Iso-Smart Field Evaluation and Case Study Report

Test Site: BETA, Coupon Test Station #18
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1. Overview

This case study documents the field deployment and performance of the GPT Industries Iso-Smart unit at Coupon Station #18. The Iso-Smart device was used to monitor cathodic protection (CP) performance and analyze signal activity at a buried pipeline. The study focused on:

- DC and AC behavior of the current between the pipeline and a 1 cm² coupon.
- CP potential monitoring with respect to a permanent zinc reference electrode.
- Signal analysis of both current and pipeline potential to identify AC presence.

2. Monitoring Setup

- Cathodic Protection Monitoring: Asset #1 input was connected to the pipeline, referenced to a permanent zinc electrode. See **Figure 1**.
- Current Monitoring: The current was measured between the pipeline and a 1 cm² AC coupon. The pipeline was connected to the negative terminal of Iso-Smart's current sensing circuit, and the coupon to the positive terminal. See **Figure 1**.
- Rectifier Details: Full-wave rectifiers provide CP to the pipeline. These generate a 120 Hz signal. Some rectifiers may include output filters (e.g., smoothing capacitors), while others may not, resulting in potential ripple on the output voltage. See **Figure 2.**

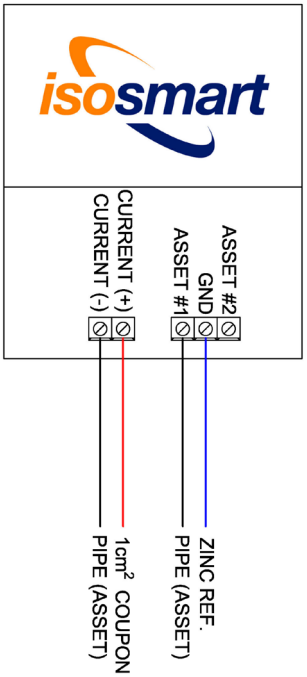

Figure 1: Iso-Smart Connections

The Iso-Smart system, known for its high sensitivity and resolution, is capable of detecting frequency components even from semi-filtered full-wave rectifier output.

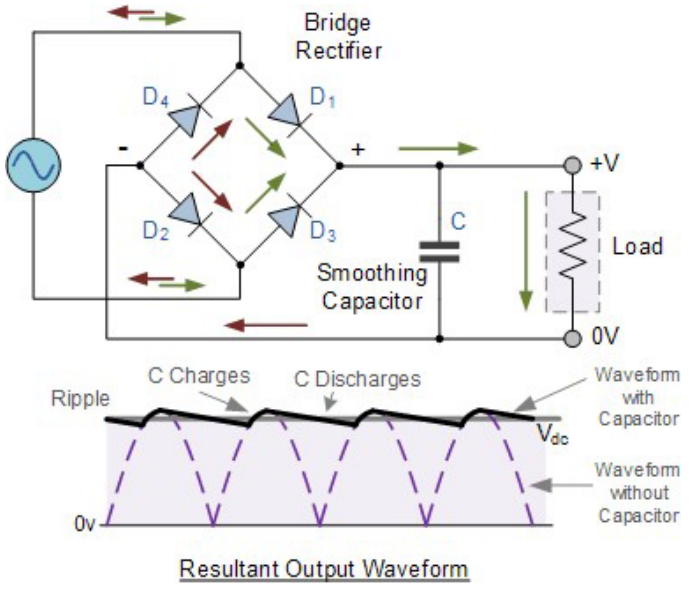

Figure 2: Smoothed, Full-Wave Rectifier

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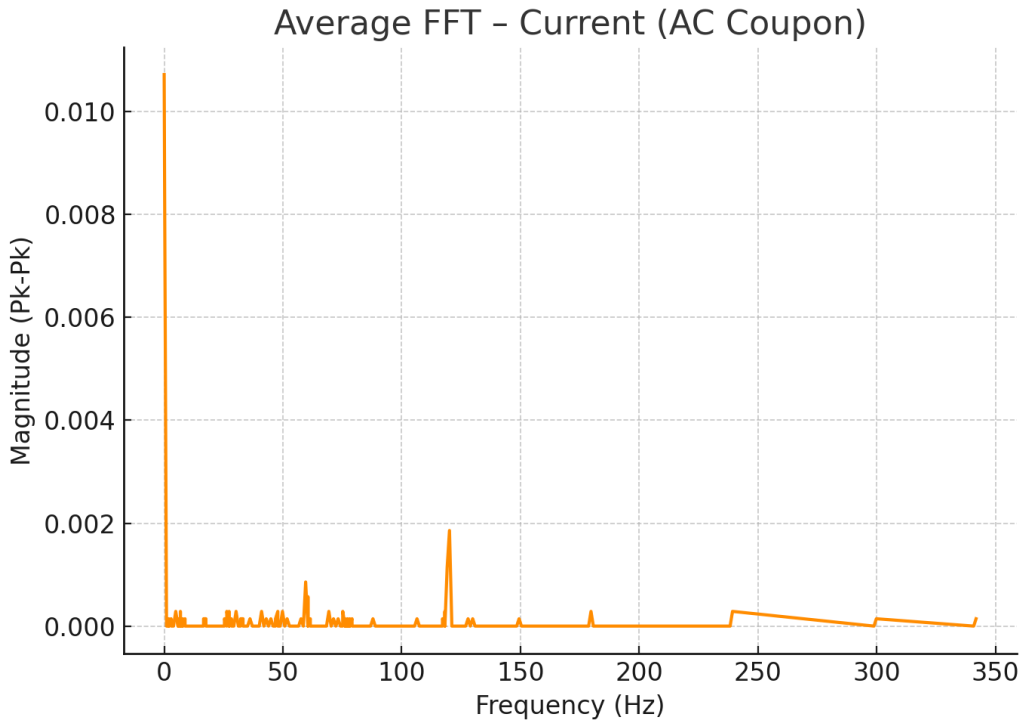
3. Signal Behavior and Current Analysis

3.1 Current Measurements

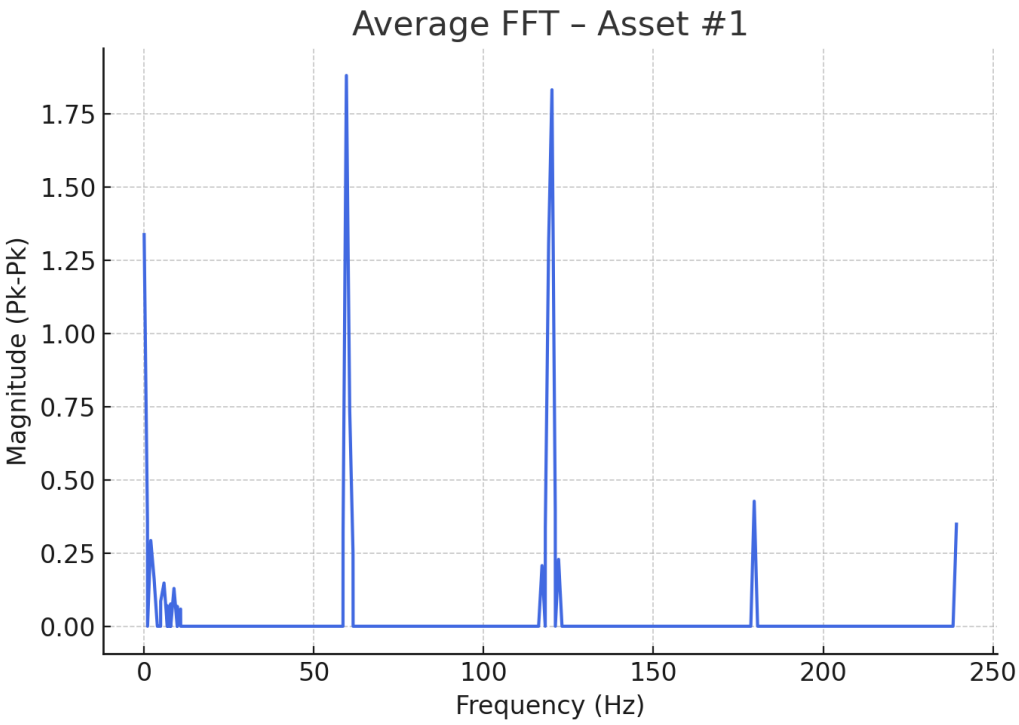
The measured DC current through the coupon was approximately -0.012 A, resulting in a current density of ~120 A/m². No polarity reversal was observed in the current waveform. FFT analysis of the current signal showed a dominant DC component with negligible higher-frequency contributions.



Conclusion: Current is DC-dominant, likely originating from the CP system. No indicators of "true" AC were observed at the coupon.

3.2 Pipeline Potential (Asset #1)

Voltage relative to the zinc reference electrode ranged from -1.6V to -1.8V, indicating effective CP protection. However, polarity shifts in potential were noted during some periods. FFT analysis revealed peaks in the 58–62 Hz range, characteristic of AC interference, likely induced from nearby HVAC or utility sources.



Conclusion: AC presence was confirmed on the pipeline, but not introduced through the AC coupon. Rather, it likely originates from external induction or rectifier ripple.

4. FFT Analysis Summary

4.1 AC Coupon Current FFT

- Strong DC peak.
- No significant harmonic activity.
- Low-magnitude and flat across frequency spectrum.

4.2 Asset #1 Potential FFT

- Dominant frequency content in the 60 Hz region.
- Additional frequency signatures may correspond to 120 Hz ripple from full-wave rectifiers.

Interpretation: The Iso-Smart's sensitivity allows it to capture small oscillations potentially tied to unfiltered rectifier outputs. These are not necessarily "true" AC, but may appear in the frequency domain due to high-resolution sampling.

5. Understanding "True" AC and Induced Corrosion

Traditional interpretations of "true" AC focus on zero-crossing behavior. However, a more precise definition centers on the electrochemical response of the pipeline. When the potential of the pipe fluctuates both more electropositive and electronegative than its native potential, alternating anodic and cathodic zones can form across its surface. This fluctuation creates conditions conducive to:

- AC-induced corrosion, where one location becomes the anode while an adjacent region becomes the cathode.
- Localized breakdown of passive films.

- Pitting and metal loss at accelerated rates.

Research (AMPP SP21424-2023) supports this mechanism and underscores the need for high-resolution, directional data like that provided by Iso-Smart.

6. Test Events: March 23–24, 2024

- March 23 (Rectifiers OFF):
  - CP voltage (Zn reference): ~-0.97 V
  - Minimal AC activity observed.

- March 24 (Rectifiers ON):
  - CP voltage: rose to ~-0.73 V
  - Increased fluctuations and some AC signature activity seen in FFT plots.

These results confirm Iso-Smart's ability to detect rectifier behavior, signal ripple, and AC interference with high precision.

7. Final Conclusions

- Iso-Smart effectively distinguished between true AC, DC ripple, and induced AC.
- AC current was not present at the coupon (no risk of direct AC-induced corrosion there).
- AC potential fluctuation was present on the pipeline, warranting further site investigation.
- High-resolution FFT analysis validates Iso-Smart's superior sensing capabilities.

For more information or technical collaboration, please contact:

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