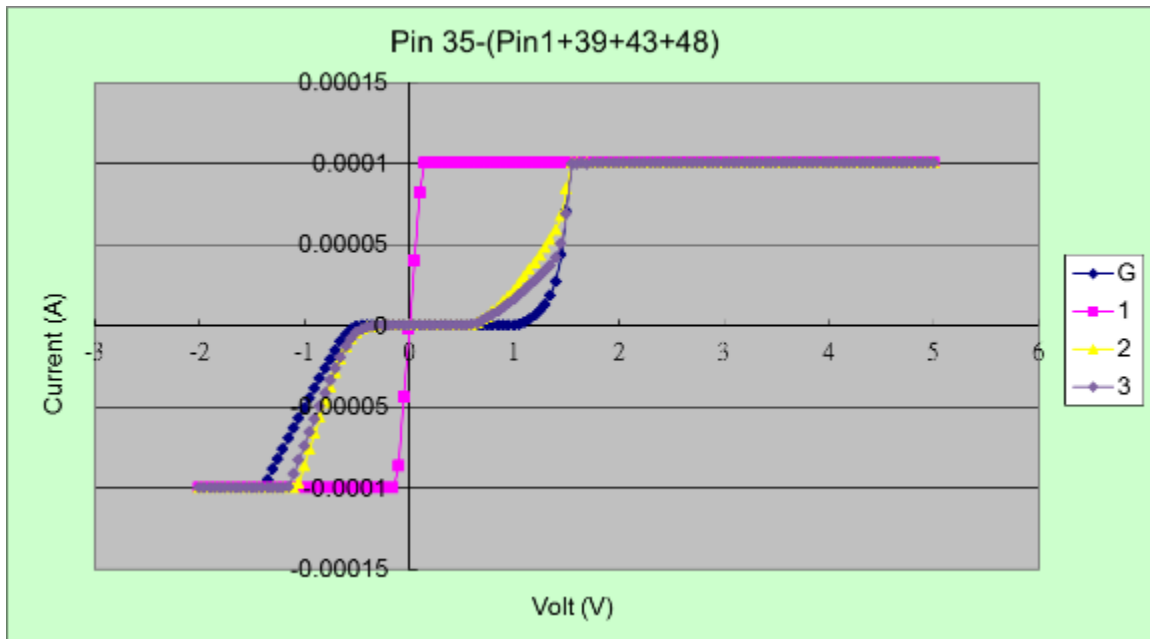


Figure 13: Typical I-V Curve of a shorted pin (Pin 35) to GND (Pins 1+39+43+48). Short was observed on **F1** sample.

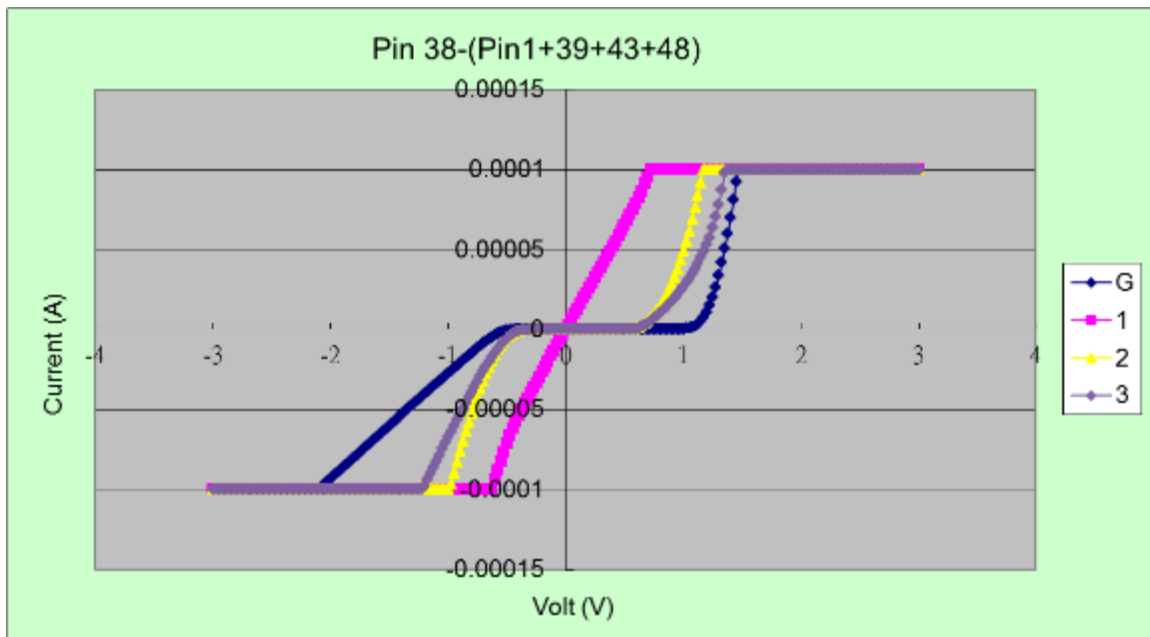


Figure 14: Typical I-V Curve of a shorted and leaking pin (Pin 38) to GND (Pins 1+39+43+48). Short and leakage were observed on **F1 and F2 & F3**, respectively.

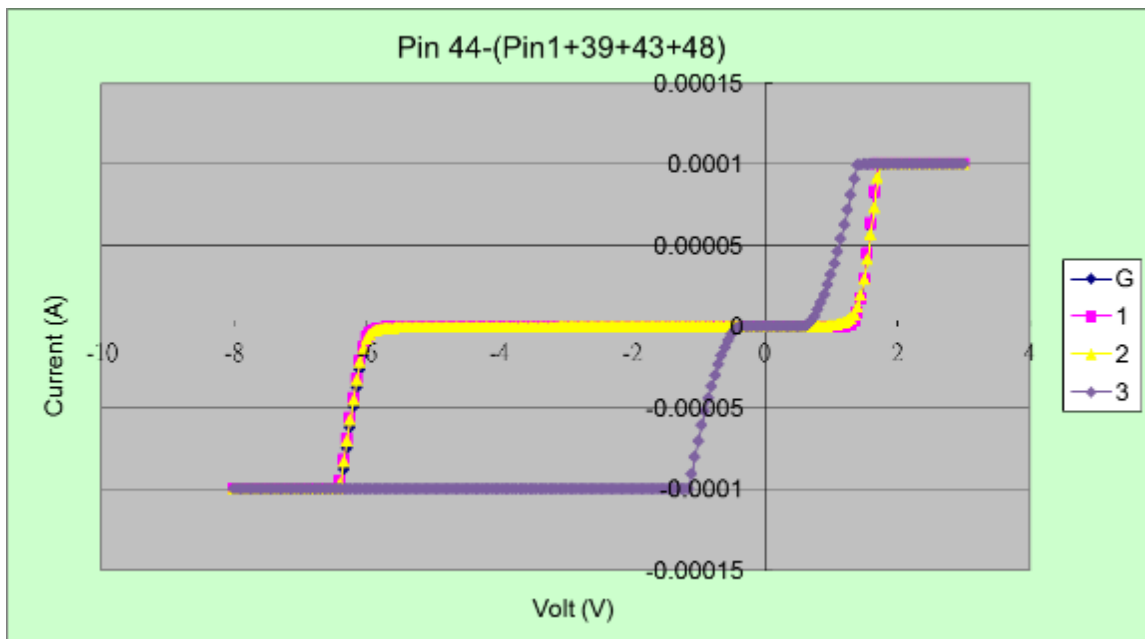


Figure 15: Typical I-V Curve of a leaking pin (Pin 44) to GND (Pins 1+39+43+48). Leakage was observed on **F3** sample.

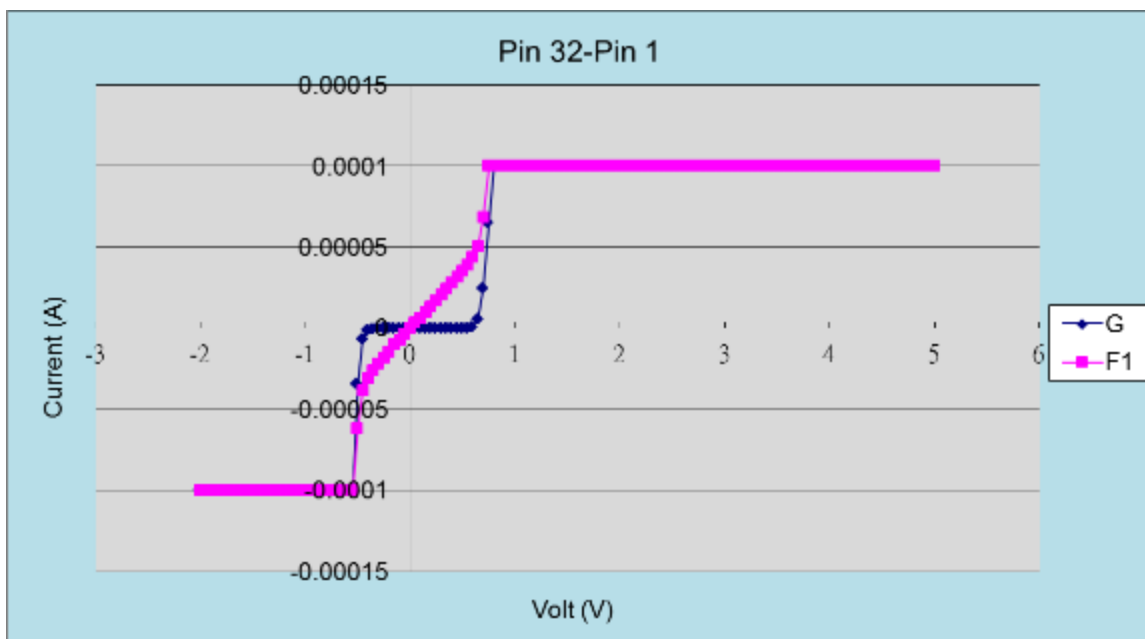


Figure 16: **F1** => Typical I-V Curve of a shorted pin (Pin 32) to GND (Pin1).



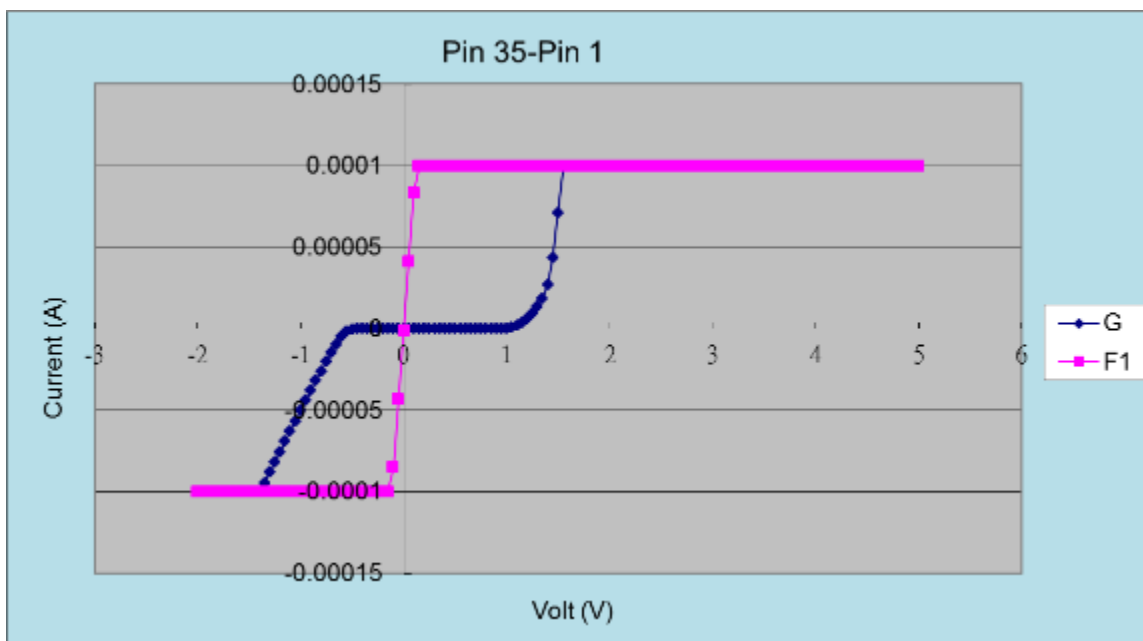


Figure 17: **F1** => Typical I-V Curve of a shorted pin (Pin 35) to GND (Pin1).

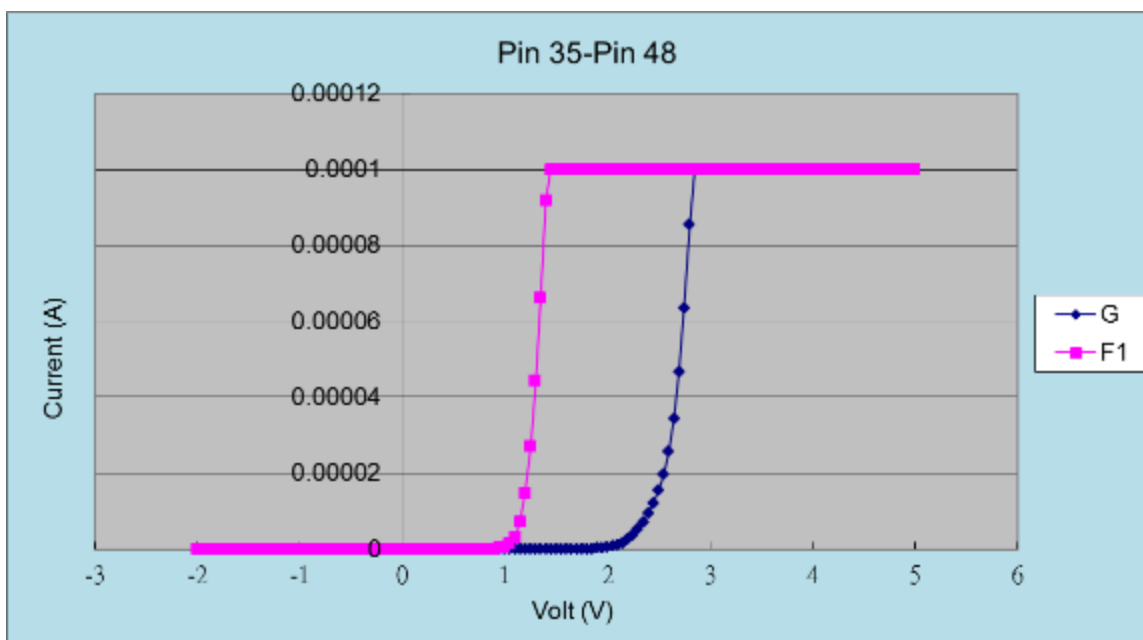


Figure 18: **F1** => Typical I-V Curve of a leaking pin (Pin 35) to GND (Pin 48).

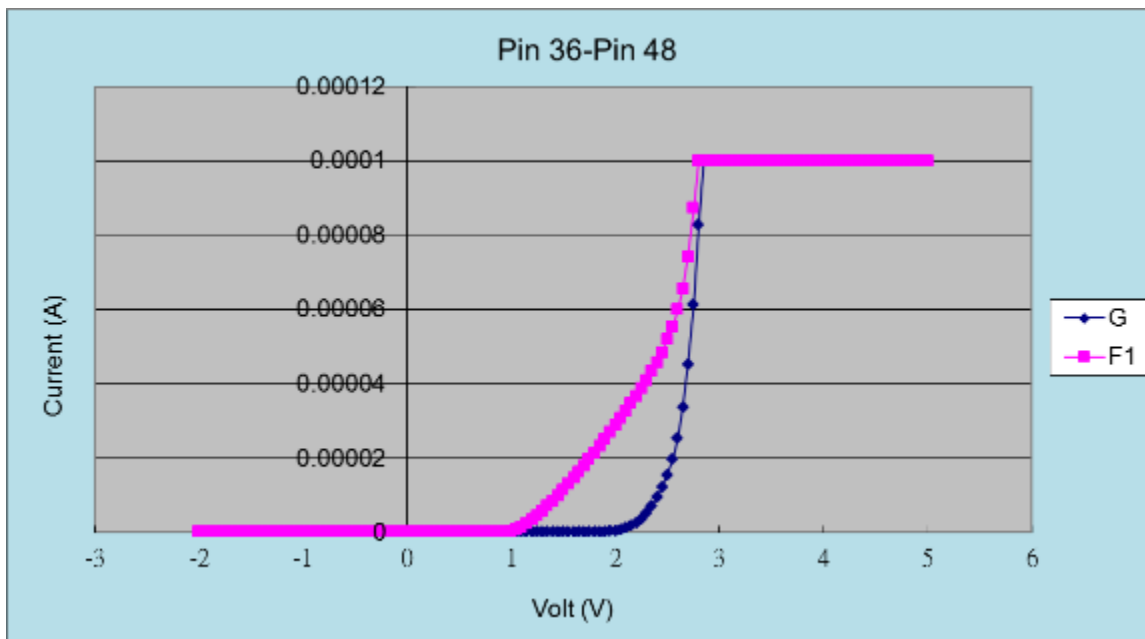


Figure 19: **F1** => Typical I-V Curve of a leaking pin (Pin 36) to GND (Pin 48).

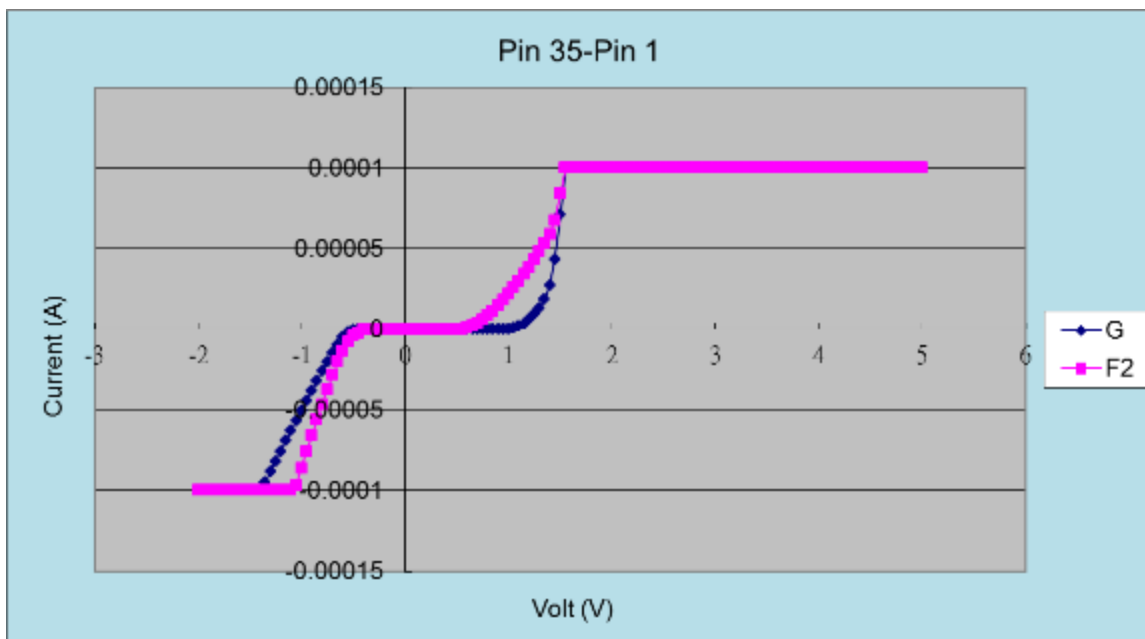


Figure 20: **F2** => Typical I-V Curve of a leaking pin (Pin 35) to GND (Pin 1).

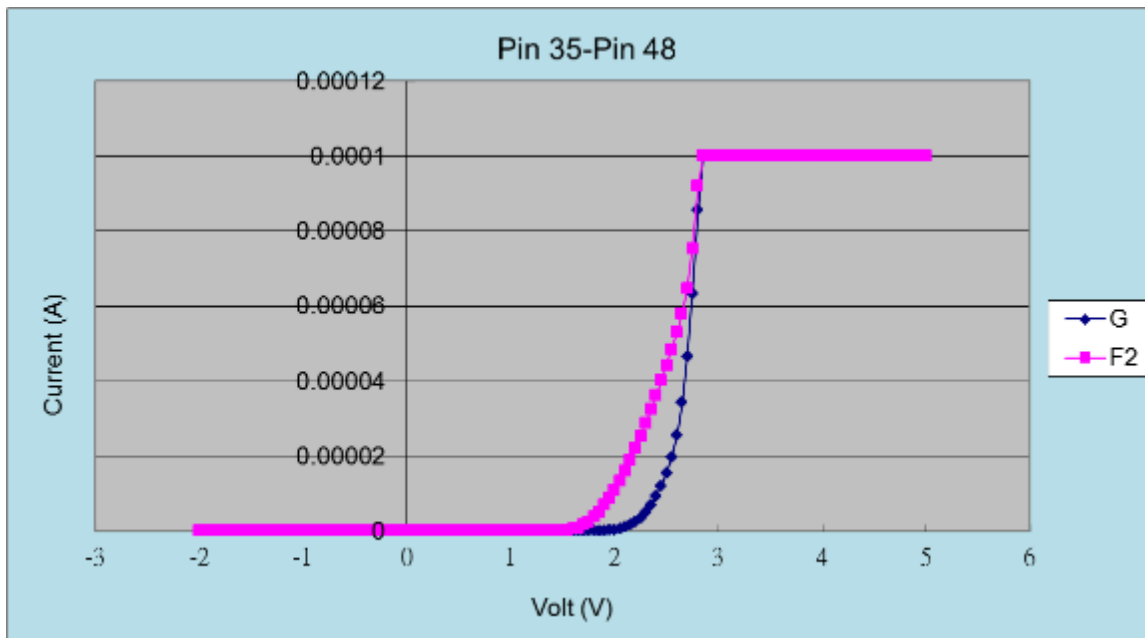


Figure 21: **F2** => Typical I-V Curve of a leaking pin (Pin 35) to GND (Pin 48).

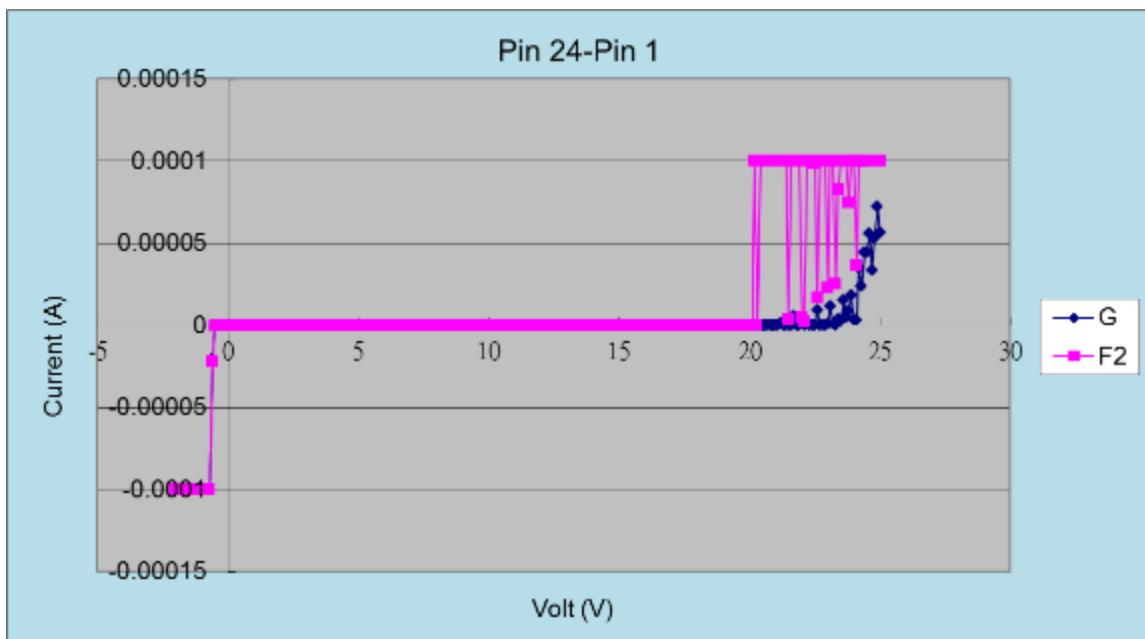


Figure 22: **F2** => Typical I-V Curve of an un-stable pin (Pin 24) to GND (Pin 1).

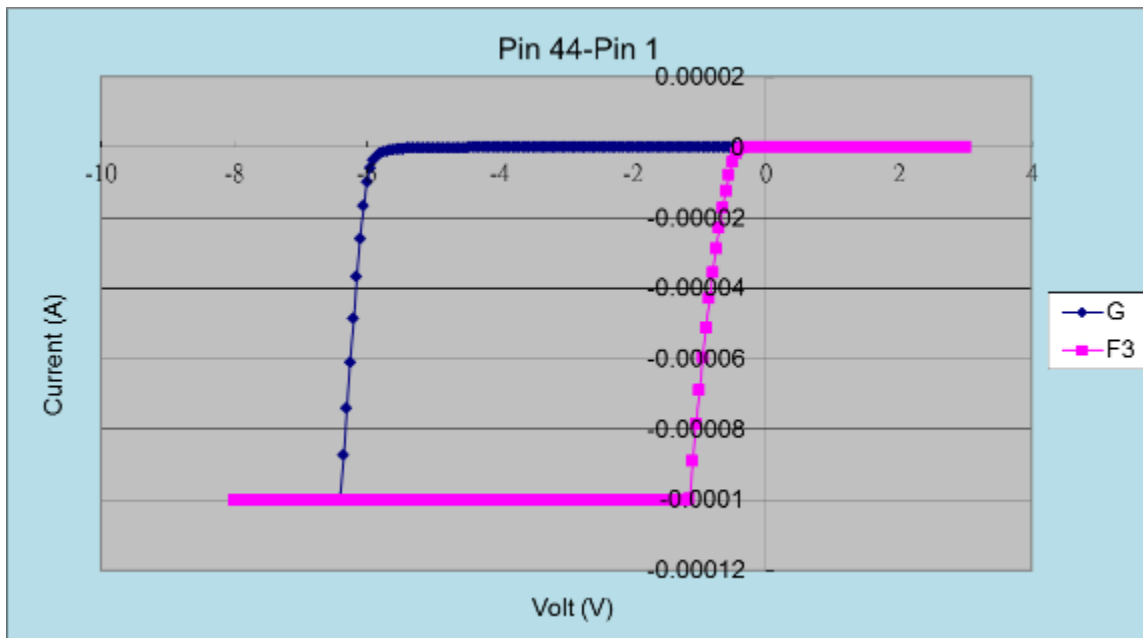


Figure 23: **F3** => Typical I-V Curve of a leaking pin (Pin 44) to GND (Pin 1).

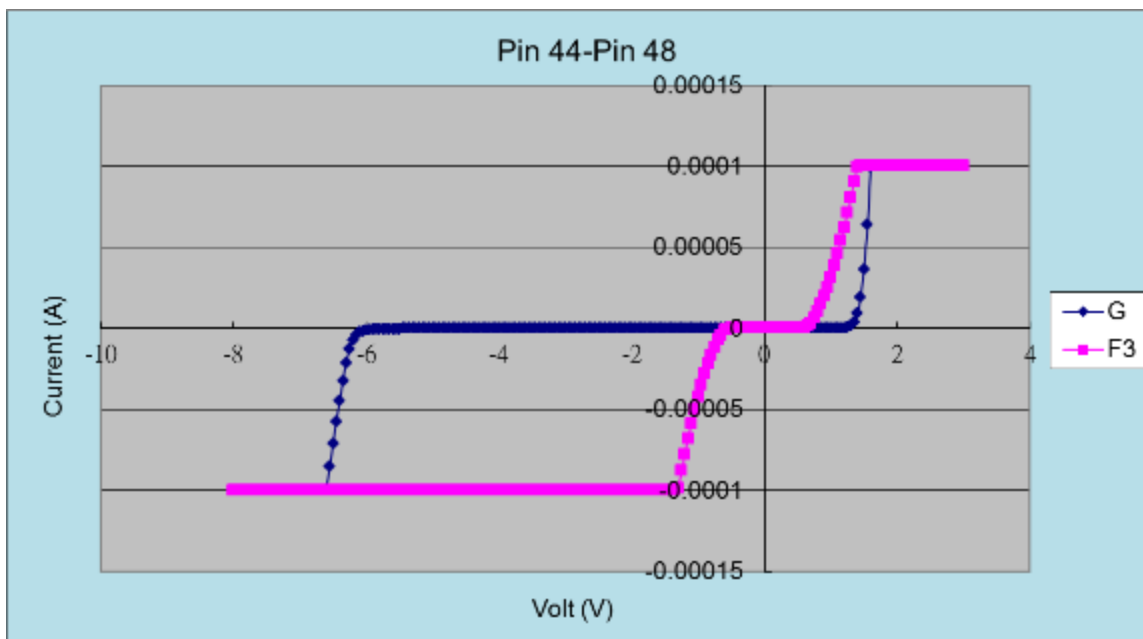


Figure 24 **F3** => Typical I-V Curve of a leaking pin (Pin 44) to GND (Pin 48).

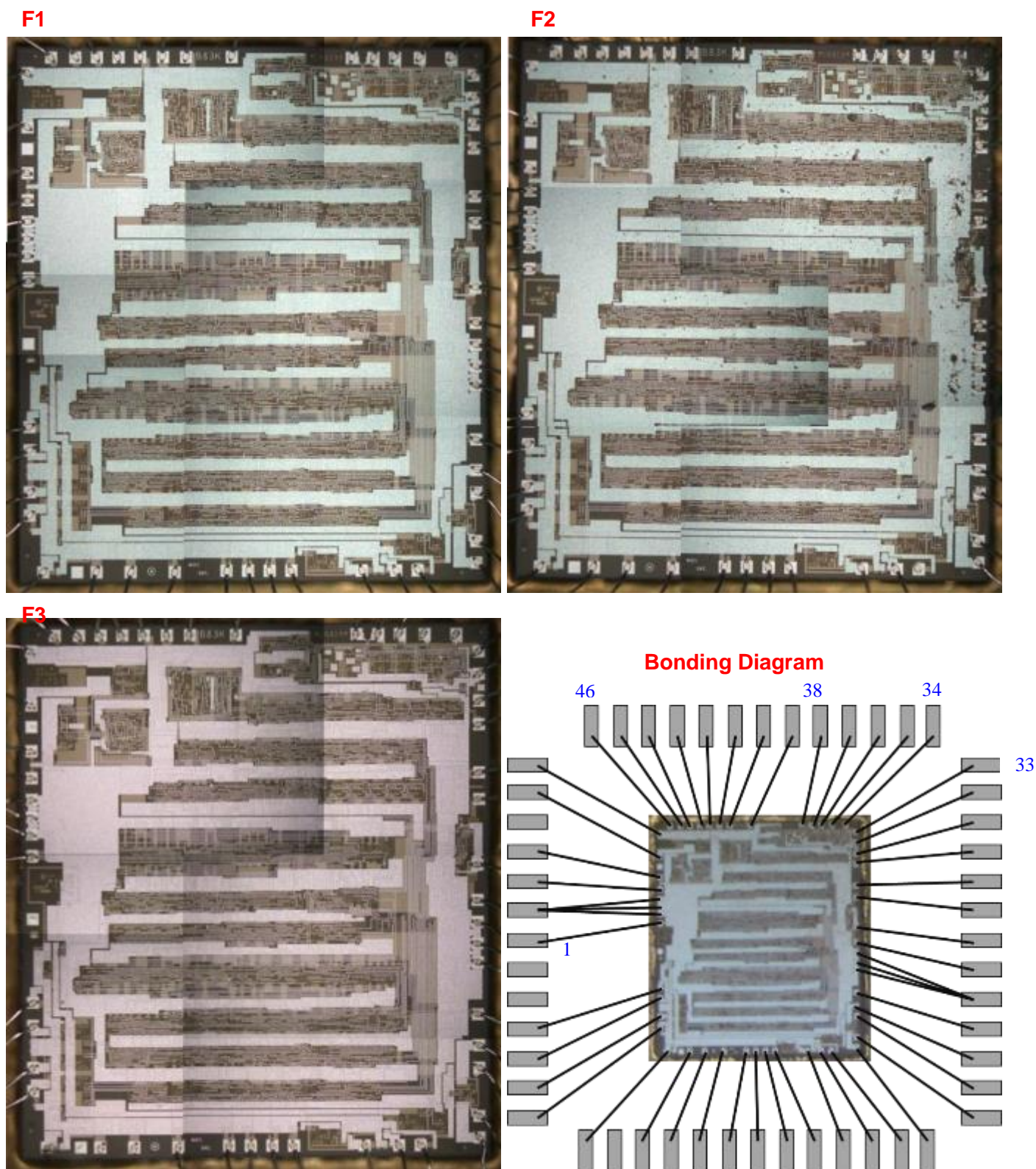


Figure 25

**F1, F2 and F3** photographs of die surfaces and bonding diagram. No anomaly was observed.



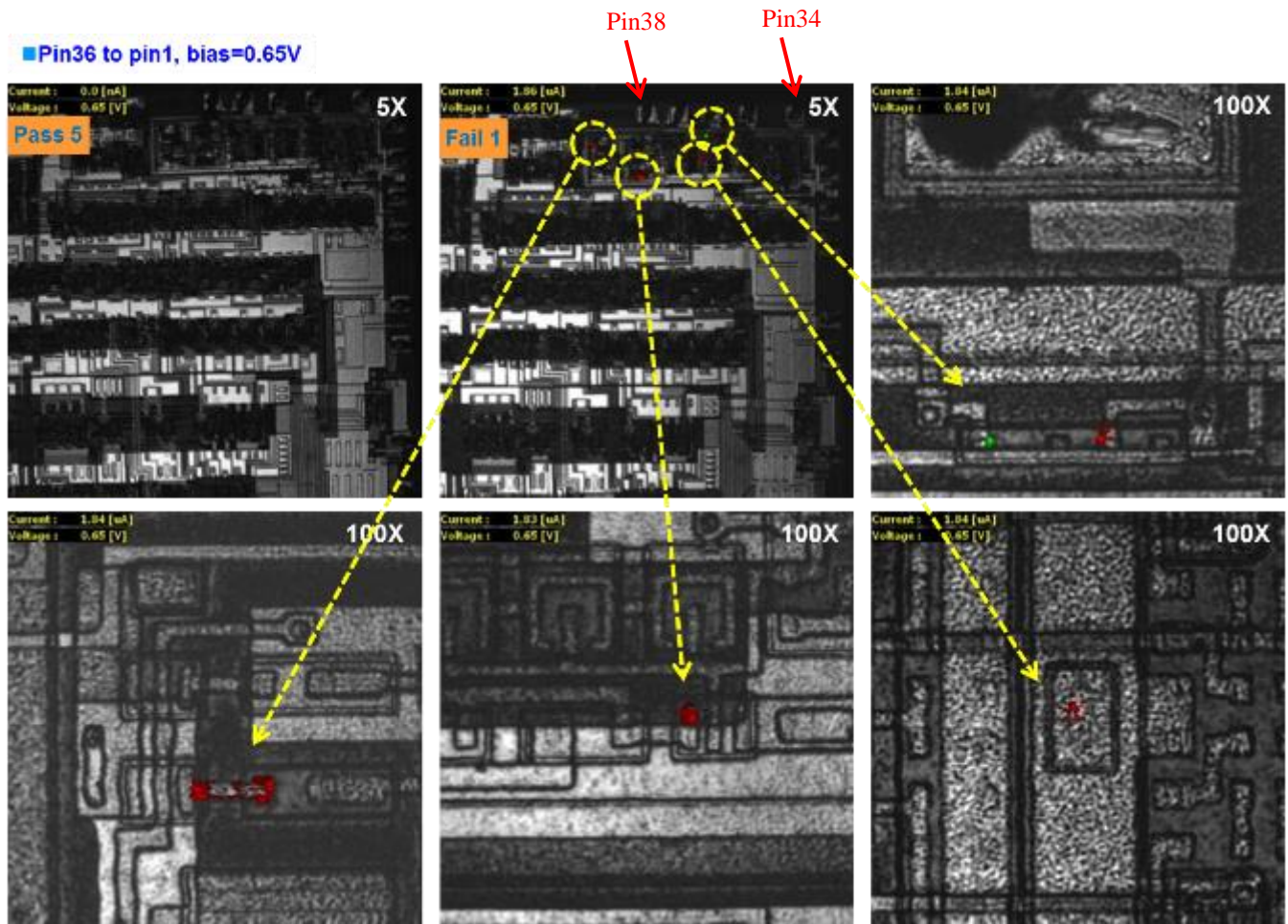


Figure 26

**F1** => OBRICH analysis of failing sample 1. Hot spots are shown in Red and Green colors. Upper left photo represents a Ref sample. No emission site is observed on the Reference sample.

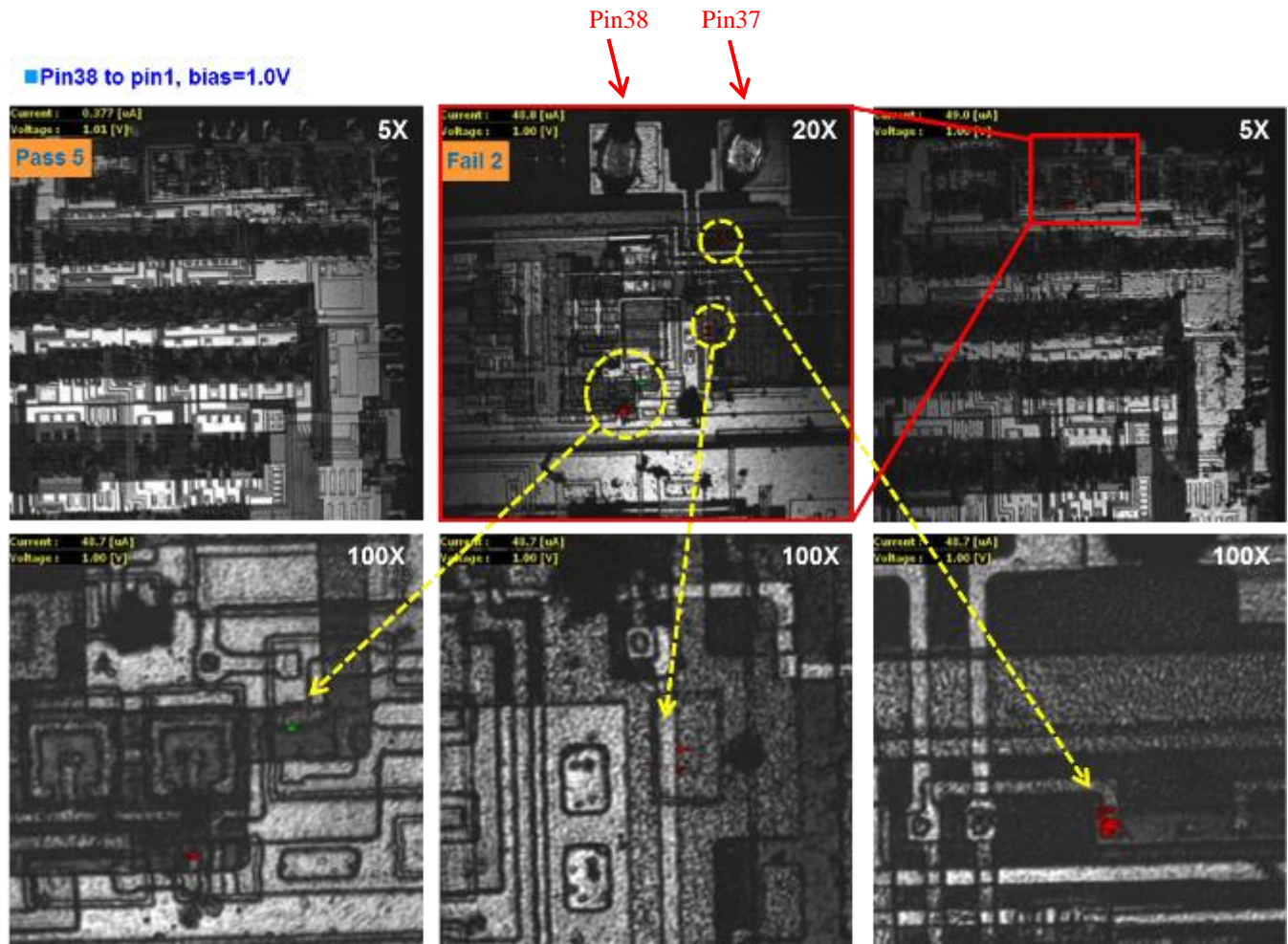


Figure 27

**F2 =>** OBRICH analysis of failing sample 2. Hot spots are shown in Red and Green colors. Upper left photo represents a Ref sample. No emission site is observed on the Reference sample.

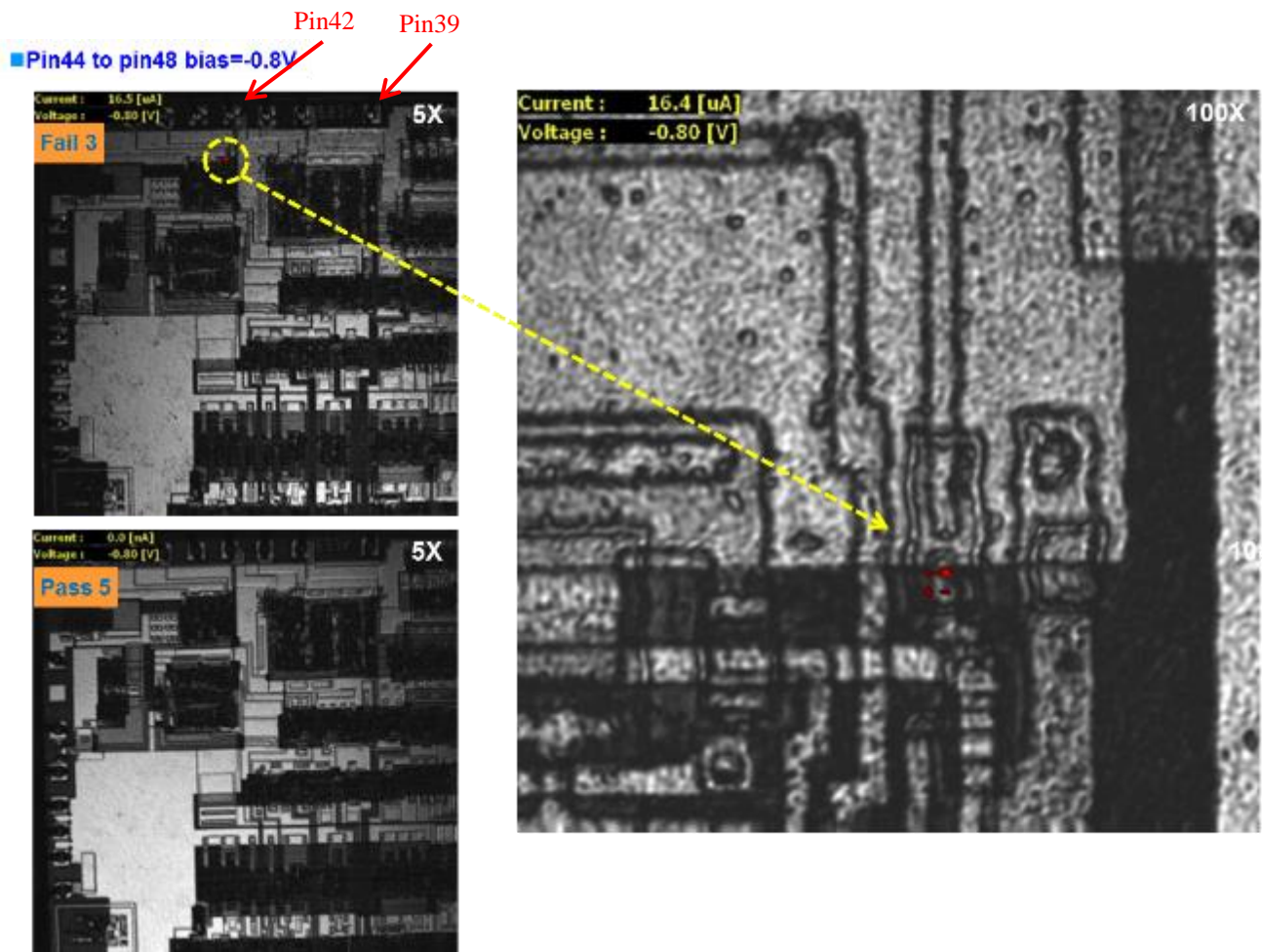


Figure 28

**F3** => OBRICH analysis of failing sample 3. Hot spots are shown in Red color. Lower left photo represents a Ref sample. No emission site is observed on the Reference sample.



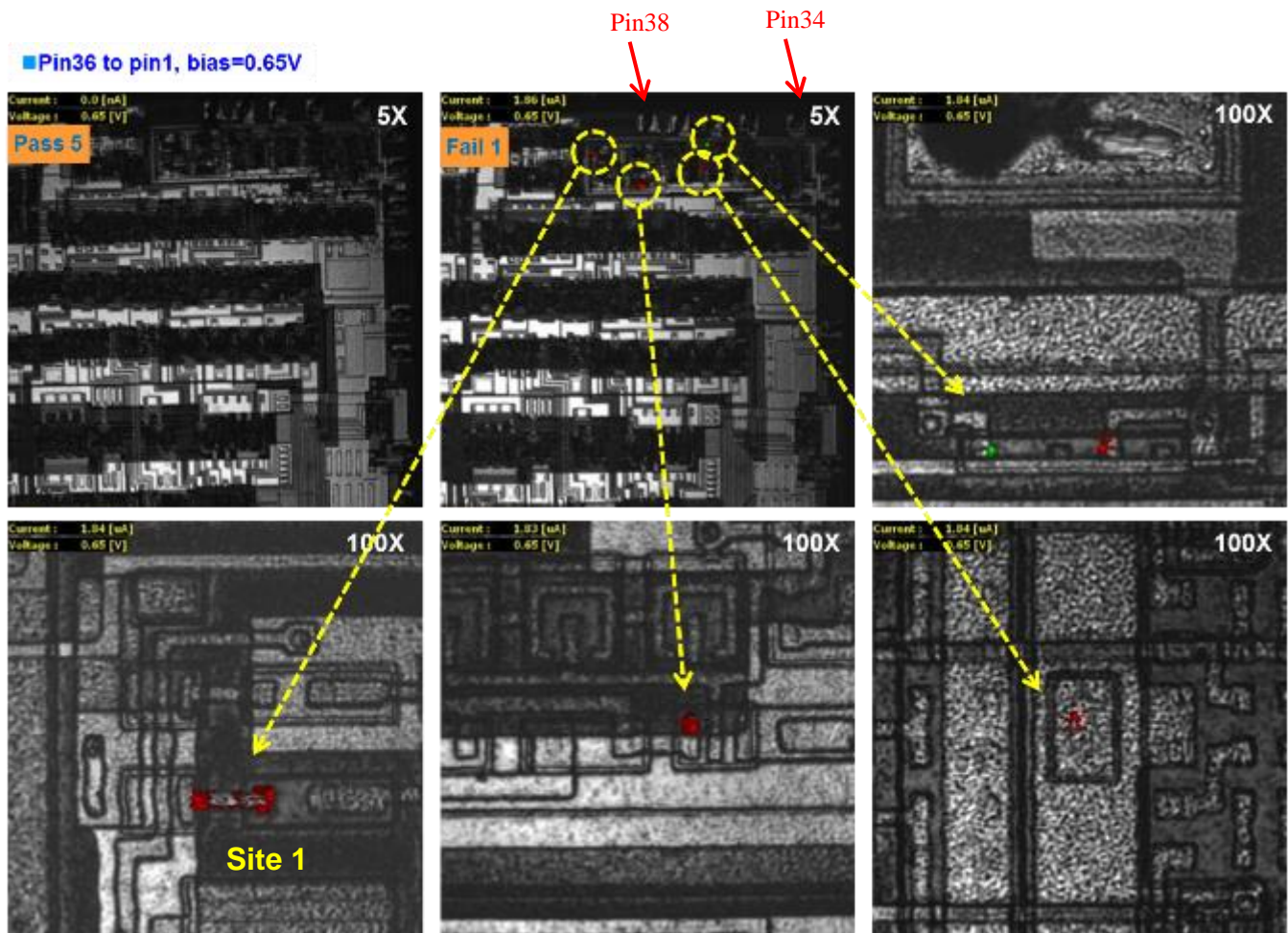


Figure 29

**F1 => OBRICH analysis of failing sample 1.** Hot spots are shown in Red and Green colors. Upper left photo represents a Ref sample. No emission site is observed on the Reference sample.

**Site 1 was selected for mechanical delayering**

### Delayer and OM Inspection of F1 Sample (M2 Layer)

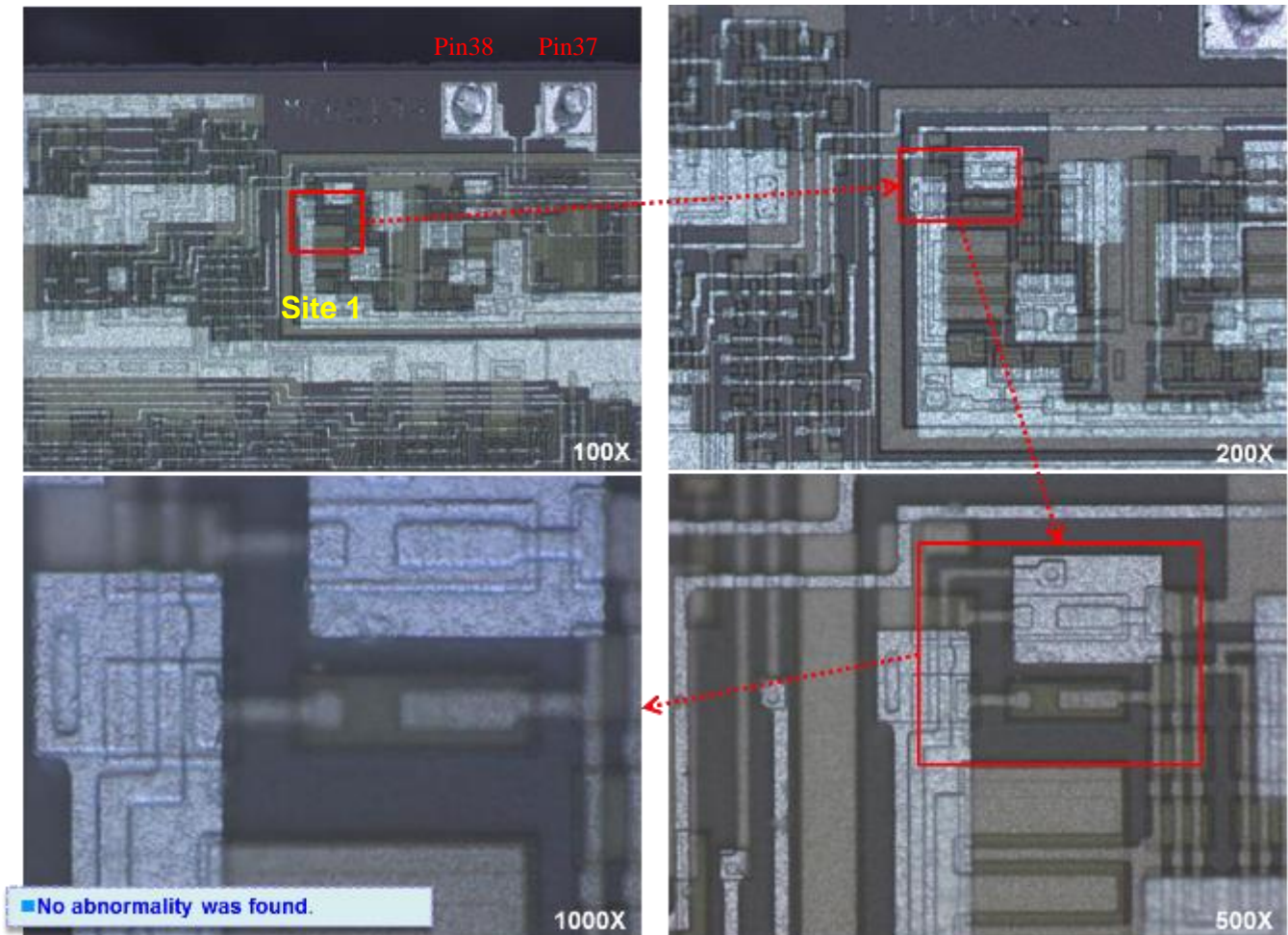


Figure 30

F1 => Close up photos of Site 1 on M2 layer. No anomaly was observed.

### Delayer and OM Inspection of F1 Sample (M1 Layer)

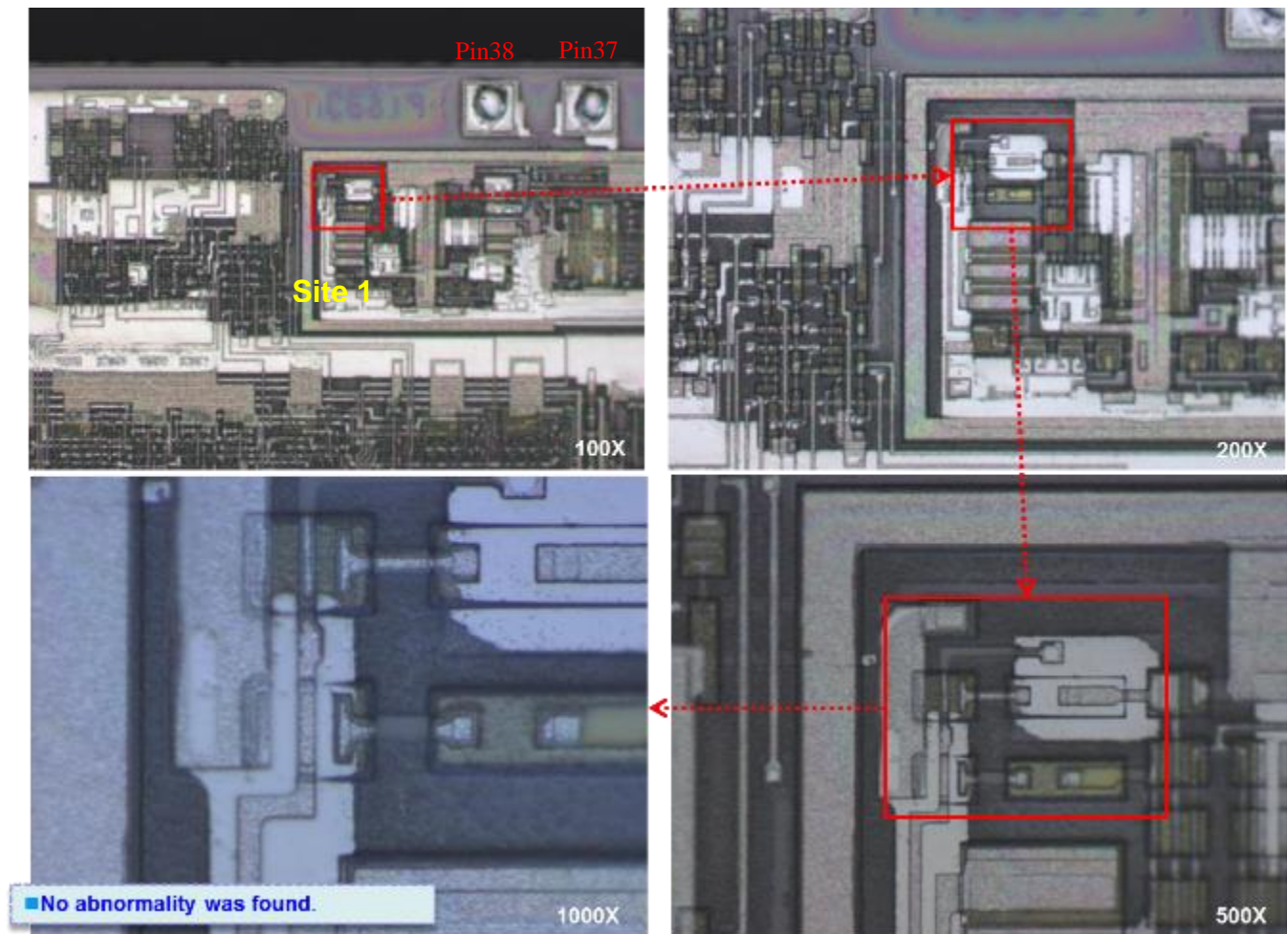


Figure 31

F1 => Close up photos of Site 1 on M1 layer. No anomaly was observed.



### Delayer and OM Inspection of F1 Sample (Contact Layer)

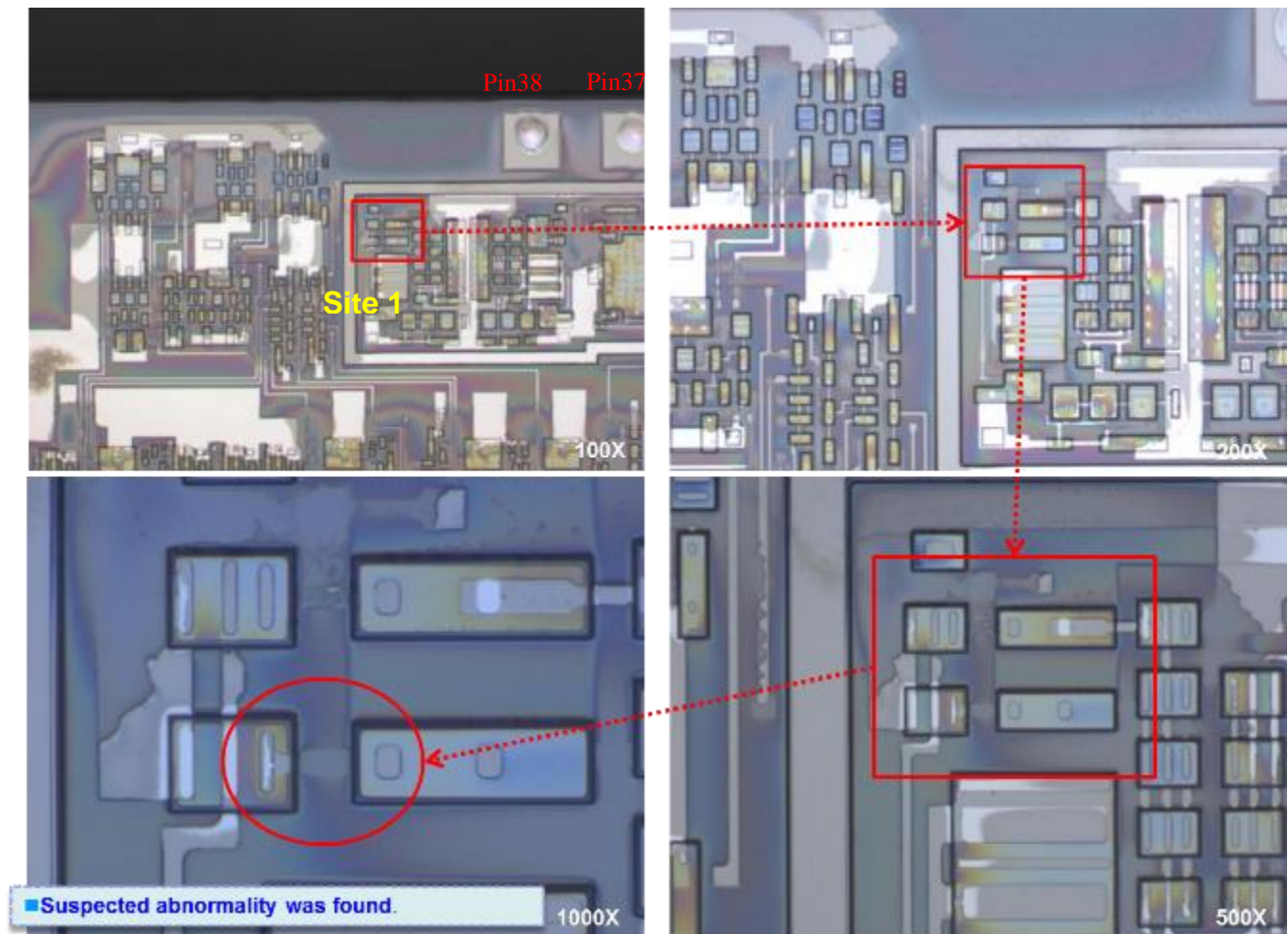


Figure 32

**F1 =>** Close up photos of **Site 1** on Contact layer. An anomaly was observed. Anomaly area is shown in red circle. Most likely cause of anomaly is ESD.

### Delayer and SEM Inspection of F1 Sample (Poly Layer)

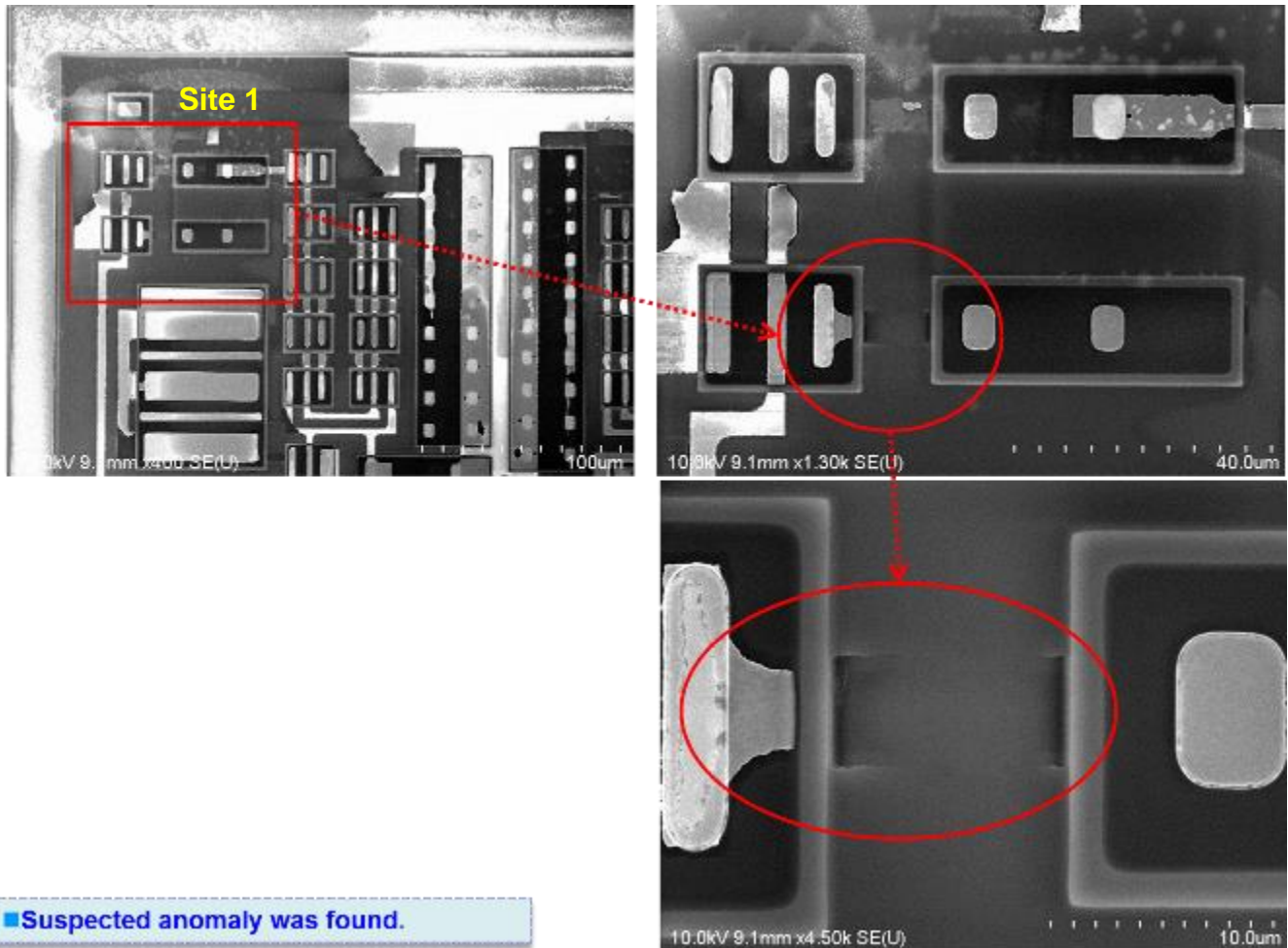


Figure 33

**F1** => Close up SEM photos of **Site 1** on Poly layer. An anomaly was observed. Anomaly area is shown in red circle. Most likely cause of anomaly is ESD.

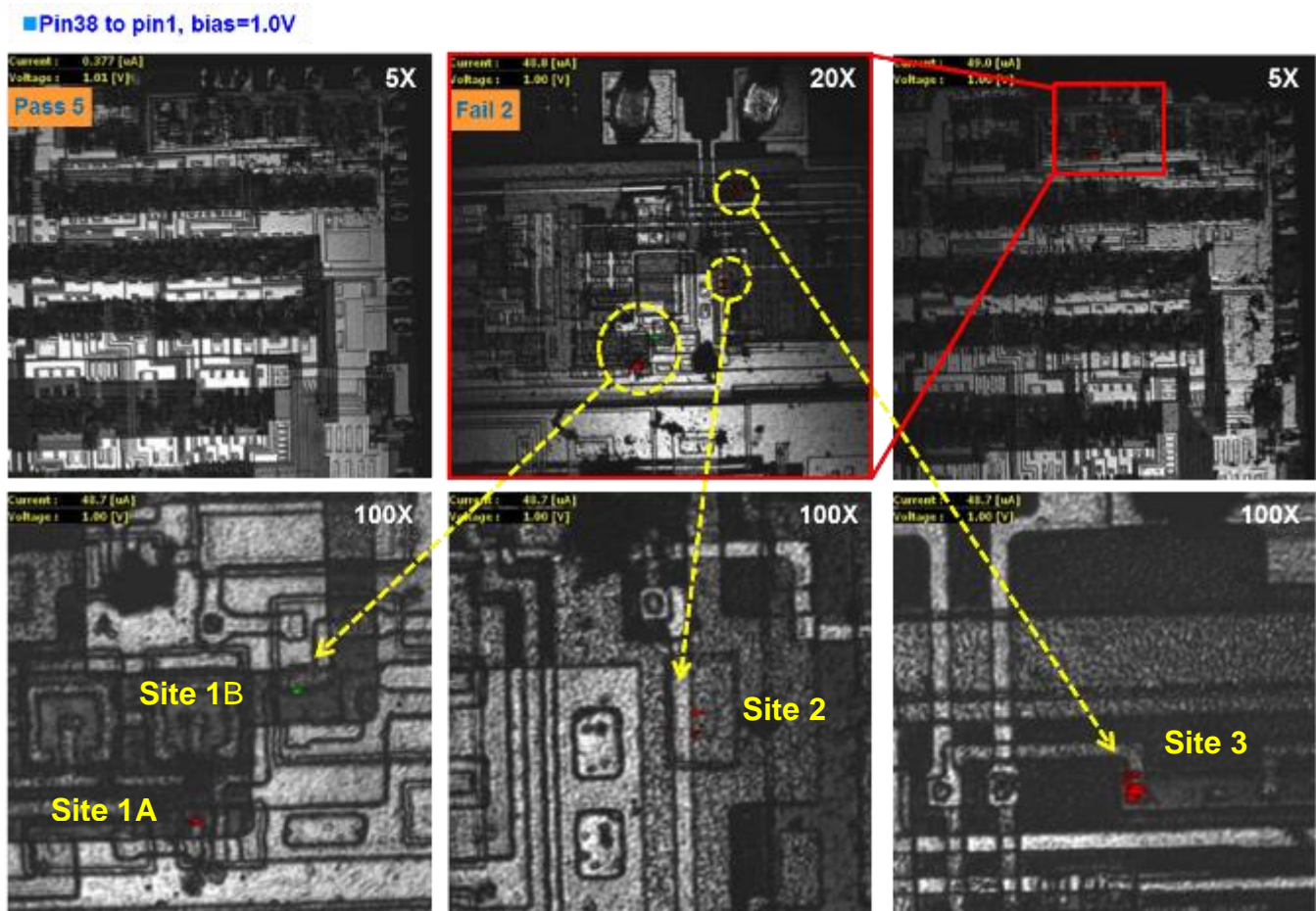


Figure 34

**F2 => OBRICH analysis of failing sample 2.** Hot spots are shown in Red and Green colors. Upper left photo represents a Ref sample. No emission site is observed on the Reference sample.

**Site 3 was selected for mechanical delayering**



### Delayer and OM Inspection of F2 Sample (M2 Layer)

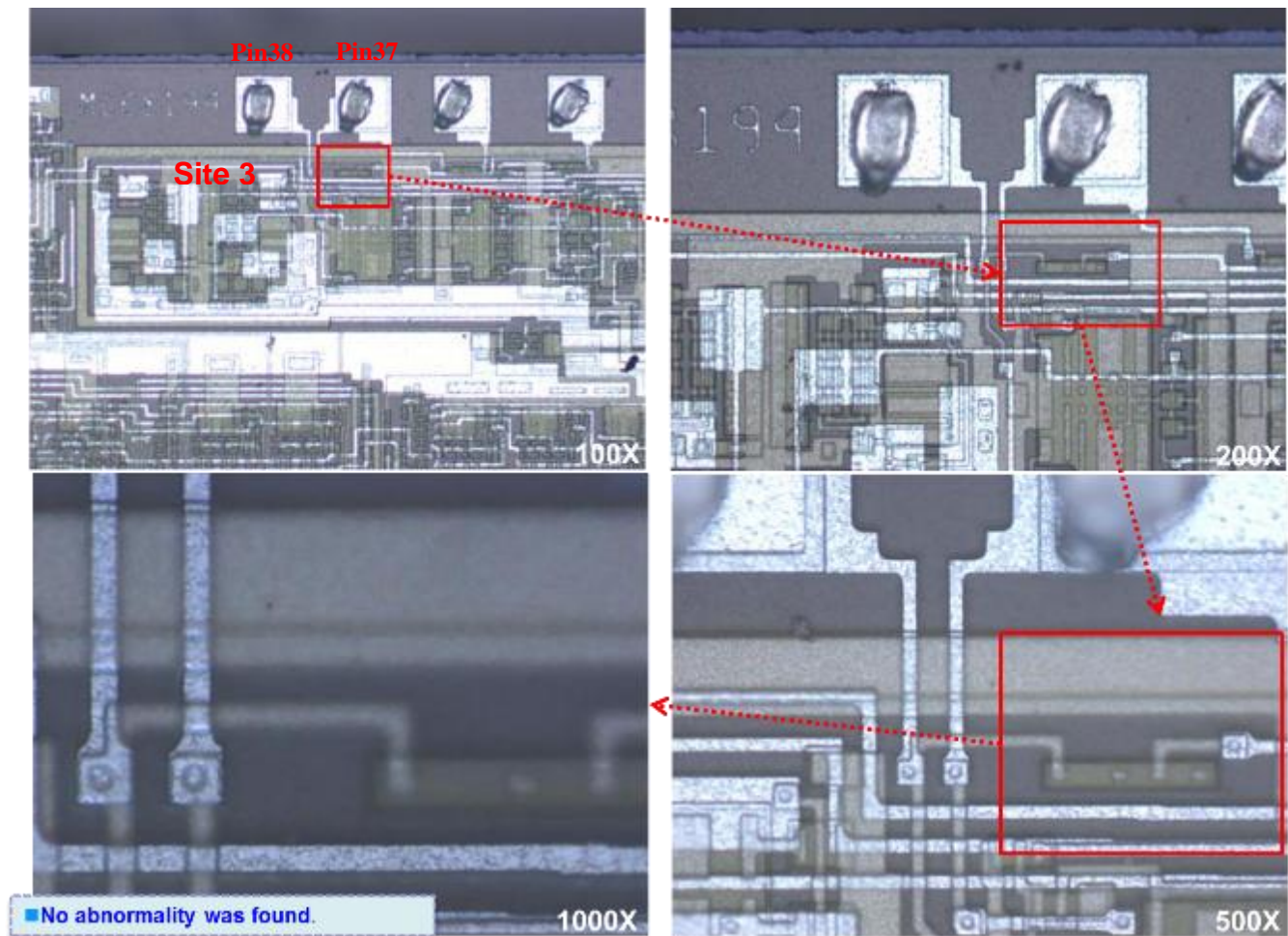


Figure 35      F2 => Close up photos of Site 3 on M2 layer. No anomaly was observed.

### Delayer and OM Inspection of F2 Sample (M1 Layer)

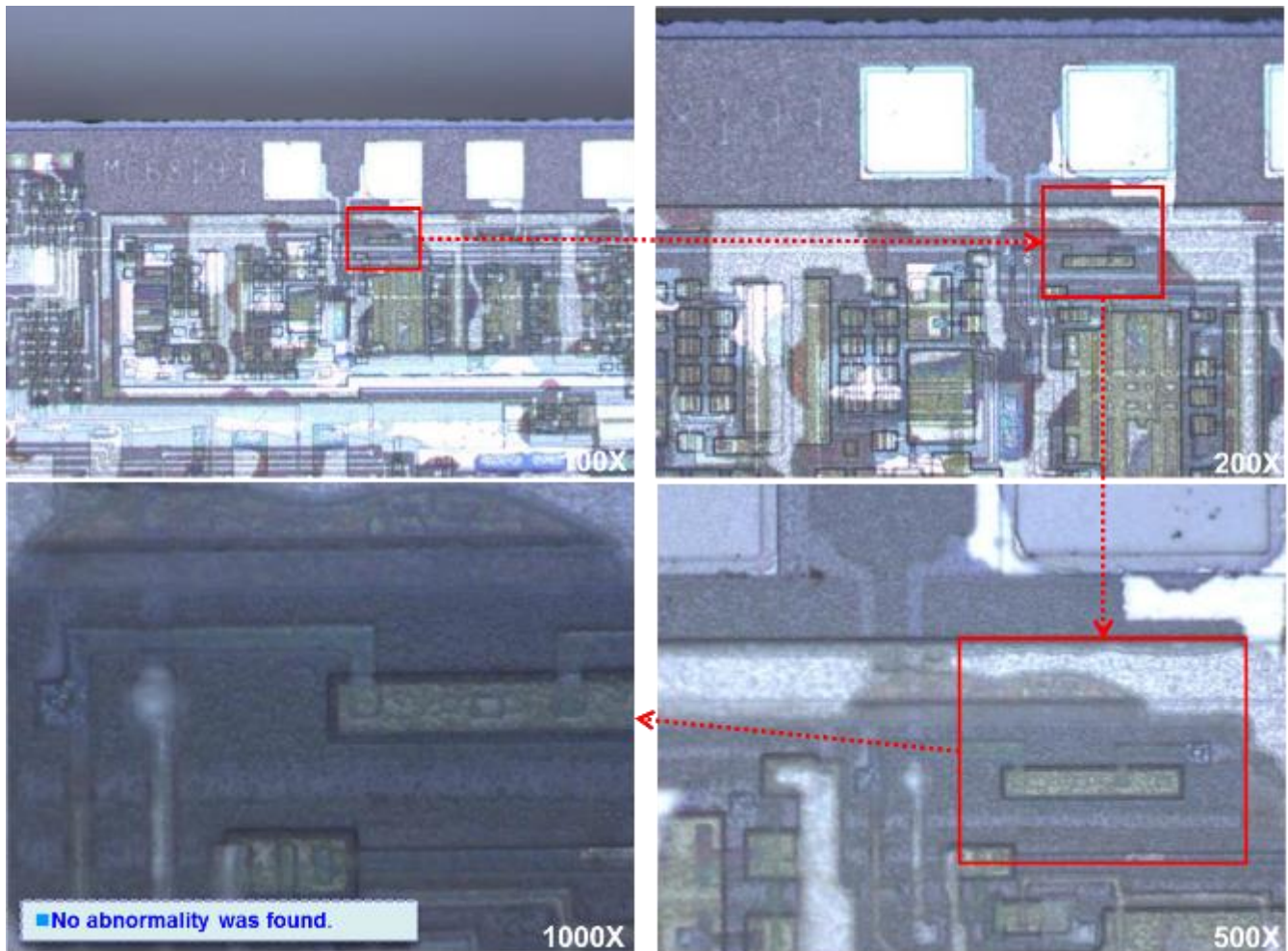


Figure 36

F2 => Close up photos of **Site 3** on M1 layer. No anomaly was observed.



### Delayer and OM Inspection of F2 Sample (Contact Layer)

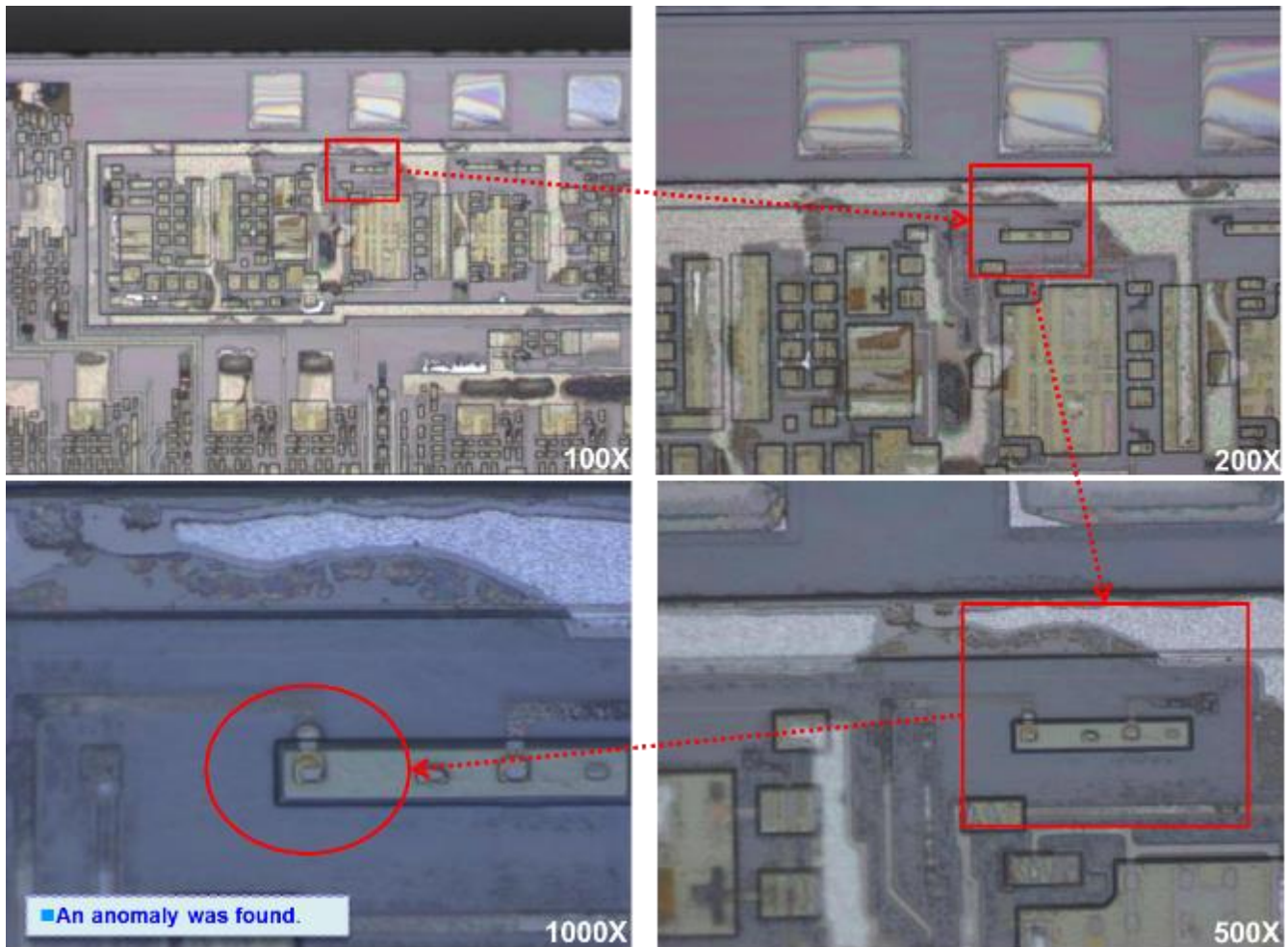


Figure 37

**F2 =>** Close up photos of **Site 3** on Contact layer. An anomaly was observed. Anomaly area is shown in red circle. Most likely cause of anomaly is ESD.

### Delayer and SEM Inspection of F2 Sample (Poly Layer)

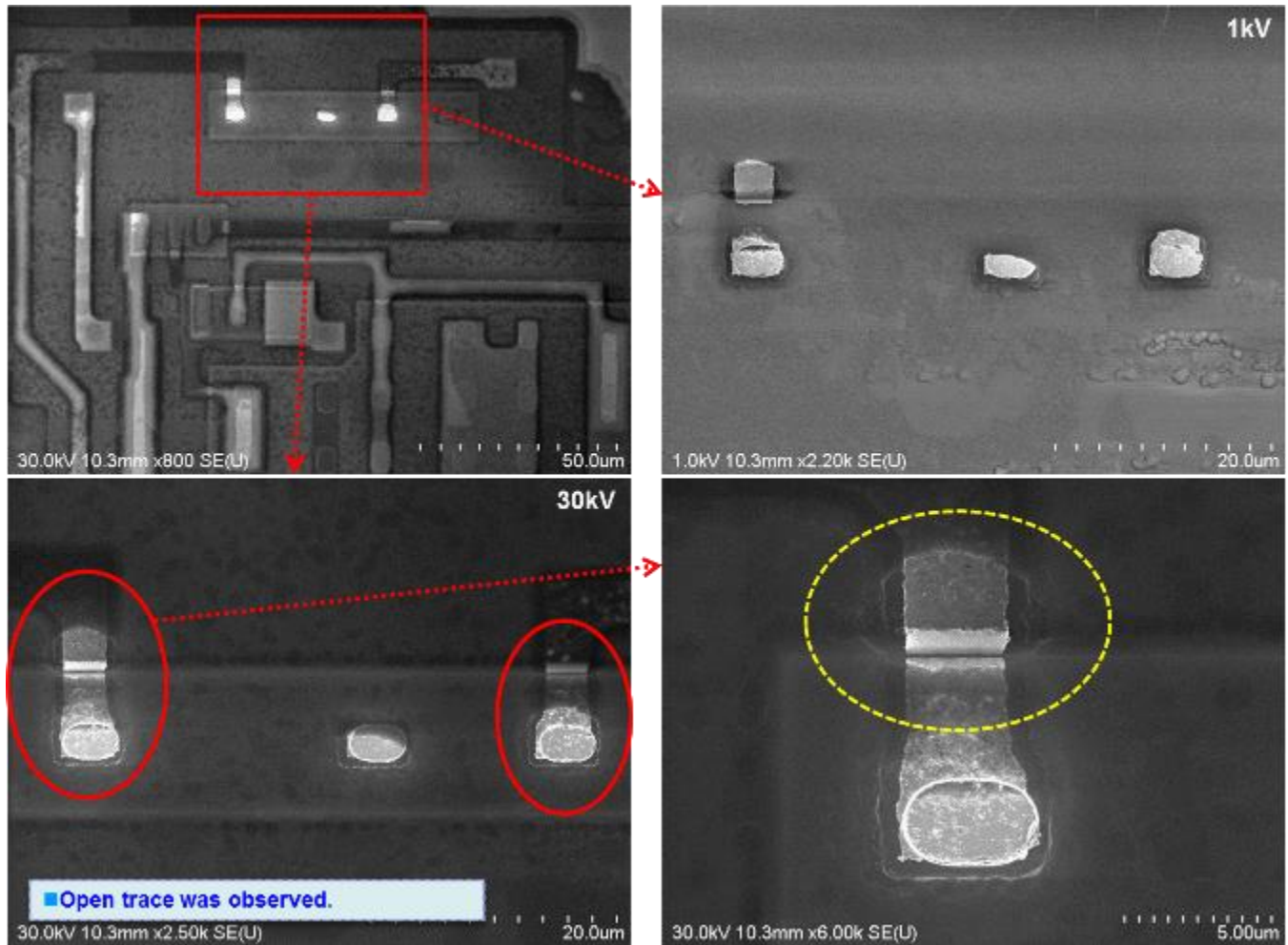


Figure 38

**F2 =>** Close up SEM photos of **Site 3** on Poly layer. Open traces were observed. Open traces are shown in circles. Most likely cause of the open is ESD.

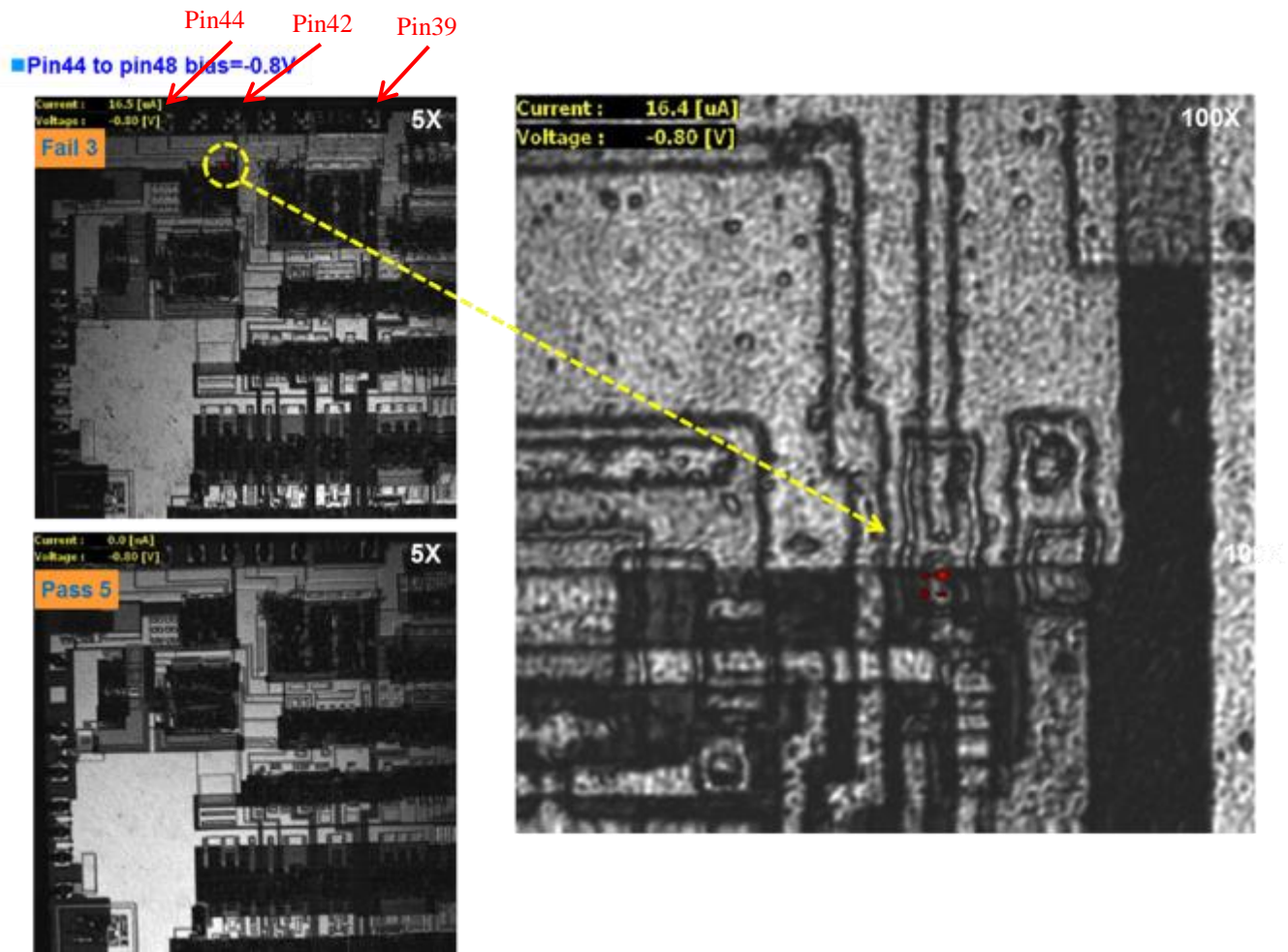


Figure 39

**F3** => OBRICH analysis of failing sample 3. Hot spots are shown in Red color. Lower left photo represents a Ref sample. No emission site is observed on the Reference sample.



## Delayer and OM Inspection of F3 Sample (M2 Layer)

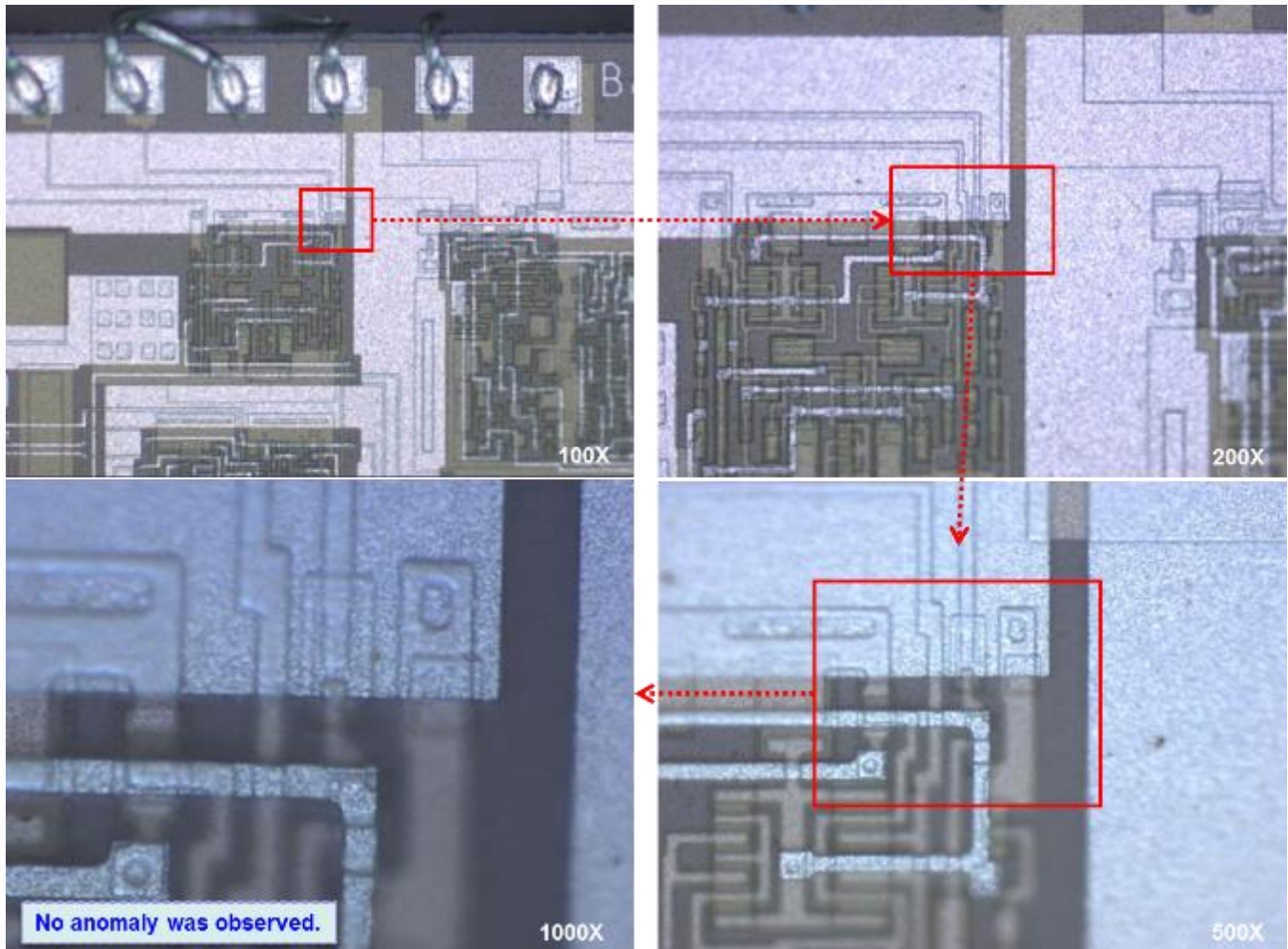


Figure 40

**F3** => Close up photos of M2 layer. No anomaly was observed.

## Delayer and OM Inspection of F3 Sample (M1 Layer)

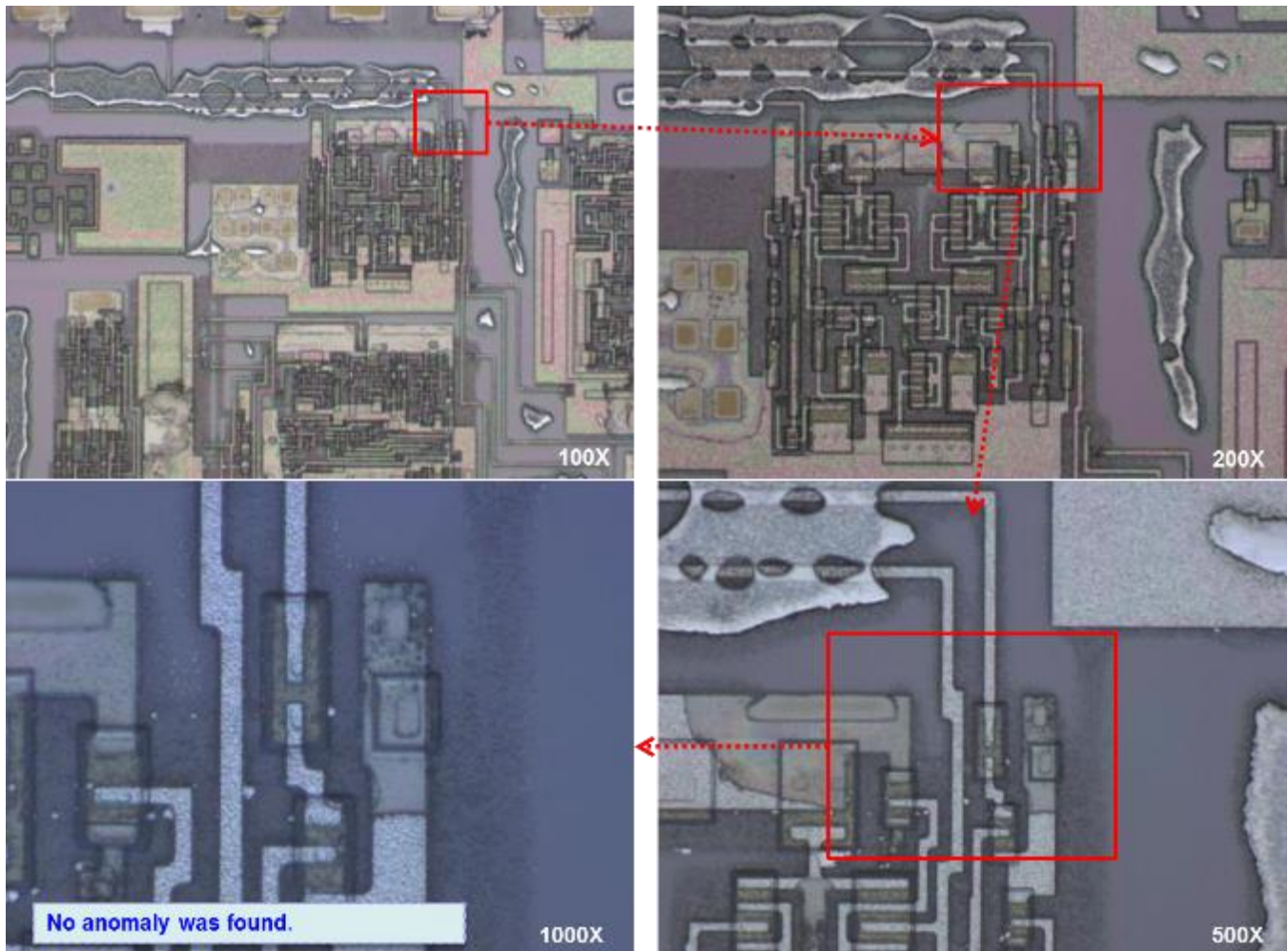


Figure 41

**F3 =>** Close up photos of M1 layer. No anomaly was observed.



### Delayer and OM Inspection of F3 Sample (Contact Layer)

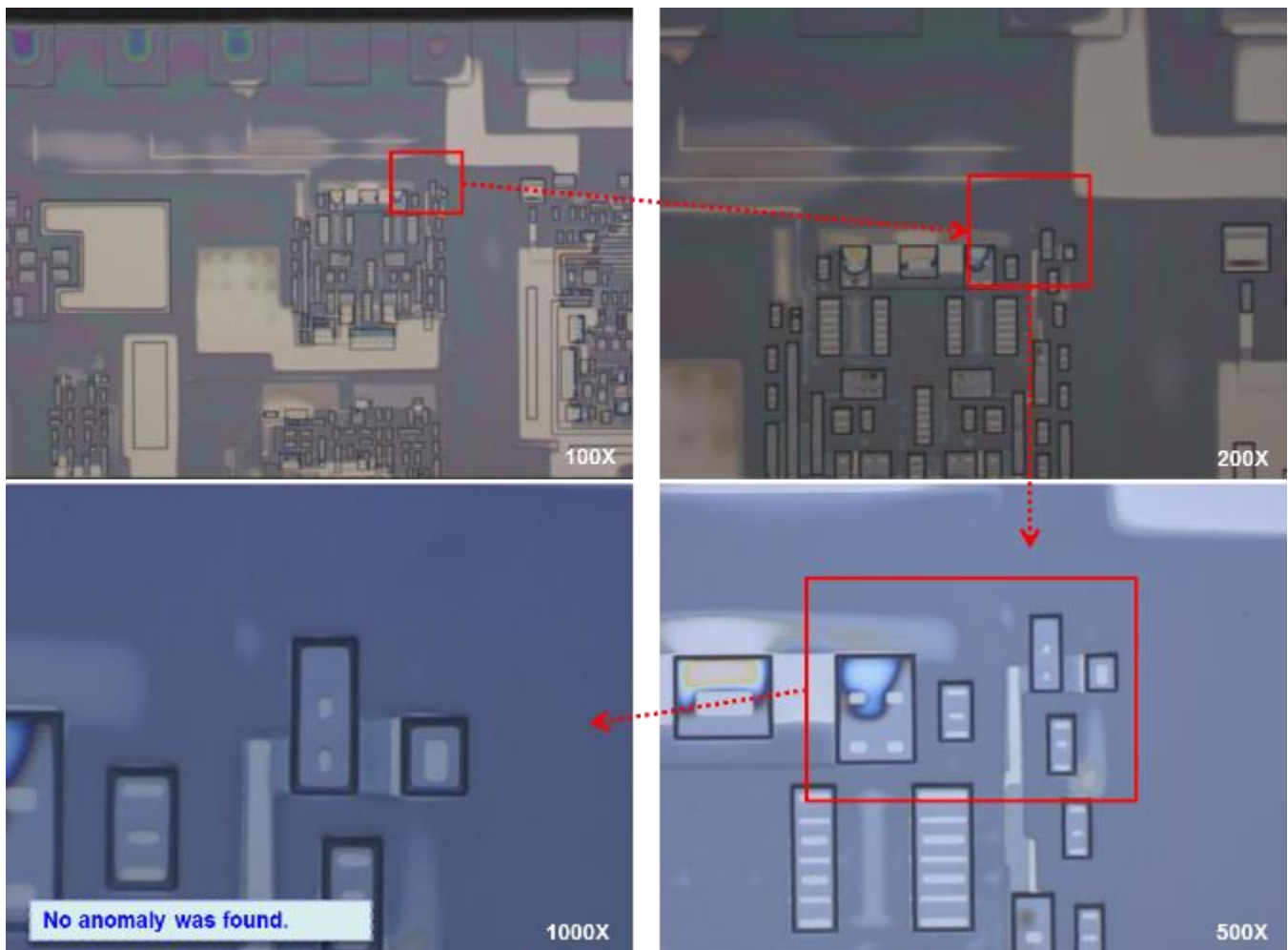


Figure 42

F3 => Close up photos of Contact layer. No anomaly was found.

### Delayer and SEM Inspection of F3 Sample (Poly Layer)

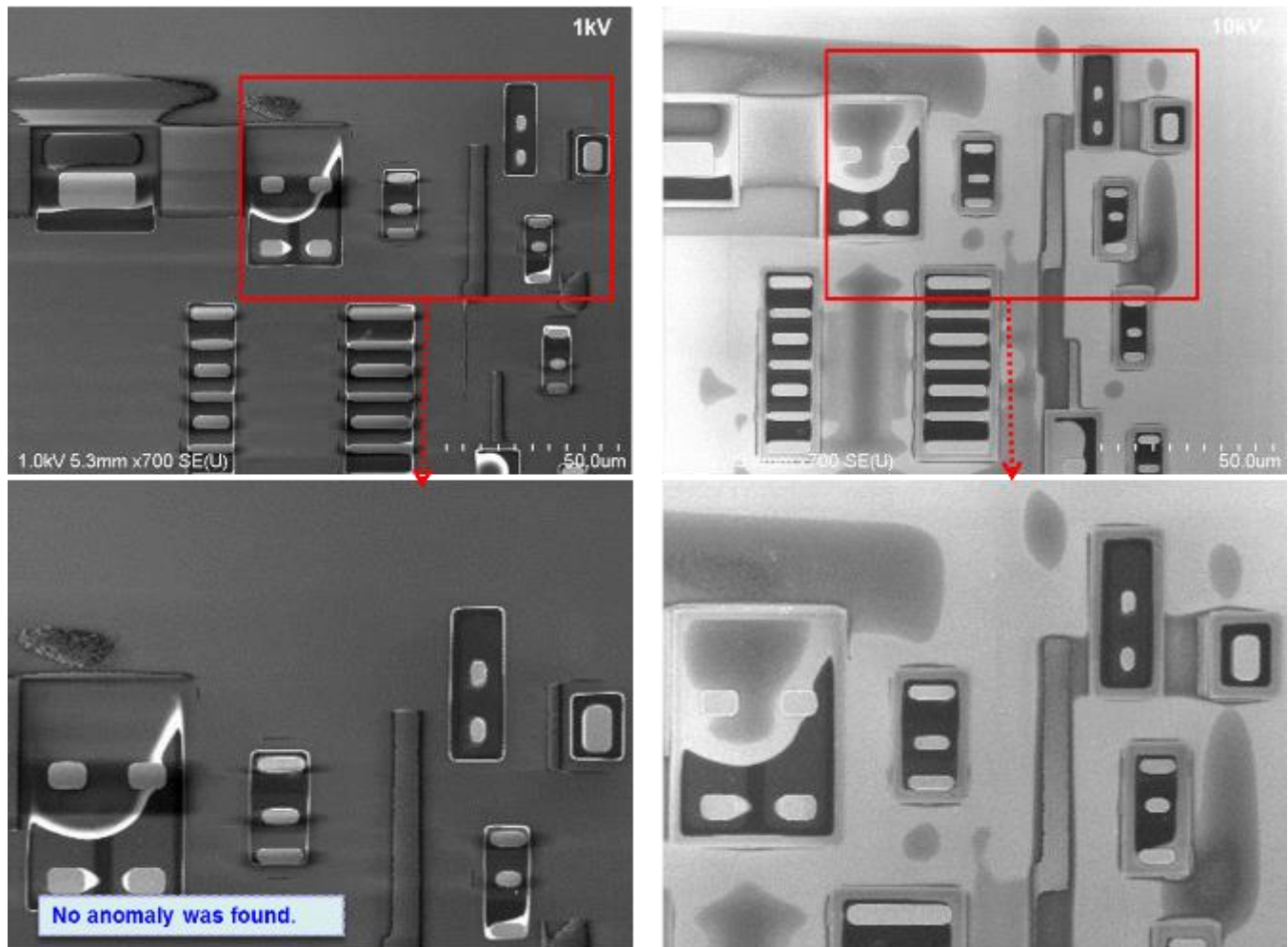


Figure 43

F3 => Close up SEM photos of Poly layer. No anomaly was observed

### Delayer and SEM Inspection of F3 Sample (Substrate Layer)

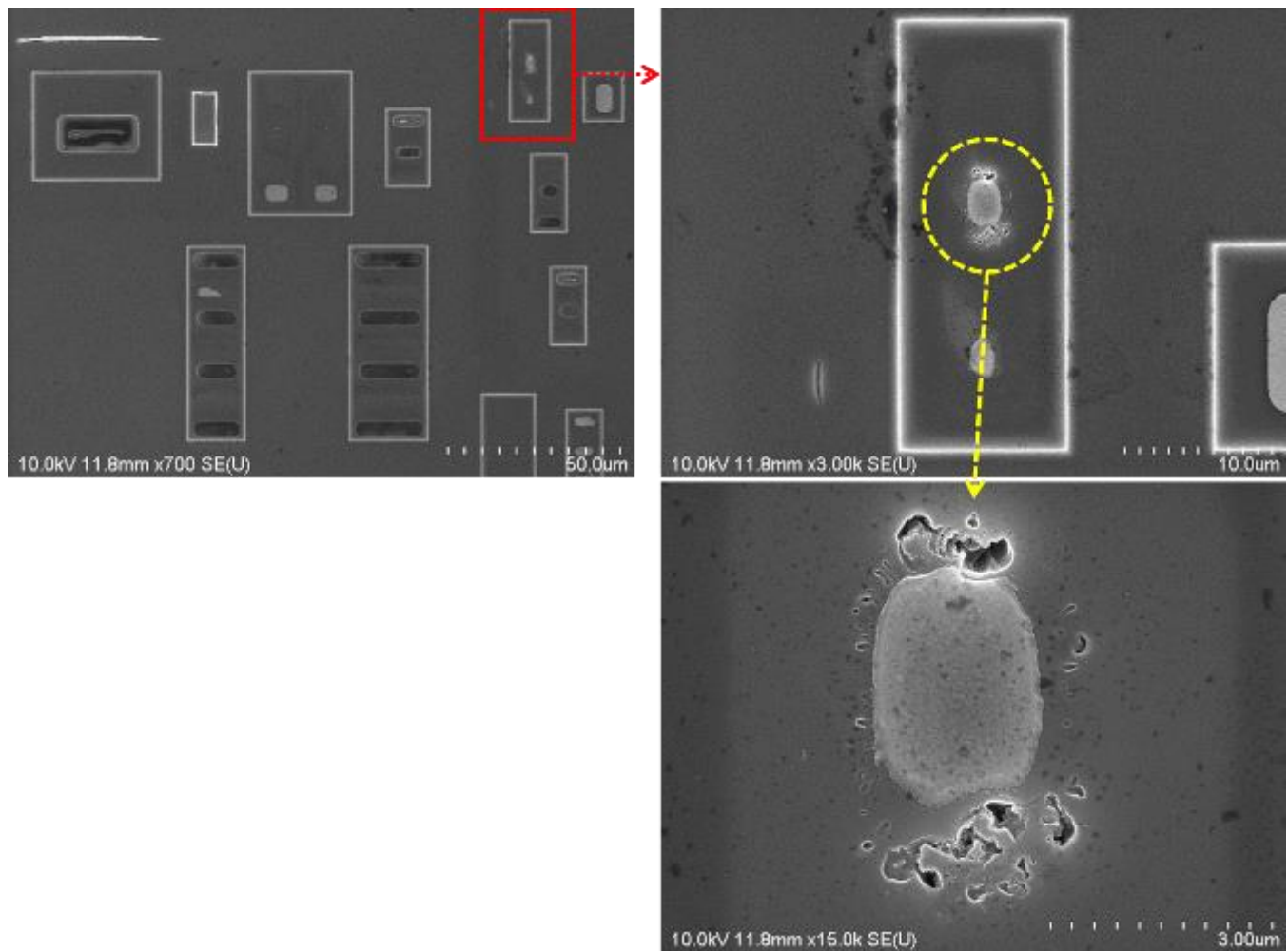


Figure 44

**F3 =>** Close up SEM photos of Substrate layer. A damage site was observed. The damage site is shown inside the yellow circle. Most likely cause of damage is ESD.