



MANUFACTURING · ELECTRONICS · CASE STUDY

Implementing Prescribe to fine-tune Siemens AXI measurement thresholds

INTRODUCTION

Siemens asked whether AI could tell it something new about the X-ray inspection of circuit boards at its electronics factory in Amberg, Germany, where quality rates were already high.

On the historical inspection data, the test routine proposed by DataProphet's algorithm cut the false call rate by 64%, against the routine set by Siemens' process experts.

64%

FEWER FALSE CALLS ON THE
66 PINS WITH IMPROVED
THRESHOLDS

38%

FEWER FALSE CALLS ACROSS
ALL PINS

70%

APPROXIMATE FALSE CALL
RATE IN FY 2019, BEFORE
THE PROJECT

Source: DataProphet's evaluation on Siemens' X-ray inspection data, September to December 2022; the 64% as reported by Siemens (Gunter Beiting, LinkedIn, August 2024). Both figures count false calls per pin on historical data, not in production; counted per board, the reduction is smaller.

Good parts flagged as faulty

The plant's automated X-ray inspection (AXI) measures every pin on a panel of 48 boards, about 150,000 measurements per panel, against thresholds set by Siemens' process experts.

The overall defect rate was very low, but the false call rate, the rate at which good parts are flagged as faulty, was around 70% in FY 2019. Each false call lowers first pass yield and adds manual inspection time.

The cost of slip

Loosening a threshold has a cost too. A slip, a faulty part passed as good, costs Siemens about ten times as much as a false call. So the team tuned the X-ray stations by hand to reduce false calls while avoiding slip, between production runs or when the input material changed.

Where the false calls were

The false calls were concentrated. Some individual pins had false call rates as high as 96.8%, and the twenty worst pins accounted for nearly half of all false calls.

96.8%

HIGHEST FALSE CALL RATE ON A SINGLE PIN

20

WORST PINS, WITH NEARLY HALF OF ALL FALSE CALLS

Source: DataProphet's analysis of Siemens' X-ray inspection data from September to December 2022; the FY 2019 rate and the cost of slip from Siemens.

Thresholds tuned from the inspection history

The data

Our team met the Siemens team on site in Amberg in May 2023, and Siemens shared its X-ray inspection database. For each flagged pin, it records the measurements and the operator's verdict on whether the pin was really faulty.

The level of detail

Thresholds were set per pin and kept the same across all boards on a panel. Some line numbers had far more false calls than others, so we considered two levels of detail: thresholds per pin, and per pin and line. We used DataProphet Prescribe for dimensionality reduction, to find the level of detail at which each threshold needed to be defined.

The tuning method

We then tuned the thresholds at each level with a local random optimisation algorithm, a derivative-free method customised for this application, scoring each candidate threshold with a loss function. The method suited this problem because it is robust and sample-efficient, and it converges well when it starts close to the true optimum, as it is here, where each search starts from the pin's historic threshold.



An operator cockpit

Siemens and DataProphet set up a continuous data flow from the shop floor to a shared cloud, and an operator cockpit in DataProphet Connect that shows false call rates per pin, board and line, so that the algorithm can give new recommendations when needed.

RESULTS

On Siemens' historical inspection data

MEASURE	RESULT
False calls on the 66 pins with improved thresholds	64% fewer
False calls across all pins, unchanged pins included	38% fewer
Tuned thresholds against the experts' thresholds, full historical dataset	At least as good
Thresholds tuned per line number, where the data supported it	Further improvement

Source: DataProphet's evaluation, March 2024, on Siemens' inspection data from September to December 2022, counted per pin.

Fewer false calls mean fewer pins for an operator to re-check by hand. The same approach applies to any other AXI machine with a detailed enough inspection history.

On the dataset, the test routine proposed by the algorithm achieved a 64% reduction in false call rates for the X-Ray testing and benchmarked on a test routine created by our skilled Process Experts!

Gunter Beitinger, Siemens, on LinkedIn, August 2024

KEY RESULTS

The key results of the AXI threshold tuning at Siemens' Amberg electronics factory were as follows:

- 01 **64% fewer false calls** on the 66 pins with improved thresholds, counted per pin on Siemens' historical inspection data, against the routine set by Siemens' process experts.
- 02 **38% fewer false calls across all pins**, with the pins where no better threshold was found left unchanged.
- 03 **Thresholds at least as good as the experts' ones** whenever the two were compared across the full historical dataset.
- 04 **A continuous data flow and an operator cockpit**, so that the algorithm can give new recommendations when needed.

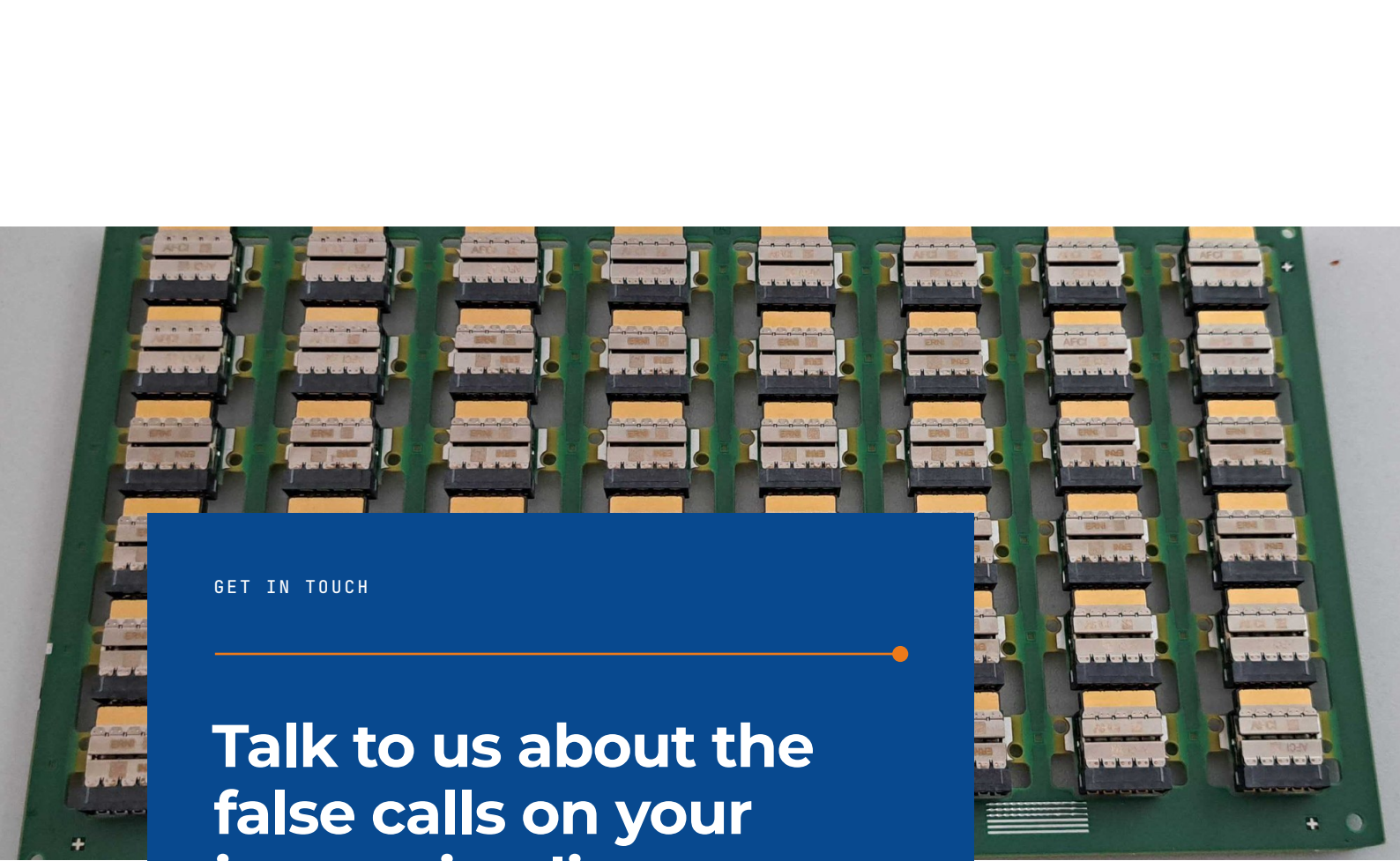
64%

FEWER FALSE CALLS PER PIN, HISTORICAL DATA

38%

FEWER FALSE CALLS ACROSS ALL PINS

Source: DataProphet's evaluation, March 2024, on Siemens' X-ray inspection data from September to December 2022; the 64% as reported by Siemens (Gunter Beitinger, LinkedIn, August 2024).



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false calls on your
inspection line**

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