TEXAS INSTRUMENTS

08/22/2014

Final Report

The following product has been received, verified and analyzed at the Texas Instruments PWR business entity in Warrenville, Illinois.

Customer:	ARROW ELECTRONICS TAIWAN LTD	**Date Received:**	07/17/2014
Customer Location:	TAIPEI (TAIWAN)		
Customer Part #:		**TI Device Type:**	DCP021212DU/1K
Customer Ref #:	Mapletek - RTW	**TI Tracking #:**	QTS # 404768
Quantity Returned:	2 devices	**CR**	CR1878
Origin of Detection:	Field and final assembly	**RMA**	3881TG

Devices:

TI Unit ID:	Customer Unit ID:	Lot Trace Code (LTC):	Assembly Site:	Wafer Fab Lot #:	Wafer Fab Site:
1		38Z3R2H	HNT	V6229XPL	TEX
2		38Z3R2H	HNT	V6229XPL	TEX

Customer Problem Description:

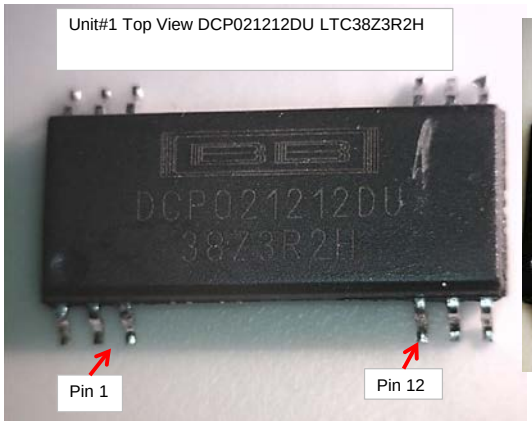
M13D12 is our power module, it is +12V input voltage convert to +12V/-12V (DC to DC) isolated power circuit. TI DCP021212DU is main component on M13D12 circuit. In previous design, we use MeanWell DCW03A-12D DC to DC isolated power module. For the failure rate issue, we would like to replace MeanWell DCW03A-12D with M13D12.

1pc from production failure, F/R:1/100. The other 1pc failed from end customer side.

QC procedure of M13D12 shows as below:
Step1: [Module TEST]: To measure the output voltage with the heavy-loading (+80mA/-80mA) and the light-loading (+30mA/-5mA). The pass condition is the output voltage range meet between 12.6V and 11.4V.
Step2: [Board TEST]: After each M13D12 had passed heavy-loading (+80mA/-80mA) and light-loading (+30mA/-5mA) test, we just add M13D12 to8-chanels A/D conversion board. In 8-chanels A/D conversion board, M13D12 actual loading are +50mA on +12V output and -25mA on -12V output. The pass condition is the output voltage range meet between 12.6V and 11.4V.
Step3: [System TEST]: Running auto-test program with CPU board over three-day in room-temperature. If we make sure the output voltage range still meet between 12.6V and 11.4V, we ship to the customer.

There are 2pcs M13D12 fail until now, the detail description shows as below:
(a) Case 1: The customer returns 1pcs 8-chanels A/D conversion board, and DCP021212 failed. After turn on power, the temperature over 150°C within 3 second, then thermal protection was enabled and the output voltage drop below 5V.
(b) Case 2: In our QC procedure, we also found 1-pcs DCP021212 failed in the system test (Step3). After turn on power the temperature of over 150°C spontaneously, then thermal protection was enabled and the output voltage drop below 5V.

Pictures Unit#1 and Unit #2



TI Test Results:

(2) DCP021212U/1K converters were received and analyzed. They have a low resistance short between (+) VIN, pin 1, and (Vout) Vout, pin 12 across the isolation barrier

1**. Package Analysis**

External Package Examination:

The external package surfaces were inspected with a stereo microscope. The packages were in normal condition with no evidence of damage to the plastic encapsulant. Residual solder was seen on the external pins.

2. X-Ray Analysis

The internal package construction was evaluated by x-ray imaging (Figures 3 and 4). Assembly workmanship was normal and there was no evidence of damage to the die or the package. Bond wire workmanship appeared normal.

3. Electrical Characterization

The unit was subjected to an unpowered curve trace evaluation. The I-V characteristics of each pin were observed and compared to a known good unit. Pin-to-pin analysis showed a shorting condition from pin 1 (Vs) to pin 12 (V0) in each unit.

4. Decapsulation:

Both units were decapsulated. An area was laser ablated over and through the transformer and core windings to provide exposure for optical inspections

5. Internal Optical Inspection:

Optical inspections found degraded and missing coating of the copper magnet wire windings.

- Physical Mechanism ID: Exposed and shorted coincident wound copper windings of the transformer

Failure Analysis Results:

1. Both DCP021212DU/1Ks failed as a result of a short from primary to secondary windings on the transformer. Laser ablation decapsulation of the transformer found exposed copper windings with missing wire coating. The transformer windings on this model are coincident wound, primary and secondary windings overlapping. This means that any damage to the wire's coating can result in a short from the transformer's primary to secondary terminals and catastrophic failure.

Failure Analysis continued

2. Degradation of the magnetic wire varnish can occur if the DCP is exposed to a high humidity environment followed by high temperature exposure, such as solder re-flow. During qualification, results from moisture reliability testing resulted in the MSL3 classification. The magnetic wire insulation, a thin polyesterimide varnish, can degrade in a moist environment. Data from magnetic wire manufactures reports polyesterimide tends to hydrolyze in the presence of water at elevated temperatures. For the DCP product line, MSL3 needs to be strictly followed. If product from previously opened packages are going to be exposed to solder re-flow, then prebake is recommended prior to re-flow solder process. .

3. SMT MSL-3 Processing Requirements:

The Converters are shipped MSL-3 (Moisture Sensitivity Level 3) from Texas Instruments in tape and reel (with 1000 converters) per reel which are dry packed and marked as MSL-3 with 168 hours open time.

a. The MSL-3 levels must be maintained through-out any entire reflow and manufacturing processes.

b. During each phase and before reflow solder processes at the CM, the MSL-3 level must be strictly adhered to at all times.

c. Once the MSL 3 package is open, it must be used within defined shelf life of 168 hours. . Prior to the next reflow processing, any remaining -unused converters must be dry packed and pre-baked (typically for 16 hours at 125°C when removed from the reel) for maximum reliability prior to the next reflow process. . The package must then resealed with sufficient desiccant bags to maintain the MSL-3 level control at all times and prior to the next reflow process.
Pre-baking is the standard processing procedure for adherence to the MSL-3 control at each facility. The defined control method and baking times are identified in JST-033. Plus additional desiccant is enclosed in the package after pre-baking to assure MSL-3 arrival compliance at the final reflow facility.

d. **Complete analysis QTS404768-1** The complete report attached 1 identifies the transformer wire hydrolyzation affected by high moisture levels with non-hermitically sealed converters during the reflow processing.

Actions / Disposition:

No further actions are planned.

Contacts:

	Name:	Email:
CQE Plug-in-Power :	Thomas Guerin	tguerin@ti.com

FAILURE ANALYSIS REPORT

TEXAS INSTRUMENTS

TI Information - Selective Disclosure

Device Analysis Services

FA404768-1

Customer:	ARROW ELECTRONICS TAIWAN LTD	**Assy Site:**	HNT
Customer Tracking ID:	Mapletek - RTW	**Fab Site:**	TEX
Customer Part ID:		**Technology:**	ST-BDCMOS
Customer Contact:	Peter Pan	**Analyst:**	Armando Garcia
Device Type:	DCP021212DU/1K	**TI Contact:**	
		Qty Submitted:	2
Flow Type:	Customer Return	**Date Submitted:**	08/04/2014
Reviewer:	R. Dynes	**Approval:**	L. Copeland

Summary

Failure Analysis	Results
Customer Reported Failure Mode	The customer reported two DCP021212DU devices with output failure. One was a field failure and the second failed during production testing.
TI Failure Description	Shorted primary to secondary by either no MSL-3 controls or shorted output bus which DCP02 does not have short circuit protection. Units sent out for laser ablation
Analysis Results	These units failed as a result of a short from primary to secondary windings on the transformer. Laser ablation decapsulation of the transformer found exposed copper windings with missing wire coating. The transformer windings on this model are coincident wound, primary and secondary windings overlapping. This means that any damage to the wire's coating can result in a short from the transformer's primary to secondary terminals and catastrophic failure.

TI Unit #	Lot Trace Code	Symbolization	Wafer Fab Lot #
1	38Z3R2H	BB, DCP021212DU, 38Z3R2H	V6229XPL
2	38Z3R2H	BB, DCP021212DU, 38Z3R2H	V6229XPL

- **Customer Reported Problem Description:**

  The customer reported two DCP021212DU devices with output failure. One was a field failure and the second failed during production testing.

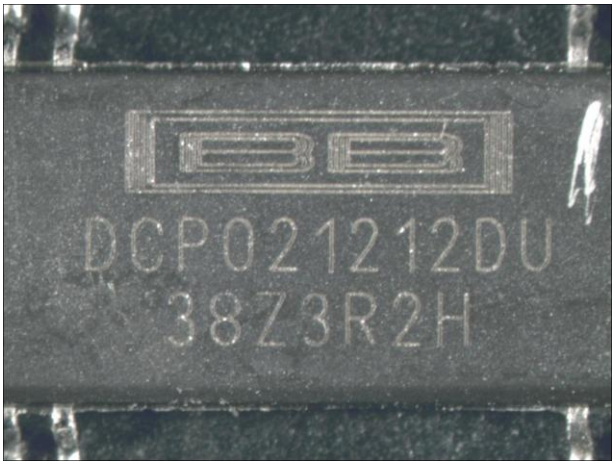
- **TI Problem Description**

  Shorted primary to secondary by either no MSL-3 controls or shorted output bus which DCP02 does not have short circuit protection.
  Units sent out for laser ablation

- **Package Analysis**

  - **External Package Examination:**

    The external package surfaces were inspected with a stereo microscope. The packages were in normal condition with no evidence of damage to the plastic encapsulant. Residual solder was seen on the external pins (Figures 1 and 2).



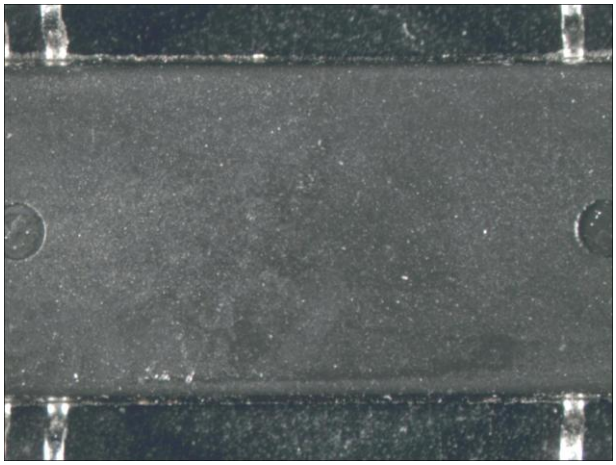


Figure 1. Unit 1. Truncated images show package condition and marking.

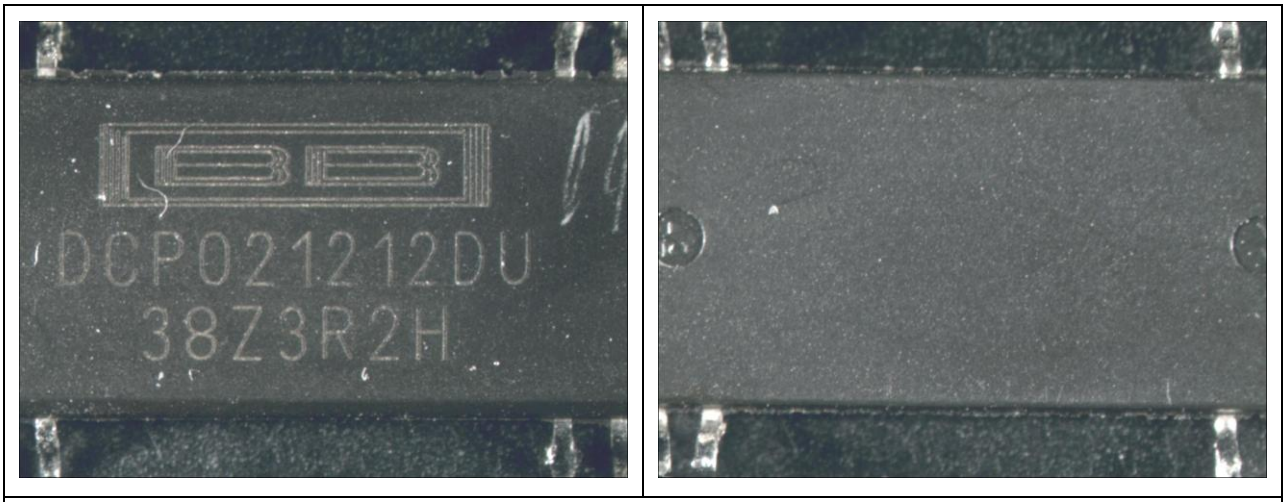


Figure 2. Unit 2. Truncated images show package condition and marking.

- **X-Ray Analysis**

  The internal package construction was evaluated by x-ray imaging (Figures 3 and 4). Assembly workmanship was normal and there was no evidence of damage to the die or the package. Bond wire workmanship appeared normal.

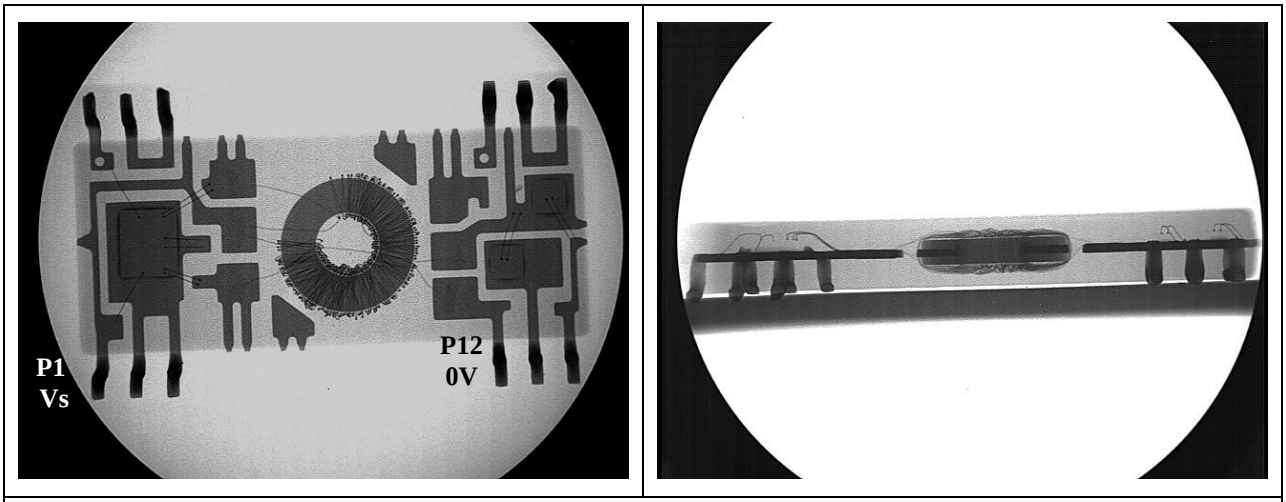


Figure 3. Unit 1. X-ray package top-down and package side views are shown.

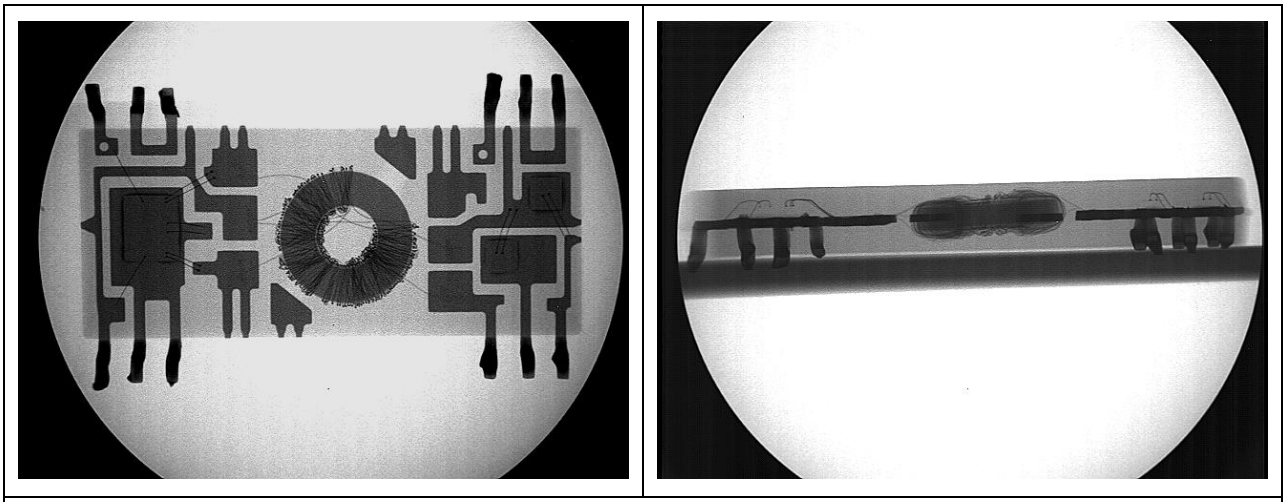


Figure 4. Unit 2. X-ray package top-down and package side views are shown.

- **Electrical Characterization**

  The unit was subjected to an unpowered curve trace evaluation. The I-V characteristics of each pin were observed and compared to a known good unit. Pin-to-pin analysis showed a shorting condition from pin 1 (Vs) to pin 12 (V0) in each unit (Figures 5 and 6).

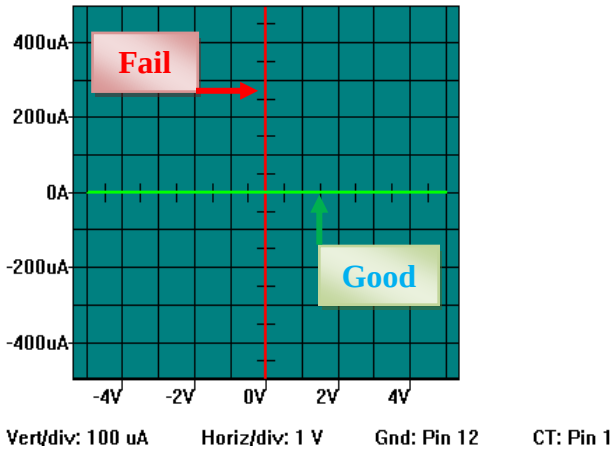


Figure 5. Unit 1. Shorting condition shown.

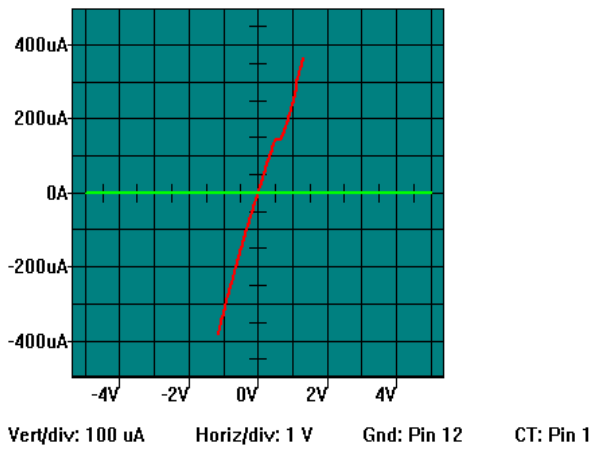


Figure 6. Unit 2. Shorting condition shown with linear resistance.

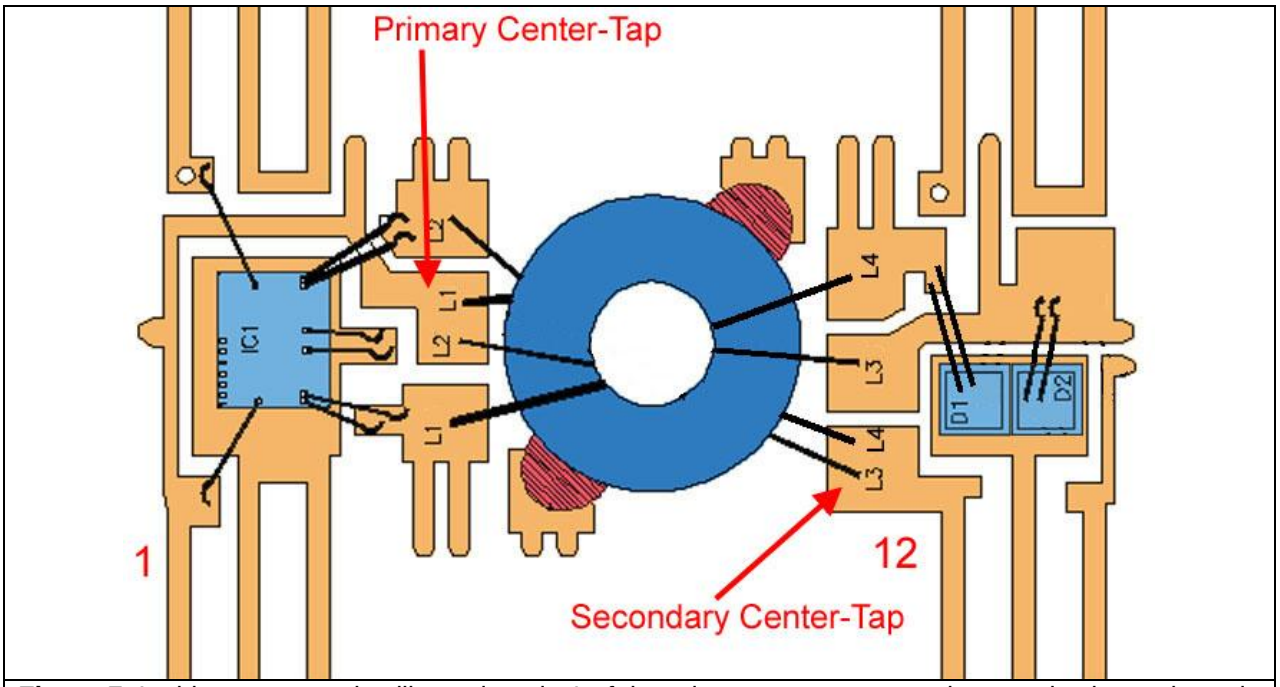


Figure 7. In this representative illustration pin 1 of the primary center-tap needs a conductive path to pin 12 of the secondary center-tap through the transformer core coincident windings to have a shorting condition.

- **Decapsulation:**

  Both units were decapsulated. An area was laser ablated over and through the transformer and core windings to provide exposure for optical inspections.

- **Internal Optical Inspection:**

  Optical inspections found degraded and missing coating of the copper wire windings (Figures 8 and 9).

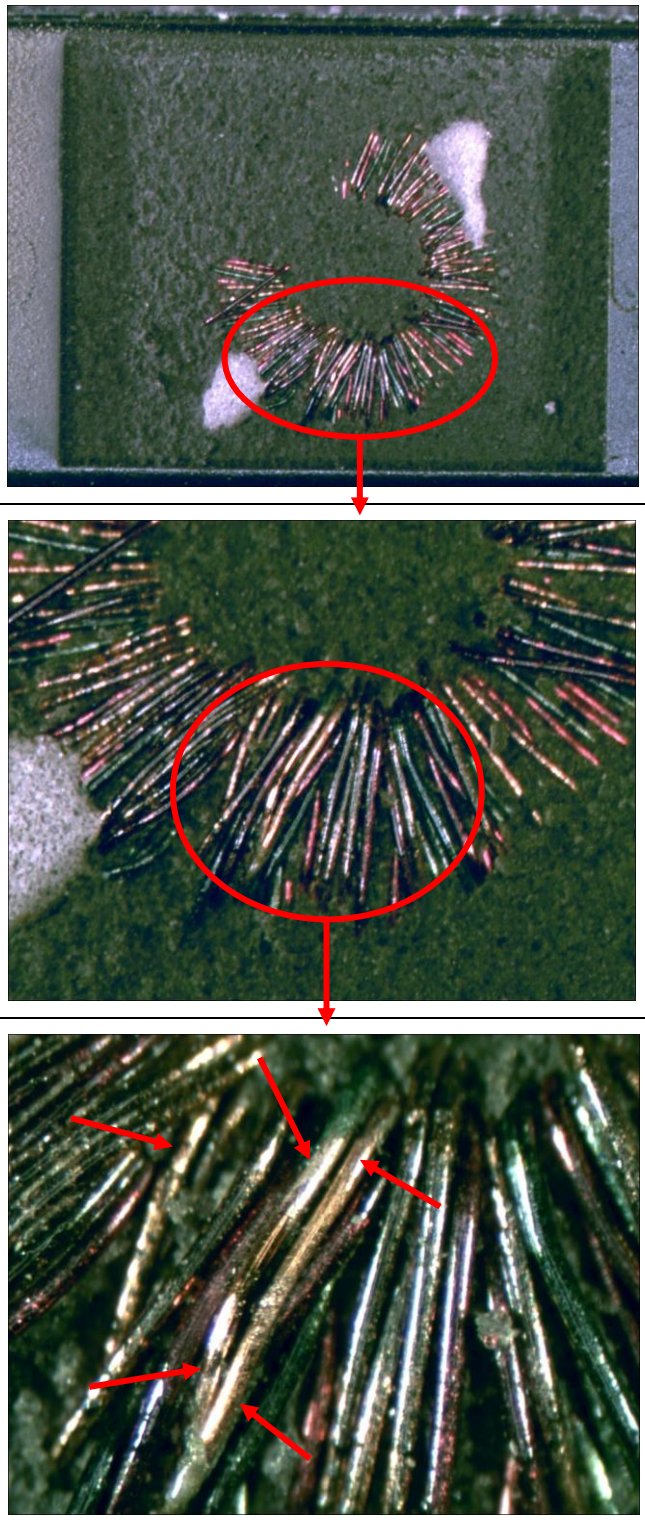


Figure 8. Unit 1. Transformer core windings showed exposed copper.

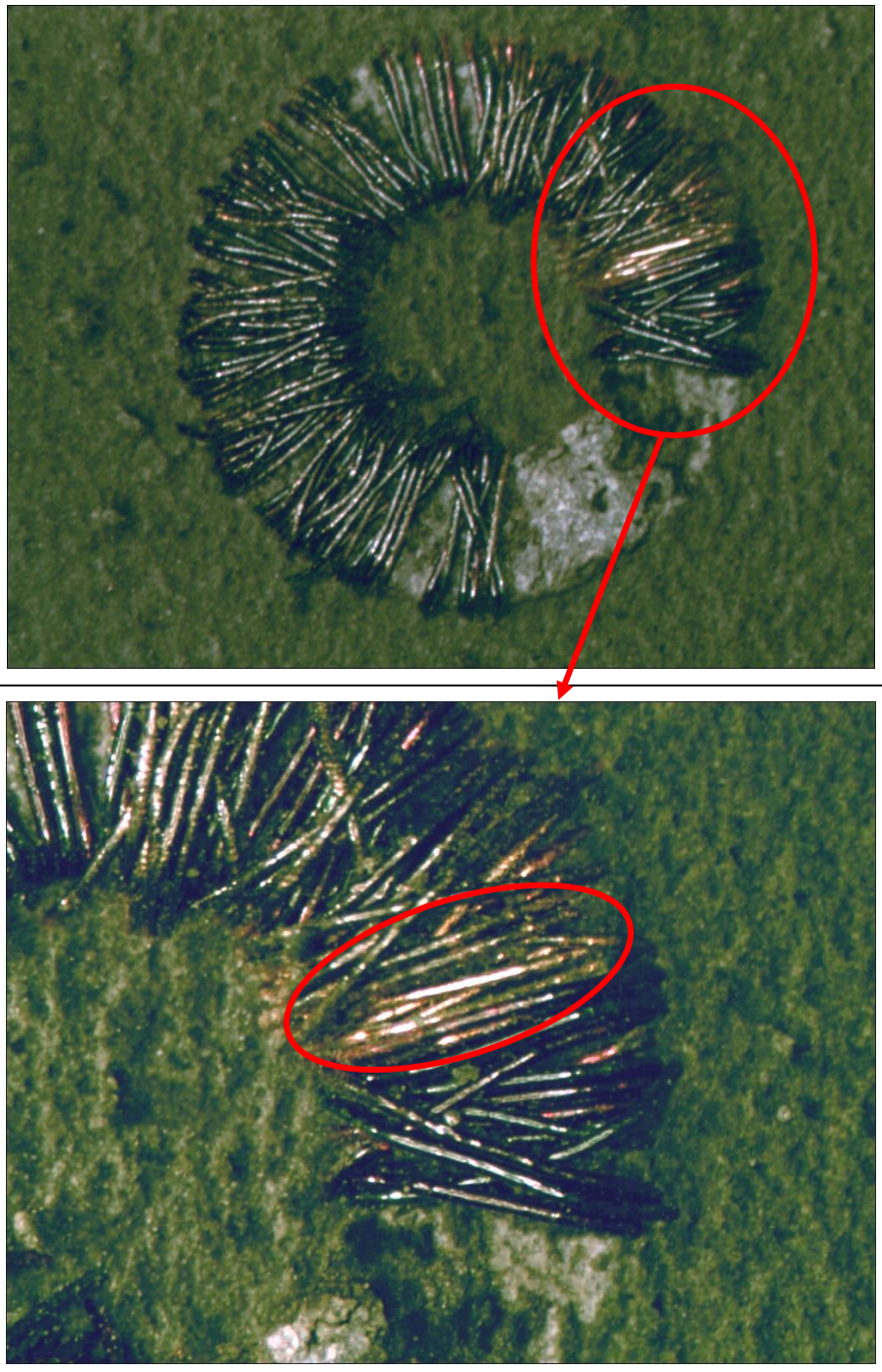


Figure 9. Unit 2. Transformer core windings showed exposed copper.

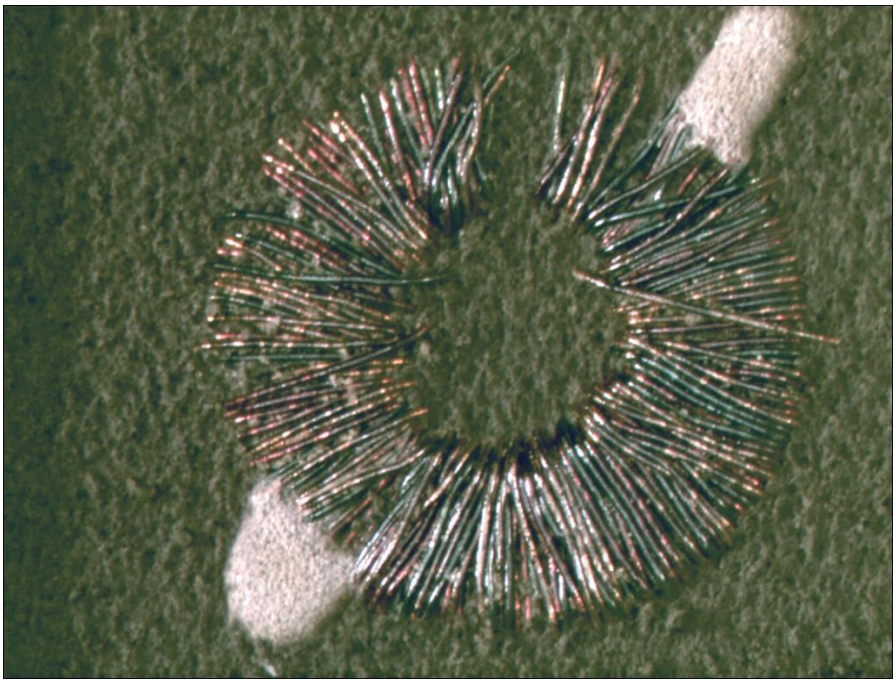


Figure 10. Control Unit. No degraded coating over copper windings is shown.

- **Physical Mechanism ID:**

  Exposed and shorted coincident wound copper windings of the transformer.

- **Conclusion:**

  These units failed as a result of a short from primary to secondary windings on the transformer. Laser ablation decapsulation of the transformer found exposed copper windings with missing wire coating. The transformer windings on this model are coincident wound, primary and secondary windings overlapping. This means that any damage to the wire's coating can result in a short from the transformer's primary to secondary terminals and catastrophic failure.

  Degradation of the magnetic wire varnish can occur if the DCP is exposed to a high humidity environment followed by high temperature exposure, such as solder re-flow. During qualification, results from moisture reliability testing resulted in the MSL3 classification. The magnetic wire insulation, a thin polyesterimide varnish, can degrade in a moist environment. Data from magnetic wire manufactures reports polyesterimide tends to hydrolyze in the presence of water at elevated temperatures.

  For the DCP product line, MSL3 needs to be strictly followed. If product from previously opened packages are going to be exposed to solder re-flow, then bake prior to re-flow needs to be performed.

Note 1: Due to digital image capture, the magnification is not calibrated nor is the aspect ratio maintained. Not all tools provide a means recorded in the image for calibrating the measurements. When a calibration marker is supplied in the image, the measurements may be calibrated in the direction of the marker.