25G x12 FireFly

Issues and Solutions

INNOVATIVE TECHNOLOGIES • SUDDEN SERVICE • GLOBAL REACH

2023 Presentation Recap

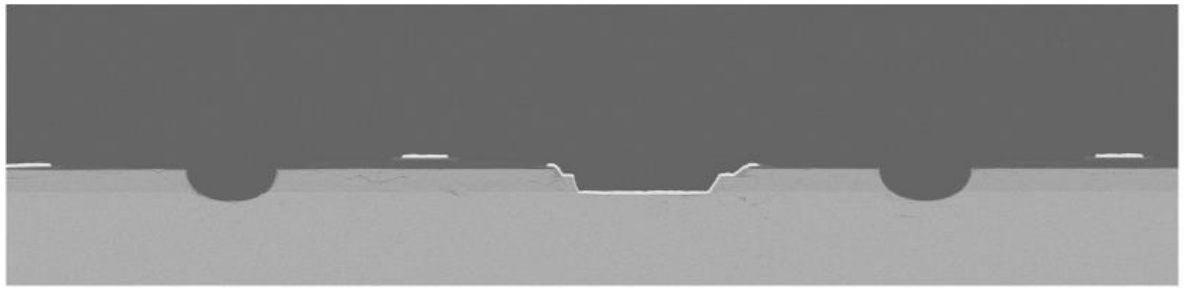
Low Power Laser Issue

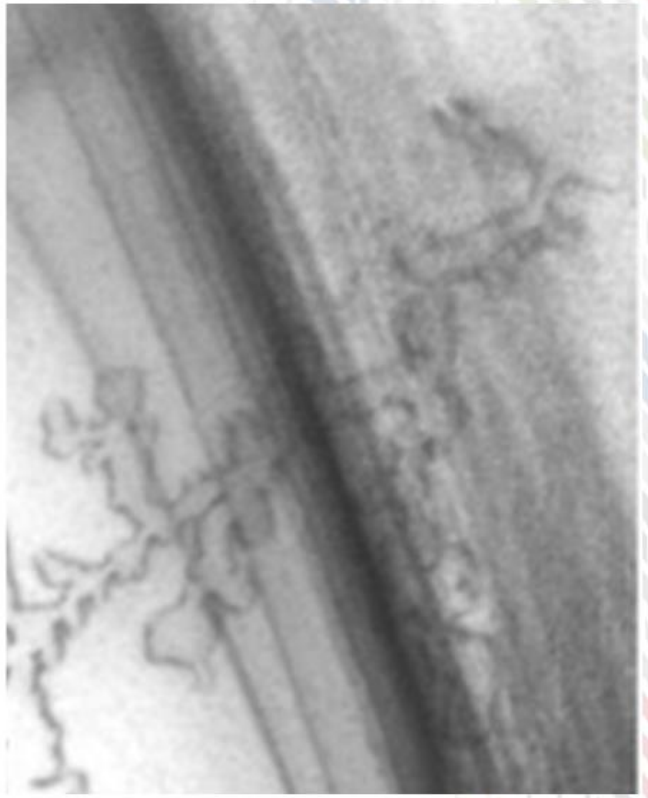
In late 2022, Samtec started to get reports of VCSELs with low/no power from customers.

Parts were RMAed to our vendor who eventually admitted that this was a known issue and that they already had a corrective action

- Aspect ratio of the laser bar combined with internal stress within the structure lead to a dislocation network through the active area

Corrective action added partial etches between the lasers





Reliability of Oxide VCSELs at Emcore, C Helms et al.

INTERPOSER CONNECTIVITITY

Interposer Issue

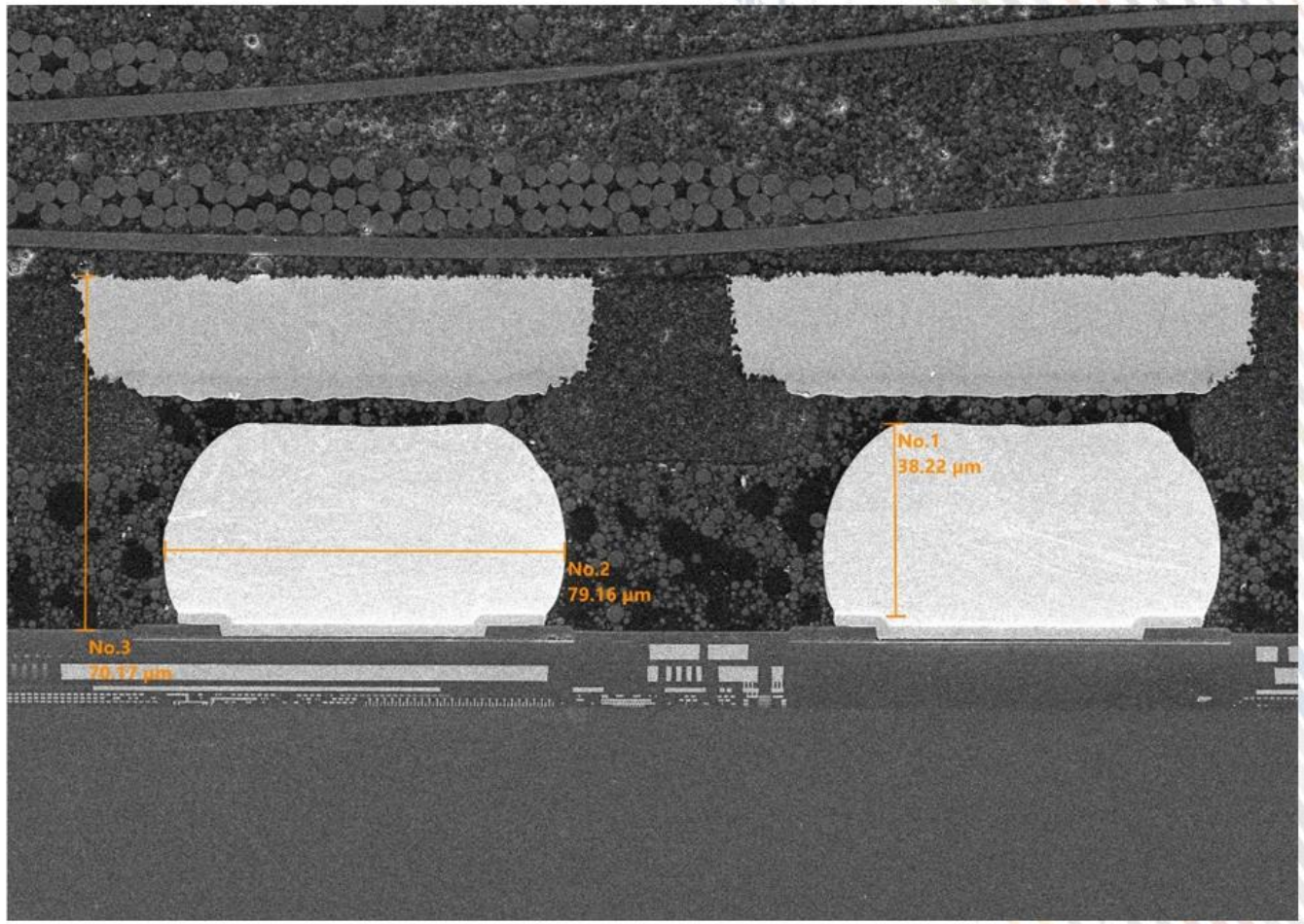
After restarting the line with new VCSEL design and improved burn-in, found a new problem with Tx channels with no output

Investigation quickly showed:

- VCSELs were good
- Laser Driver was good

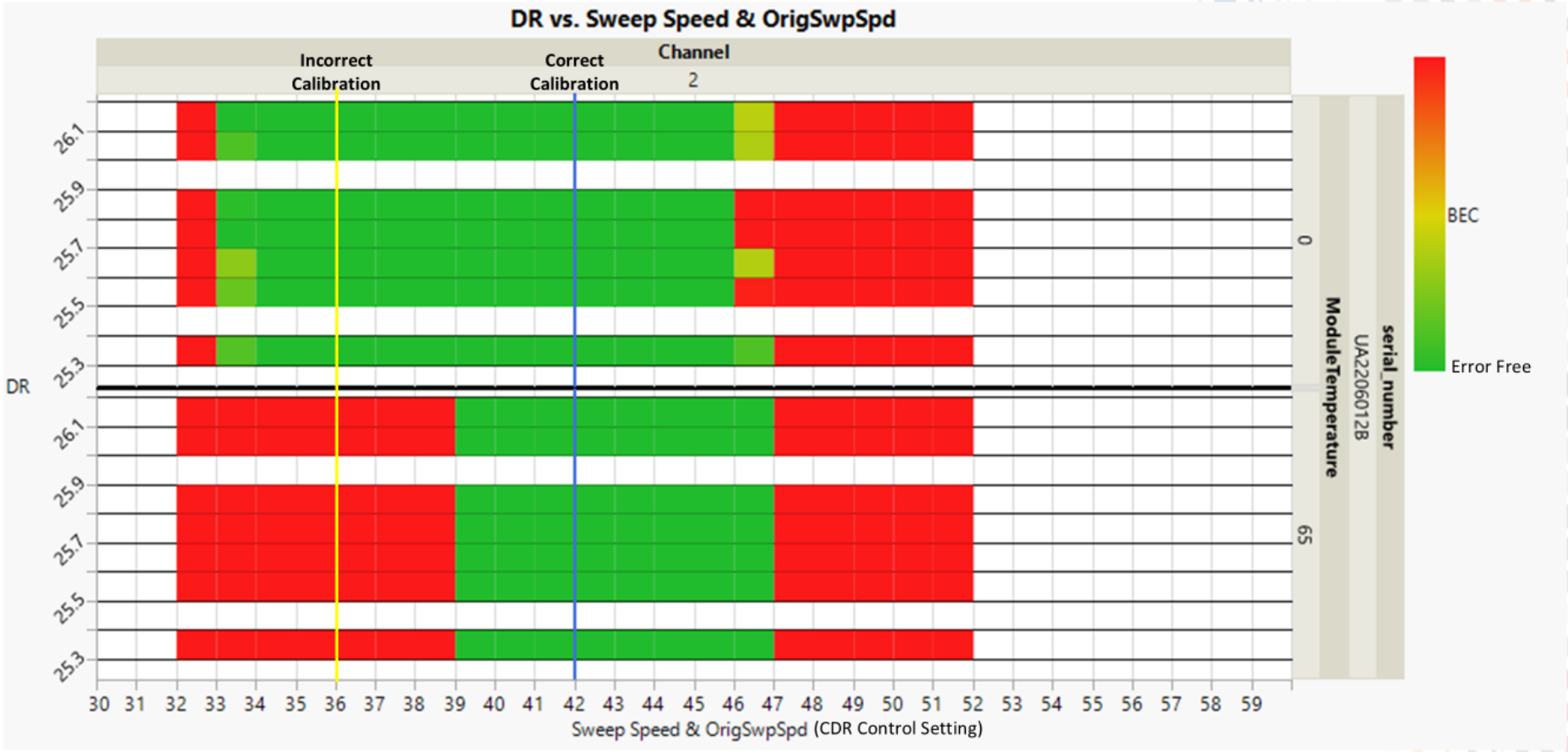
Interposer connection issue:

One single lot of material.

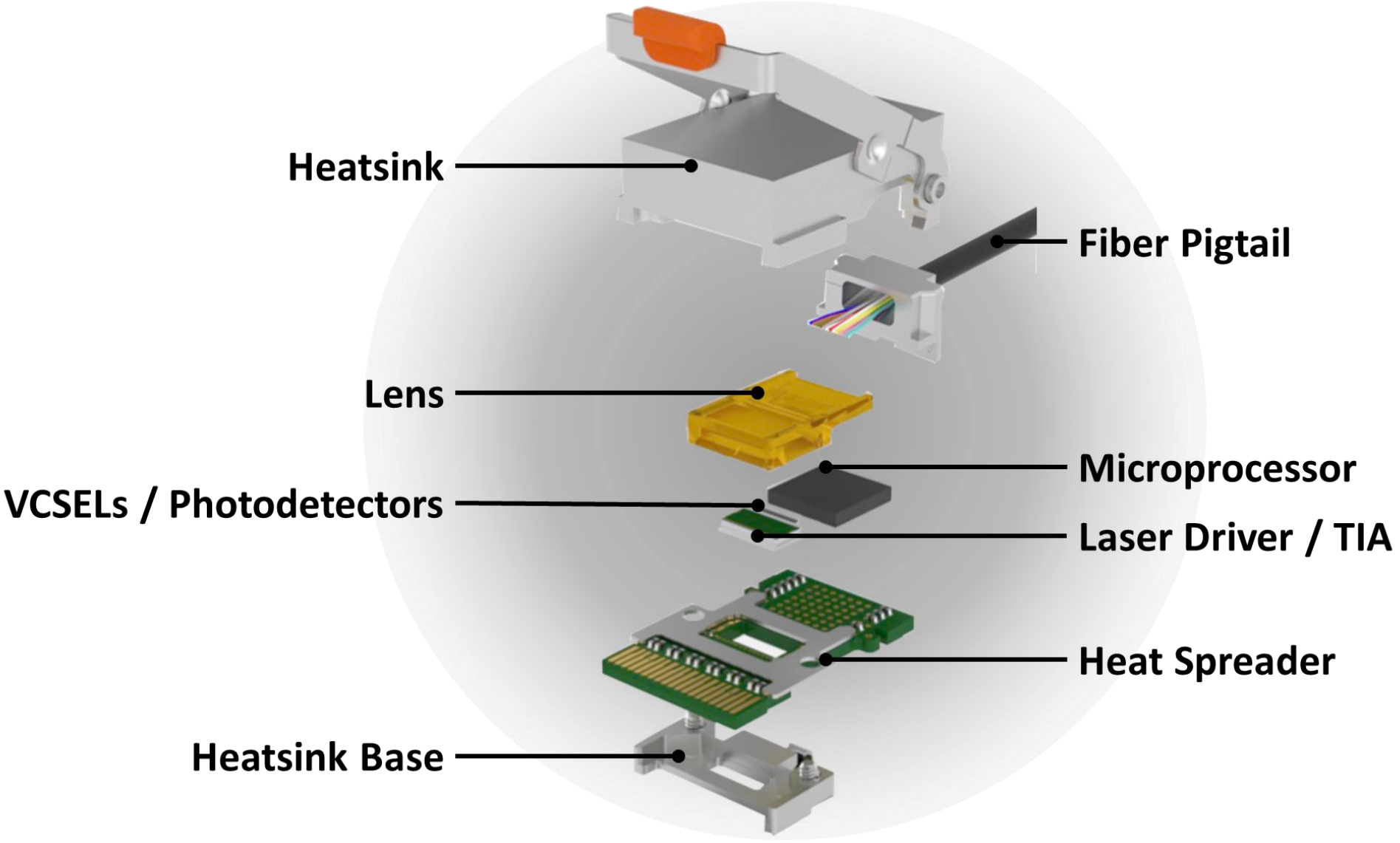


CDR CALIBRATIONS

CDR Control Scan over Datarate & Temperature



25G X12 DESIGN



2024 Issues

VCSELS

In early 2024, the University of Wisconsin reported new VCSEL failures.

They are still the only customer who has reported laser failures:

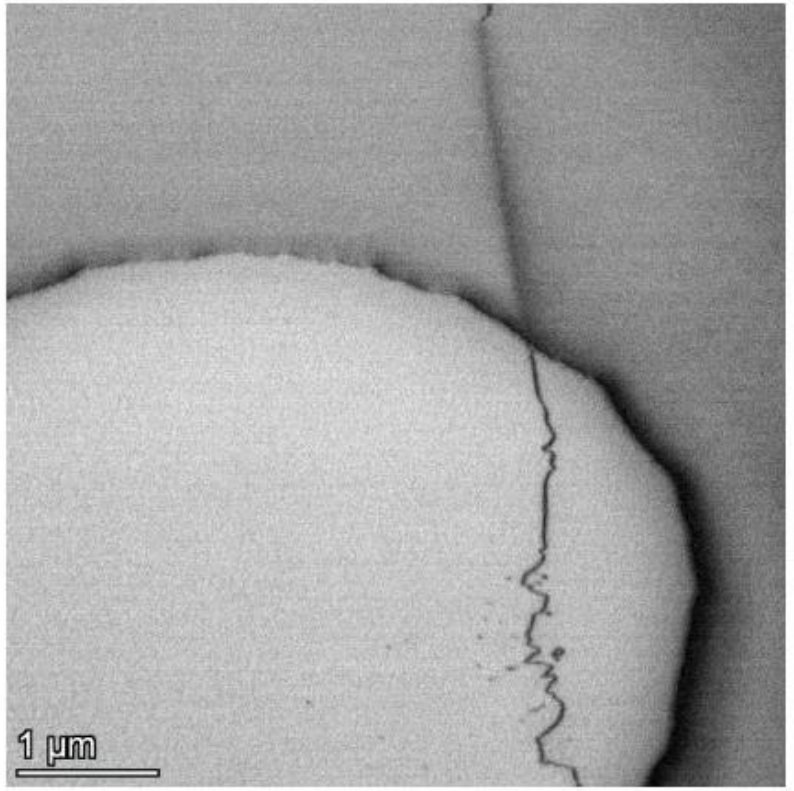
- In their test environment, they would power cycle the part every 10 minutes
- This resulted in ~5,000 power cycles before failure.
- Which is in addition to the ~2,000 power cycles that Samtec performed during our laser burn-in conditioning.

“A well designed, well manufactured VCSEL should have not suffer early life failure because of power cycling”.

As a result, Samtec switched both:

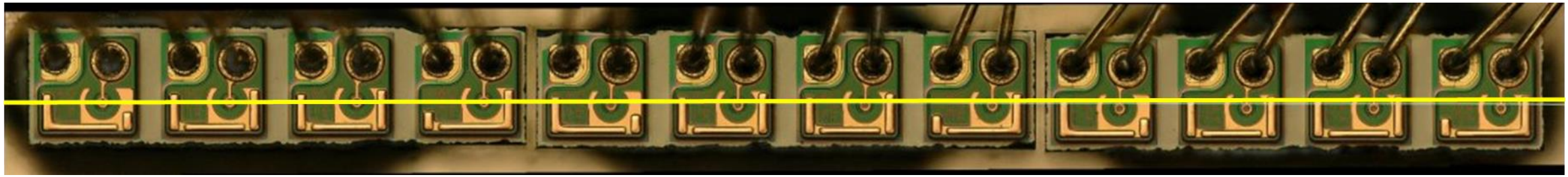
- The laser vendor
- The VCSEL array from a single x12 to three x4 VCSELS

This VCSEL was not new to Samtec, and was used in our high temperature products aimed at the military market.



VCSEL CHALLENGES

Placing three VCSELs is more challenging than a single one:



The coupling variation across the arrays leads to test challenges:

- Internal test limits derived from extensive process/test data analysis
- SPC breaks

SENSITIVITY

Test results showed that there was a sensitivity degradation in Q2 2024

- No correlation with process / material / equipment

All FireFly Tx engines have an offset calculated for the lens relative to the VCSEL output apertures

- Per lens attach machine
- Lens batch
- VCSEL type

We have now replicated this onto the Rx using the measured RSSI photocurrent to quantify the coupling efficiency

CALIBRATION

Last week, we sent a notification of a potential issue affecting the CDR calibration of both Tx and Rx shipped in the last 18 months.

- 5 parts reported with this failure mode

A CDR calibration was systematically written over in manufacturing

- Occurred between the Electro/Optics test and shipping

Results in the CDR, generally of a single channel, not locking resulting in a high BER

All data suggests that:

- Parts fail out of the box
- Working parts continue to work

Samtec has created a reprogram tool that we can share if you have concerns about parts that you have.

- Parts can also be RMAed to Samtec for reprogramming

ROOT CAUSE

Problem is due to two issues:

A firmware feature implemented to prevent a false CDR lock

- Monitors a control voltage
- If the voltage is out of range, then this is a false lock
- In these cases, temporarily change the CDR calibration by 2 counts
- But…the control voltage can out of range when the part is run without input data

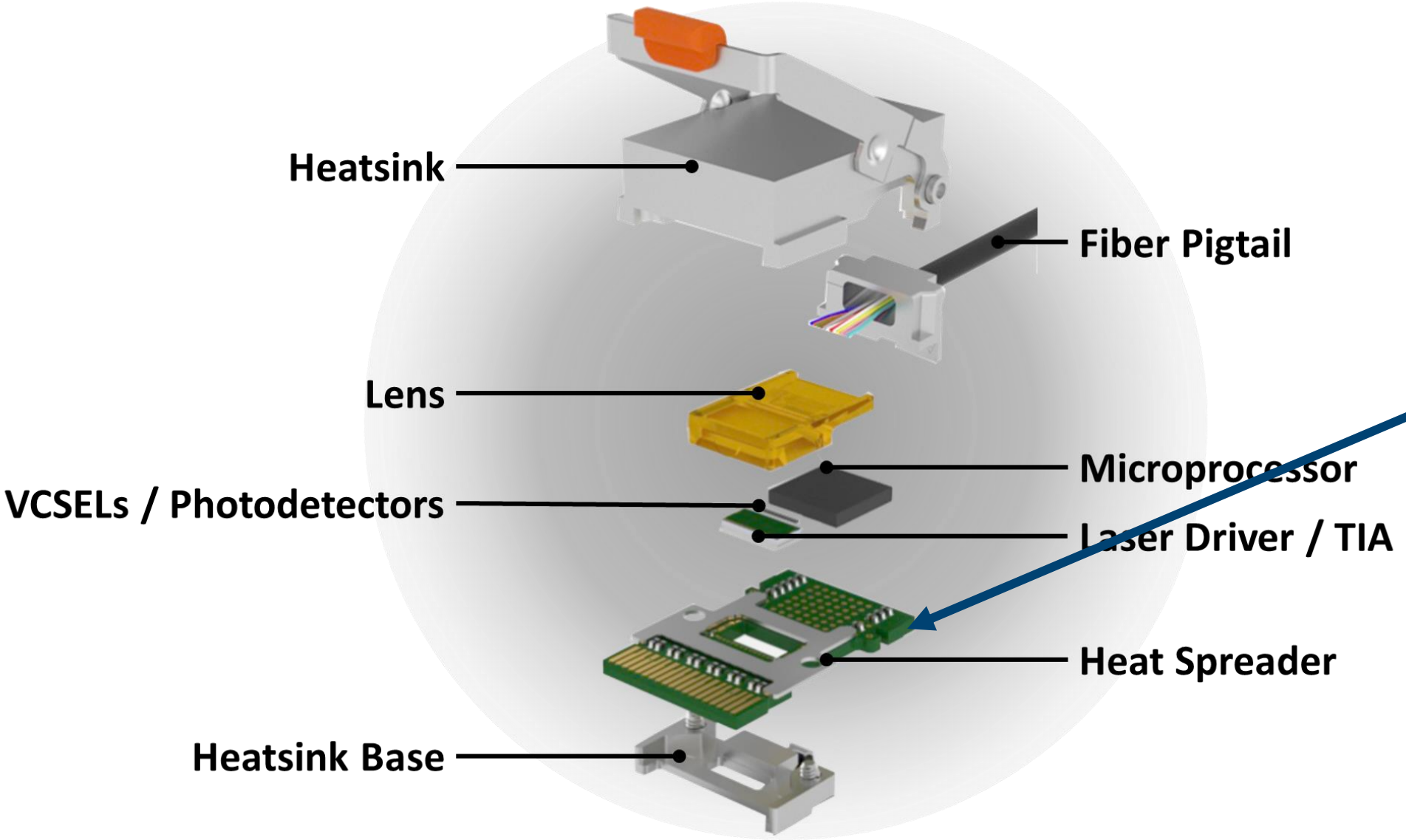
53	5C	0E	0E	34	12	15	24	64	4C	2F	01	0E	58	2B	35
05	4C	08	18	3D	12	3D	60	48	38	5E	35	3B	5E	29	5E
34	3C	3A	09	10	44	54	1C	47	10	2C	09	16	2F	44	3B
5C	4C	33	55	53	18	24	4E	30	52	41	23	34	3C	26	47
1C	1E	26	29	18	1F	4B	29	2B	2B	0C	4A	5C	5F	48	4B
1D	42	2E	52	3B	58	0C	55	37	17	50	0D	3E	09	2C	34
08	62	63	3F	00	1D	37	4A	45	06	21	20	57	43	5A	3D
33	2B	38	1D	54	3E	60	31	5F	46	3B	09	0E	3F	2E	19
35	51	23	3B	2F	45	29	22	2B	1B	14	40	39	2C	29	5F
35	28	1E	29	31	42	38	2E	5B	4A	52	3D	39	43	11	5B
11	5E	05	33	3E	55	18	22	0D	28	5D	64	36	26	47	48
15	60	0C	3C	55	35	55	3C	3D	15	20	42	0D	33	4E	18
2F	3B	43	05	53	43	2B	12	14	14	53	3F	54	02	3C	5C
4B	27	24	4C	3D	0D	14	00	0D	4F	15	3D	2B	1C	2F	06
45	60	3C	39	1A	4B	57	23	37	5B	15	28	43	3E	61	5A
5C	5B	1A	2E	35	1E	59	2F	3C	3C	06	3F	5E	04	62	33

“Efficient Programming” in manufacturing:

- Single global write versus multiple writes

DFM Tweaks

PCB ROUTING

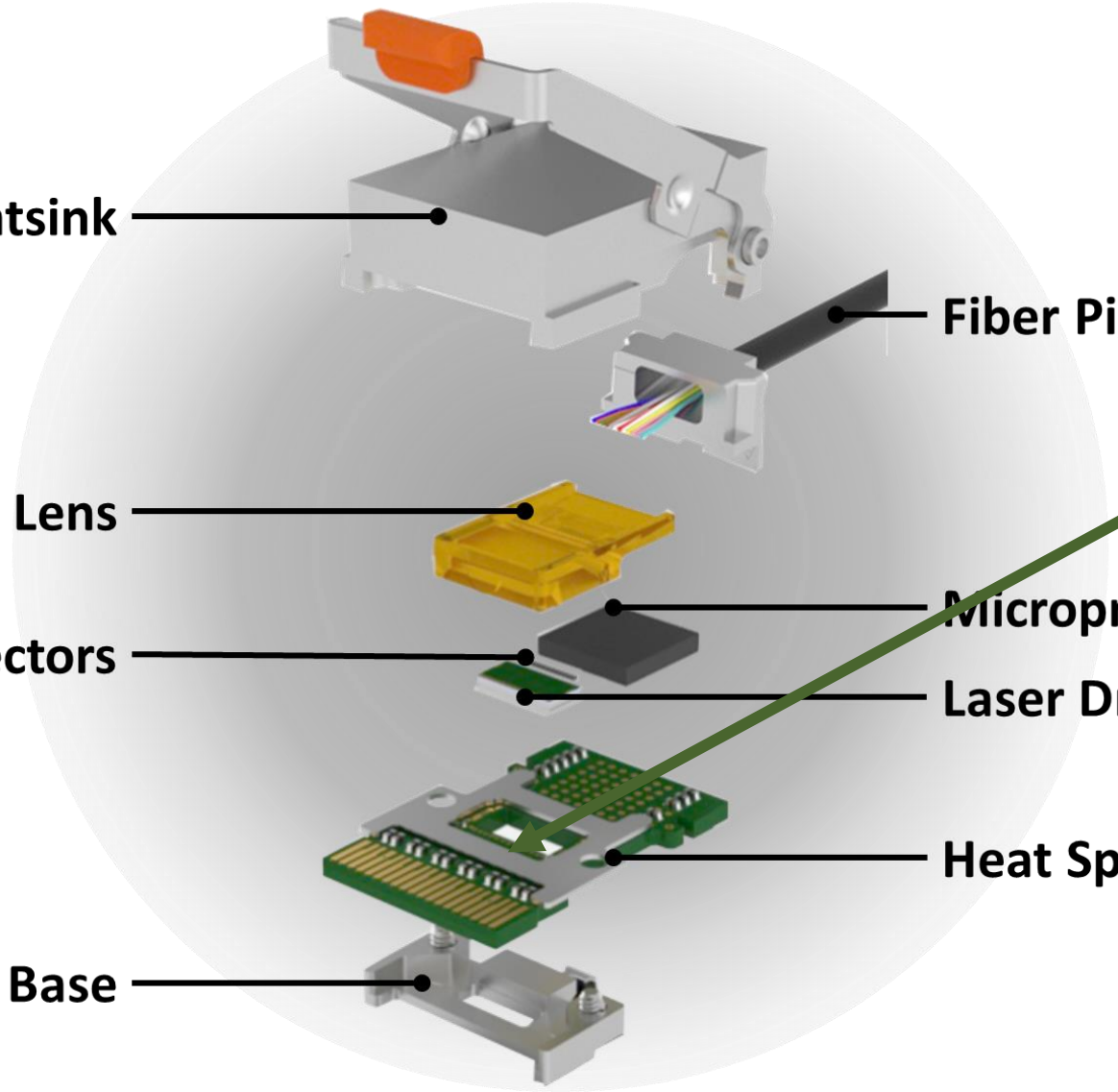


Minimized clearance between heatsink base center plug and PCB center cutout.

Increased clearance between heatsink base wrap-around features and PCB outline to

Modified PCB outline for consistent 0.15 mm distance between edge of metallization to laser routed edge

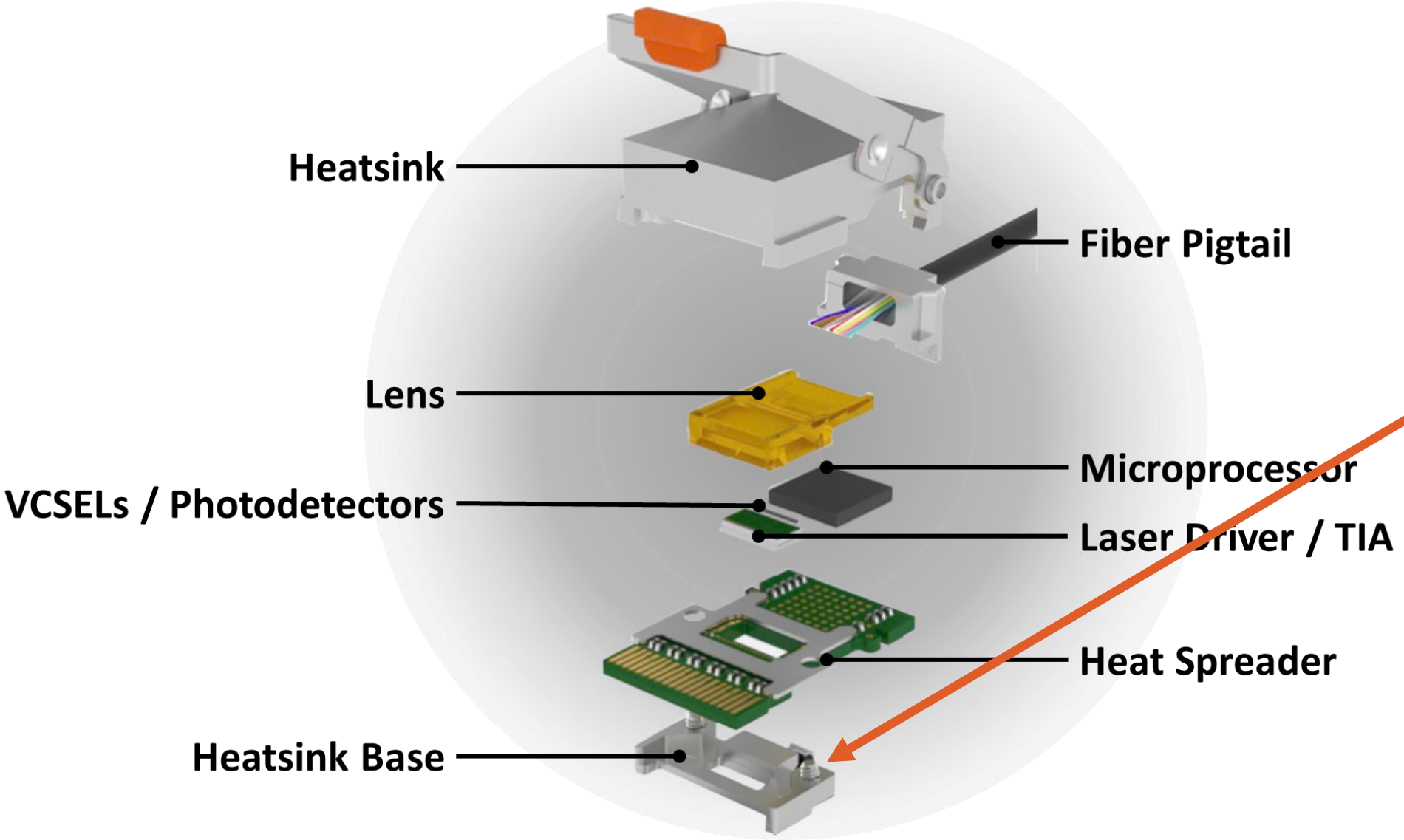
HEAT SPREADER



Decreased size of center cutout to ensure half bridge is always supporting north edge of lens

Bridge thickness increased by 0.022 mm for improved stiffness and better lens support

HEATSINK BASE

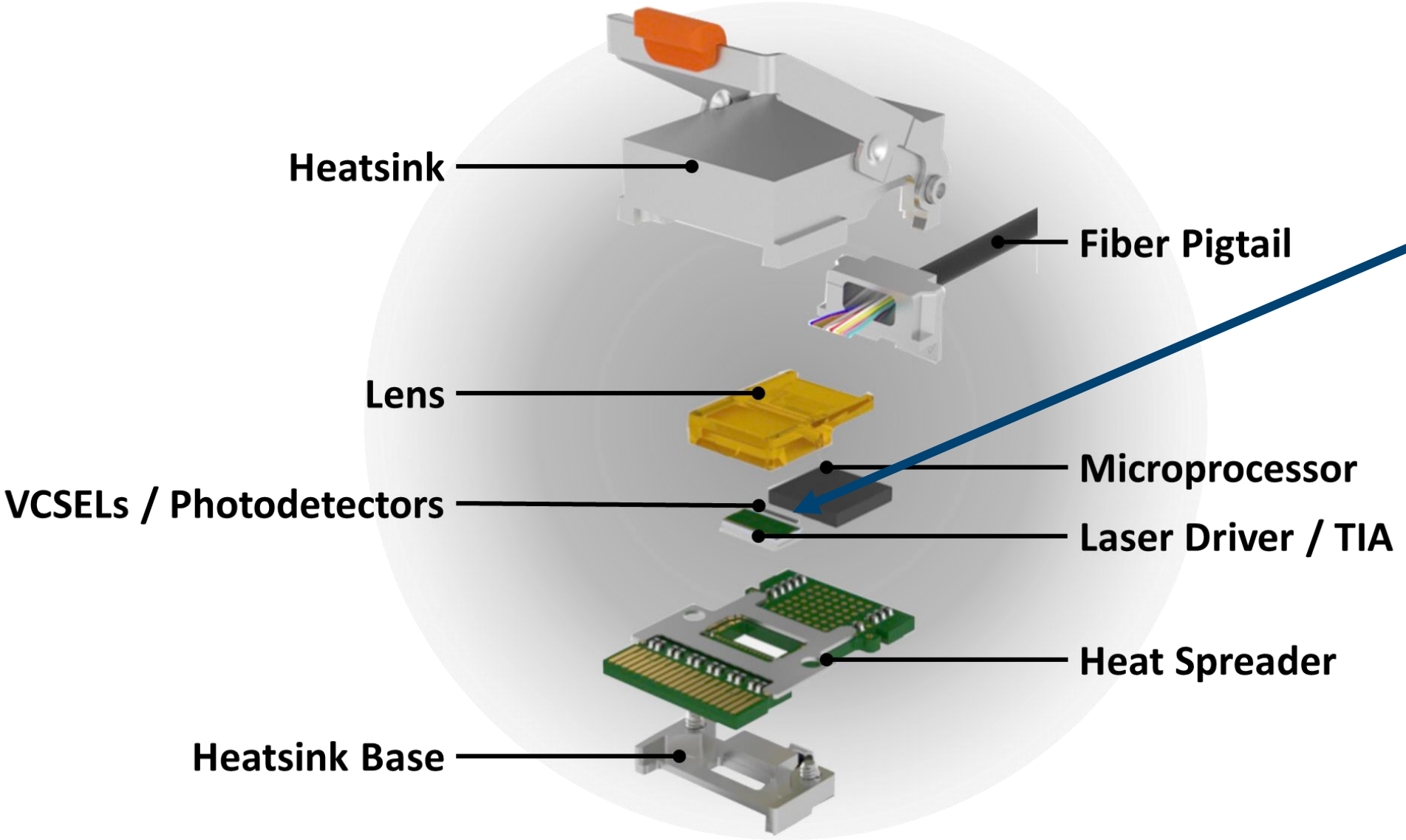


Added clearance between riser base and outer PCB cutout to avoid interference

Changed screw clearance holes from circles to slots to ensure taper stopper on heatsink will engage back of PCB

Add palladium plating to solderable surface for improved joint strength and wettability

VCSEL / PIN PLACEMENT



Moved the VCSEL/PIN 53 µm south to prevent die overhang at worst case conditions and to accommodate shifting the riser south

Change to three x4 VCSEL Arrays

Future Changes

SAMTEC INTERNAL DRIVER / TIA

The following components have been declared end of life by their vendors:

- Laser Driver
- TransImpedance Amplifier
- Photodetector

For the ICs, Samtec has bought all available material:

Still in the process of evaluating alternative suppliers for the Photodetector

Samtec has our own internal IC development underway, with the following new FireFly variants on our Roadmap:

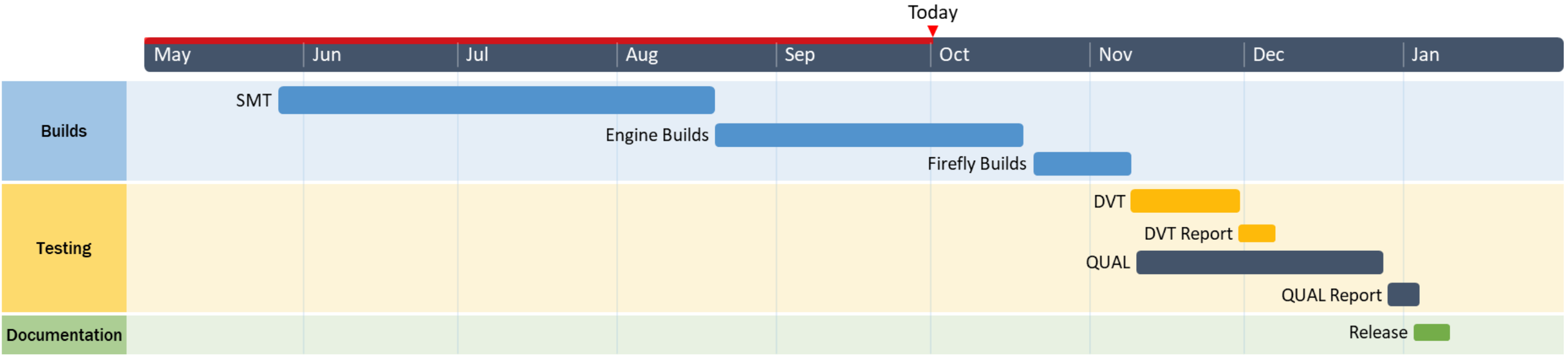
- Extended temperature 28G x12
- PCUO 5.0

Samtec believes that this will be a better product and will transfer longer scale orders to this design.

RELEASE TIMING

Project has slipped slightly due to incoming inspection failures of some components.

Release is scheduled for the beginning of January:



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