COHERENT

Failure Analysis Report

1. GENERAL INFORMATION

Coherent RMA Number	987359 – 1.1	**Customer**	JABIL CIRCUIT SDN BHD (IPC)
Coherent Part Number	FTLF8536P4PCL-C2 (Cisco P/N: 10-3227-03)	**End Customer**	CISCO SYSTEMS, INC.
Failure Analysis Report Date	02/07/2023	**Customer Reference**	3908618-CISCO
Analysis by	Liau Jian Yang	**Received Date**	02/01/2023

2. Summary

Serial number (S/N)	Date Code / Traceability	Customer Reported Failure / Issue	FA Findings
FNS25210YT8 [P5LAZGJ]	21-21	TX_POWER = -88.627442 Failed () MODULE_ALARM_STATUS LOS Alarm,RX CDR LOL Alarm,Rx Power Low Alarm = FAIL Failed () ERROR_COUNT = 1651517 Failed () DDM_TX_POWER_DELTA = 85.167442 Failed () DDM_RX_POWER = -40.0 Failed () BER = 1.07e-06 Fai	Customer reported failure was confirmed. Module failed with low Tx power. The failure was isolated to faulty VCSEL within TOSA.

3. Failure Analysis Details

S/N(s): FNS25210YT8

FA Steps	Results
Visual Mechanical Inspection	No abnormality was observed.
Digital Diagnostic Analysis	Module's digital diagnostics (DDM) reported nominal laser bias current (LDI) and low Tx power as compared to before shipment data. Low Tx output power was measured from the module.
Internal Visual Inspection	No abnormalities were observed on PCBA and OSA of the module.
Electrical Probing	Probing on the components of PCBA up to Tx hotbar area along the Tx path did not show any abnormality. This suggests the fault was internal to the TOSA.
TOSA/VCSEL Analysis Results	TOSA was then removed and tested separately. LI sweep on the TOSA showed low laser output power (Fig. 1). Reverse bias IV trace (Fig. 2) revealed excessive reverse bias leakage current compared to a known good unit. This confirms the failure was due to faulty VCSEL within TOSA.

Condition	LDI (mA)	Diagnostics Tx Power (dBm)	Actual Tx Power (dBm)
Before shipment	7.994	-0.50	-0.70
Upon return	8.054	-3.28	-4.42

Table. 1: Tx parameters

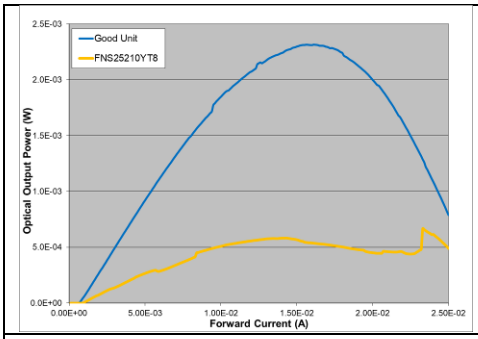

Fig. 1: Forward LI Trace

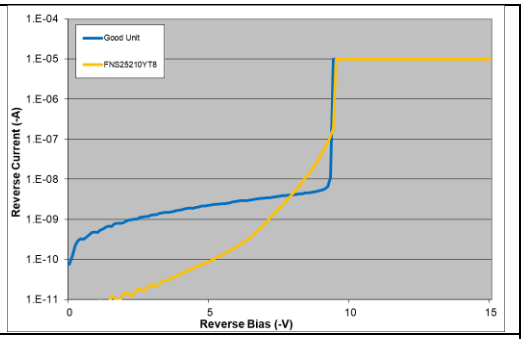

Fig. 2: Reverse Bias IV Trace

4. Root cause (RC), containment, and corrective actions

RC analysis	Module failed with low Tx power. The failure was isolated to faulty VCSEL within the TOSA. Based on analysis conducted on similar failures in the past, the failure was determined to be due to oxide related defects.
Failure mechanism	Faulty VCSEL caused the module to fail with low optical output power.
Containment/ Corrective action(s)	Coherent switched to a new oxidation furnace with tighter controls to improve the oxide layer quality in Q3 2019. The returned modules were all assembled with VCSELs from a wafer with this improvement. The effectiveness of this change was validated by performing 5000 hours of accelerated aging tests on > 12K devices. A failure rate of 103 FIT was estimated based on 5k hrs. of accelerated aging test results. In addition, field data since Q4 2019 has shown that the above action is effective in reducing overall failure rate due to oxide issue.

Risk Assessment	In response to the field failures, Coherent has taken actions to improve the laser reliability. Coherent expects the field failure rate to drop accordingly over time as more and more modules with improved VCSEL are deployed in the field. Wafer number and power on hours data for the unit is tabulated below.

Serial Number	Wafer#	TTF (hrs.)	CA Info
FNS25210YT8	192904-20	6762	CA3

5. Conclusion

S/N(s): FNS25210YT8	Customer reported failure was confirmed. Module failed with low Tx power. The failure was isolated to faulty VCSEL within the TOSA. Coherent has been taking actions to improve VCSEL reliability. The field data available so far indicates that such improvement actions are effective in reducing oxide defects as indicated in Section 4.

Note: This FAR is considered closed should there be no feedback from the customer within 2 weeks