A Harness Crimping quality Issue Analysis

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Key Words: Instrument Panel (IP)Harness, Crimping, CFA(Crimping Force Analyzer), KB(Kanban), Komax machine.

Abstract: Harness is the very important component of vehicles, there are many technologies about the quality control of harness cable crimping in the terminal. This thesis proposes a crimping quality issue happened in the instrument panel (IP) harness, using FTA and 5Whys to analyze the root cause and make the effective action plans.

Introduction

Crimping is a very important process of theharness, how to make sure the crimping parameters accurately in the process is the first concern. At the beginning of this thesis, let's take a quick presentationfor the manufacturing process of the IP harness.In simple terms, peeling off the cable head insulation and crimping it into the terminal by Komax machine, we call them as cutting KBs, then using some of them to do sonic or twister process. In the assembly line, we put cutting KBs, sonic KBs and twisted KBs together and insert their terminals into the same connectors, tape the cables together, and the final IP harness had been made.

Now let's start the Vehicle IP Harness Crimping Issue Analysis as below.

Problem Description

In the middle of Aug.2015, there is a quality issue happenedin the BX3 IP harness final assembly line in Delphi supplier plant, a KB named L9805252(Terminal IDis 15364267;and the KB cable ID M4721005size is 0.35mm2) produced by Komax No.8 machine at the night shift on 11th,Aug had been found that, the insulation was crimped into the core crimping wing area, caused the terminal was ruptured. When we do the containment for the related harness finished goods or WIP KBs in the warehouse and production lines, we sorting the same defect parts, total quantities are 8pcs.

Root Cause Analysis

We use FTA(Failure Tree Analysis)tool to do the root cause analysis， as photo 1.

We now start to do the detailed analysis for each potential cause.

①+②: For the raw material issue, Check the appearance and dimension of the same lot terminal 15364267 and cable M4721005, the result are OK.

③: Check the defect parts, there were trace in insulation cut by crimping tooling, but the insulation didn't cut off, check the crimping tooling and found it wasn't obvious attrite.

The Komax machine operator feedback No.8 crimping tooling can't cut off insulation of the cablewhose cable size is 0.35mm2 matching terminal 15364267, we test short sample 100pcs and found 1pc defect sample, maybe the crimping tooling can't cut off the insulation easily.

④: Checked the first sample reserved by quality inspectors, the learning sample was OK.

⑤: Lookup night shift Komax No.8 machine daily check sheet, the operator does the CFA validation every day, and the result was OK on Aug.11.

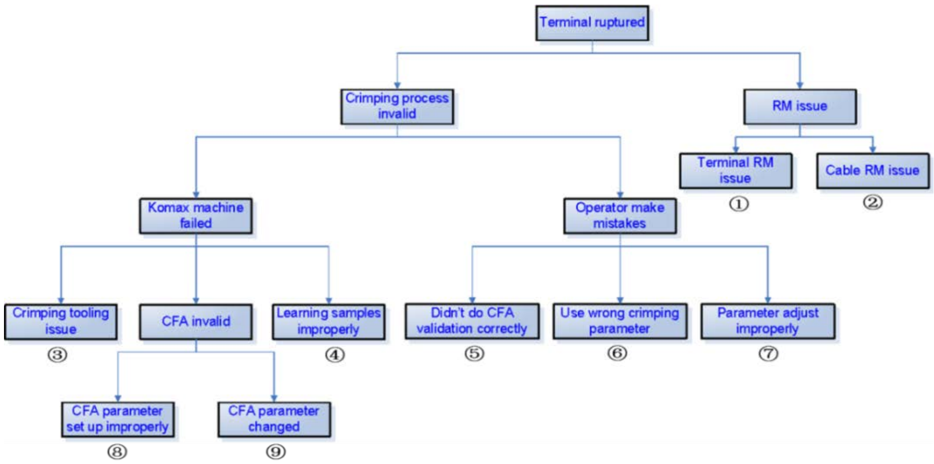

Photo1: FTA analysis

In order to confirm the CFA function, ask Komax No.8 machine operator doing CFA validation using start of production KB(KB ID: L9800512, Terminal ID:15327261, Cable Size:0.5mm2), we found it can alarm normally.

⑥: Check the first sample crimping parameter in E-Cutting system was correct. And measure the defect sample CCH (Core Crimping Height) and ICH (Insulation Crimping Height), the result was OK.

⑦: Checked the first sample reserved by quality inspectors, the appearance was OK.

⑧+⑨: CFA is the short word of crimping force analyzer, it can do the force error proofing test according to the machinecommunication interface in crimping process.

The piezo ceramic sensors assembledonKomax machine corresponds to the newest technical knowledge and allows a high measurement accuracy also under difficult conditions.Two parallell incorporated piezo ceramic sensors contribute as a transducer in the press slide for precise force measurement. Even in case of unsymmetrical load of the crimp die exact force measurements are possible.

The communication interface collect the force data detected by the piezo ceramic sensors and then changed them to a force-time cure. We distinguish between the original and the drift compensated reference curve. During production each crimp will be compared to the reference curve.

For the good or bad separation the actual crimp curve will be compared with the reference curve and the area difference will be calculated. If the area difference is smaller than the error limit, the actual crimp will be recognized as a good crimp. But if the area difference is bigger than the error limit, the actual crimp will be recognized as a bad crimp (see photo 2).

Based on the force-time curve, we can set up the error-proofing parameter of CFA(see chart 1), the machine stop and alarm rules is that, $|RS1| \geq BL1$ or $RU1 \geq BL1$, $|RS2| \geq BL2$ or $RU2 \geq BL2$, $|RS3| \geq BL3$ or $RU3 \geq BL3$, and $|RSO| \geq BLO$ or $RUO \geq BLO$.

After we known the alarm rules of CFA, we re-checked the defect KB(KB ID:L9805252,Terminal ID:15364267,Cable Size:0.35mm2), when we didn't shell the insulation and do CFA validation, it can alarm normally at the Komax machine die station 1# but abnormally at die station 2# ,Why?

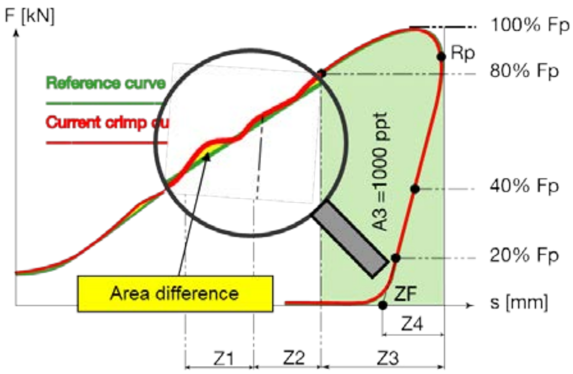

Photo 2: Force-Time Curve

Table 1: Explanation of the CFA parameter

Item	Z1 Insulation Crimping	Z2 Core Crimping	Z3 Crimping to the best position	Overall
W: Width of zone n	W1	W2	W3	
	Typical： W1=1.0*W4 W4 = 90% Fp - 10% Fp	Typical：W2=1.0*W4 W4 = 90% Fp - 10% Fp	90% - 90% Fp	
S: Sensitivity of zone n	S1	S2	S3	
	Typical：S1=0.7	Typical：S2=0.7	Typical：S3=0.7	
A: Area of zone n Area under the averaged reference Force [ppt=parts per thousand]	A1	A2	A3 = 1000 ppt	
RS: Result Signed	RS1	RS2	RS3	RSO=RS1+RS2+RS3
RU: Result Unsigned	RU1	RU2	RU3	RUO=RU1+RU2+RU3
BL: Bad Limit	BL1 =BLO*W1/S1(W1+W2+W3)	BL2 =BLO*W2/S2(W1+W2+W3)	BL3 =BLO*W3/S3(W1+W2+W3)	BLO Typical 70, over limit 200

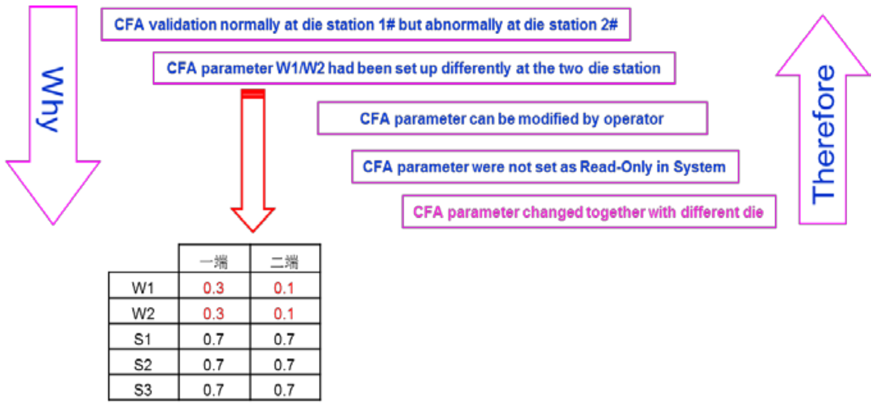

Photo 3: 5 Whys for CFA validation

So, CFA parameter for 15364267 terminal +0.35mm2 cable set up improperly and CFA parameters changed together with different dies result in this crimping issue.Furthermore, Komax No.8 machine operator inspection loss will lead to escape.

In summary, the root cause of this crimping issue are as below.

Manufacturing Reason:The crimping tooling can’t cut off the insulation easily.

Escape Reason:Komax No.8 machine operator inspection loss and nobody double check for it.

System Reason:CFA parameter set up improperly and CFA parameter changed together with different die.

Corrective Action

According to the analysis reason as above, we made the action plans as Table 2.

Table 2: Corrective action plan

Reason	Action Plan
Manufacturing Reason: The crimping tooling can't cut off the insulation easily.	Replaced the crimping tooling for Komax No.8 machine immediately.
	Check the crimping tooling status of other Komax machines and replace un-useful ones one by one as soon as possible.
	Strictly implement the maintenance work instruction, confirm the crimping tooling status in the preventive or protective maintenance for all Komax machines.
Escape Reason: K8 operator inspection loss and nobody double check for it.	Training Komax machine operators do the crimping appearance inspection carefully.
	Change Komax No.8 machine day shift and night shift inspection status from self-inspection to quality inspector inspection for a period time.
System Reason: CFA parameter for 15364267 terminal +0.35mm^2 cable set up improperly and CFA parameter changed together with different die.	For 15364267 terminal +0.35mm^2 cable, change CFA parameter W1/W2 to 0.3/0.3 at die station 2# for Komax No.8 machine, and set them as read-only.
	Check all die CFA parameter, for 0.35mm^2 cable, adjust CFA parameter W1/W2, in order to alarm sensitive, and set them as read-only.
	For all Komax machines, choose the terminal matching the lowest cross section area cable, and adjust the die CFA parameter W1/W2, in order to alarm sensitively, and set them as read-only.
	Ask operators alarm immediately whenever they find CFA abnormally.
	Cross function team confirm Komax machine alarm normally whether or not randomly.

Conclusions

In this article we presented a harnesscrimping quality issue using FTA and 5Whys to analyze the root cause, and also research the working principle of the CFA, according to the analysis we make the action plans for each root cause. The same method and technology could be used for any other quality issues analysis.

References

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