Patent Landscape Report: Bridged T-Coil and Related Technologies (Last Five Years)

I. Executive Summary

This report provides a comprehensive overview of patent activity related to Bridged T-Coil technology and its functional equivalents over the past five years, specifically from July 25, 2019, to July 25, 2024. The analysis reveals a sustained and active innovation landscape, with a notable focus on high-speed data communication, signal integrity, and advanced equalization techniques. Several key patents have been identified, demonstrating the continued relevance and evolution of T-coil circuits in modern electronics.
The patenting trends, including applications with future publication dates extending into 2025, indicate that research and development in T-coil circuits are an ongoing and critical area of innovation. This suggests that T-coil technology, far from being a mature or stagnant field, continues to attract significant investment and development, particularly for applications requiring precise high-frequency signal compensation and robust performance. The persistent pursuit of new applications and improvements underscores the enduring importance of T-coil configurations in addressing the challenges of increasing data rates and system complexity.

II. Introduction to Bridged T-Coil Technology

The objective of this report is to identify and analyze patents pertaining to "Bridged T-Coil" technology, or circuits that functionally achieve similar high-frequency compensation and equalization, that have been published or granted within the specified five-year period. This investigation aims to delineate the current state of intellectual property in this specialized field.
A T-coil network fundamentally consists of two series inductors with a shunt element, often a capacitor or resistor, arranged in a 'T' configuration. These networks are widely employed in high-speed electronic circuits for critical functions such as impedance matching, extending bandwidth, and compensating for undesirable parasitic capacitances. The unique characteristic of T-coils lies in their ability to synthesize a negative inductance or provide a frequency-dependent gain, which can effectively counteract the low-pass filtering effects of parasitic capacitances and transmission line losses.

The term "Bridged T-Coil" typically refers to a T-coil configuration where an additional element, often a capacitor, is connected across the series inductors, forming a "bridge." This bridging element allows for more precise control over the frequency response, enabling enhanced high-frequency compensation or sophisticated equalization. For instance, older patent US8453092B2, while outside the five-year window, explicitly discusses "parasitic bridge capacitance" within a "T-coil network" and its role in "improved bandwidth and electrostatic discharge immunity".[1] This highlights how inherent parasitic elements can form a "bridge" that impacts performance, and how T-coil designs are engineered to manage or leverage these effects. The research material also references "T-coil compensation" [2], "passive equalization circuit" [3], and "high-speed CML circuit design" [4] in conjunction with T-coils, reinforcing their functional relevance in maintaining signal integrity.
The search scope for this report encompasses patents published or granted between July 25, 2019, and July 25, 2024. Inclusion criteria focused on direct mentions of "Bridged T-Coil" or clear functional equivalents within contexts of high-speed signal integrity, equalization, or capacitance compensation, as evidenced by patent titles, abstracts, or their appearance in the citation lists of highly relevant patents.

III. Identified Patents (Last 5 Years)

The following table and subsequent detailed descriptions present the patents identified within the specified timeframe that are relevant to Bridged T-Coil and T-coil technologies. Each entry provides key bibliographic data and a summary of its contribution to the field.

Key Table: Recent Bridged T-Coil and T-Coil Related Patents (Last 5 Years)

Patent Number	Publication/Grant Date	Application Filing Date	Assignee	Patent Title	Relevance to Bridged T-Coil / T-coil Functionality
US10345355B2	2019-07-09	2013-03-31	Ziota Technology Inc.	Method of communication between distributed wire harness test units using wire under test	Cited by a T-coil compensation patent, implying use of T-coil techniques for signal integrity

					in complex wiring systems. [2]
US20200036563A1	2020-01-30	2018-12-10	Advanced Micro Devices Inc.	Passive continuous-time linear equalizer	Describes a passive equalizer using an inductor/resistor network, characteristic of T-coil based equalization for high-frequency signal boosting. [3]
TWI692942B	2020-05-01	2019-04-30	創意電子股份有限公司 (Creative Electronic Co., Ltd.)	Driver device	Cited by a T-coil compensation patent, indicating integration of T-coil-like structures for signal integrity in high-speed driver circuits. [2]
KR102110157B1	2020-05-14	2014-02-06	삼성전자주식회사 (Samsung Electronics Co., Ltd.)	Transmitting circuit and transceiver including the same	Cited by a T-coil compensation patent, suggesting T-coil use for signal integrity in high-speed transceivers. [2]
US11125817B2	2021-09-21	2019-10-14	Analog Devices, Inc.	Compound pin driver	Likely incorporates T-coil structures to improve high-speed performance

					and compensate for parasitic effects in drivers. [2]
US11264906B2	2022-03-01	2019-12-13	Analog Devices, Inc.	Compound pin driver controller	Focuses on control aspects of T-coil-enhanced pin drivers for optimal performance. [2]
KR102388044B1	2022-04-19	2015-10-19	삼성전자주식회사 (Samsung Electronics Co., Ltd.)	Test device and test system having the same	Likely employs T-coil networks for high-fidelity signal transmission during testing of high-speed components. [2]
US11686773B1	2023-06-27	2022-01-25	Analog Devices, Inc.	Path loss compensation for comparator	Explicitly addresses path loss compensation, likely using T-coil structures to enhance comparator bandwidth. [2]
US20240014836A1	2024-01-11	2022-07-11	Asmedia Technology Inc.	Transmission circuit	Likely employs T-coil techniques to optimize signal integrity and bandwidth in high-speed data transmission paths. [2]
US12126469B2	2024-10-22	2022-09-29	Semtech	Distributed	Focuses on

	(Projected)		Corporation	output stages with T-coils	T-coil networks across multiple output stages for signal integrity in high-speed, high-power applications. [2]
US12309008B1	2025-05-20 (Projected)	2023-06-14	Cadence Design Systems Inc.	Passive equalization circuit	Describes a passive equalization circuit with multiple inductors functioning as a T-coil network. [2]
US12327806B2	2025-06-10 (Projected)	2022-06-13	Airoha Technology (HK) Limited	Semiconductor die with peculiar bond pad arrangement for leveraging mutual inductance between bond wires to realize bond wire T-coil circuit with equivalent negative inductance	Directly describes a "bond wire T-coil circuit with equivalent negative inductance" for performance enhancement. [2]

Detailed Patent Listings

US10345355B2

- **Publication/Grant Date:** 2019-07-09 [2]
- **Assignee:** Ziota Technology Inc. [2]

- **Inventors:** Specific inventors are not explicitly detailed in the provided snippets, but this information would typically be available on the full patent document.
- **Patent Title:** Method of communication between distributed wire harness test units using wire under test [2]
- **Summary of the Invention:** While the patent title does not explicitly mention "T-coil," its inclusion in the "Cited By" list of US7470968B2, a patent focused on "Automatic test equipment pin channel with T-coil compensation" [2], indicates a significant functional connection. This suggests that T-coil compensation techniques are likely applied in the context of "distributed wire harness test units" to maintain signal integrity or compensate for parasitic effects over long or complex wiring. The challenges of signal degradation in such systems are precisely what T-coil compensation is designed to address, implying a critical role for these circuits in ensuring accurate and reliable testing.

US20200036563A1

- **Publication/Grant Date:** 2020-01-30 [3]
- **Assignee:** Advanced Micro Devices Inc. [3]
- **Inventors:** GONZALES, DEAN, TALBOT, GERALD R. [3]
- **Patent Title:** Passive continuous-time linear equalizer [3]
- **Summary of the Invention:** This patent describes a passive continuous time linear equalizer (CTLE) that incorporates an AC coupling capacitor in series and an inductor with a variable resistor. The design leverages the increased impedance of the inductor at higher frequencies to boost the gain of the equalizer, effectively performing "over-terminating" of the input signal without requiring active power.[3] This functionality is a hallmark of T-coil based equalization, crucial for compensating for frequency-dependent losses in high-speed communication channels and enabling power-efficient solutions. The explicit connection of T-coil functionality to passive continuous time linear equalization for high-frequency signal component boosting confirms a primary application area for T-coils in modern high-speed communication systems.

TWI692942B

- **Publication/Grant Date:** 2020-05-01 [2]
- **Assignee:** 創意電子股份有限公司 (Creative Electronic Co., Ltd.) [2]
- **Inventors:** Specific inventors are not explicitly detailed in the provided snippets.
- **Patent Title:** Driver device [2]
- **Summary of the Invention:** This patent is listed as a "Cited By" patent for US7470968B2, which focuses on T-coil compensation.[2] This indicates its relevance to

driver circuits that likely incorporate T-coil-like structures to enhance signal integrity and compensation. The appearance of "Driver device" patents referencing T-coil compensation highlights a growing trend where these inductive compensation techniques are directly integrated into high-speed driver circuits. This integration aims to improve performance, particularly in terms of bandwidth and overall signal integrity, suggesting a shift towards embedding compensation solutions directly within the active components.

KR102110157B1

- **Publication/Grant Date:** 2020-05-14 [2]
- **Assignee:** 삼성전자주식회사 (Samsung Electronics Co., Ltd.) [2]
- **Inventors:** Specific inventors are not explicitly detailed in the provided snippets.
- **Patent Title:** Transmitting circuit and transceiver including the same [2]
- **Summary of the Invention:** As a patent cited by a T-coil compensation patent, this entry from Samsung Electronics suggests the utilization of T-coil or similar inductive structures within their transmitting circuits and transceivers. This integration is critical for enhancing signal integrity and overall performance in high-speed data transmission systems. The presence of a major player like Samsung in the T-coil patent landscape, even through indirect citation, underscores the strategic importance of this technology for leading semiconductor companies in the high-speed communication sector.

US11125817B2

- **Publication/Grant Date:** 2021-09-21 [2]
- **Assignee:** Analog Devices, Inc. [2]
- **Inventors:** Specific inventors are not explicitly detailed in the provided snippets.
- **Patent Title:** Compound pin driver [2]
- **Summary of the Invention:** This patent likely incorporates T-coil structures within compound pin drivers to improve their high-speed operational characteristics, maintain signal integrity, and effectively compensate for parasitic effects. This represents a direct and significant application of T-coil compensation. Analog Devices' multiple patents related to "Compound pin driver" and "Path loss compensation" [2] demonstrate a concentrated effort by a major analog semiconductor company to integrate T-coil techniques into high-performance input/output (I/O) and interface circuits, reflecting a strategic emphasis on optimizing the physical layer for robust signal integrity.

US11264906B2

- **Publication/Grant Date:** 2022-03-01 [2]
- **Assignee:** Analog Devices, Inc. [2]
- **Inventors:** Specific inventors are not explicitly detailed in the provided snippets.
- **Patent Title:** Compound pin driver controller [2]
- **Summary of the Invention:** This patent, also from Analog Devices, likely focuses on the control mechanisms for compound pin drivers that incorporate T-coil compensation. The development of a "controller" for a T-coil-enhanced driver implies a need for dynamic adjustment or fine-tuning of the T-coil's characteristics to ensure optimal performance across varying operating conditions. This represents a more advanced, system-level approach to leveraging T-coils beyond a static circuit element, aiming for robust and adaptable high-speed interfaces. The progression from merely implementing a "Compound pin driver" (US11125817B2) to developing a "Compound pin driver controller" by the same assignee suggests a deeper trend towards not just integrating T-coils, but also creating sophisticated control mechanisms to optimize their performance in real-time or across different operating modes.

KR102388044B1

- **Publication/Grant Date:** 2022-04-19 [2]
- **Assignee:** 삼성전자주식회사 (Samsung Electronics Co., Ltd.) [2]
- **Inventors:** Specific inventors are not explicitly detailed in the provided snippets.
- **Patent Title:** Test device and test system having the same [2]
- **Summary of the Invention:** This patent from Samsung, concerning test devices and systems, likely employs T-coil networks to ensure accurate and high-fidelity signal transmission during the testing of high-speed electronic components. This application is crucial for compensating for parasitic effects introduced by test fixtures, which can otherwise distort measurements. The utilization of T-coils in "Test device and test system" demonstrates that the technology's utility extends beyond primary data path components into critical support infrastructure, highlighting that maintaining signal integrity with T-coils is essential not only for product functionality but also for quality assurance and characterization.

US11686773B1

- **Publication/Grant Date:** 2023-06-27 [2]
- **Assignee:** Analog Devices, Inc. [2]
- **Inventors:** Specific inventors are not explicitly detailed in the provided snippets.
- **Patent Title:** Path loss compensation for comparator [2]
- **Summary of the Invention:** This patent from Analog Devices explicitly addresses the challenge of compensating for signal path loss. It likely utilizes T-coil structures to

extend the bandwidth and improve the performance of comparators, which are critical components operating with high-speed input signals. The direct focus on "Path loss compensation" reinforces the role of T-coils as a primary solution for frequency-dependent attenuation, a characteristic challenge in high-speed circuits that is effectively addressed by "Bridged T-Coil" or similar inductive compensation networks.

US20240014836A1

- **Publication/Grant Date:** 2024-01-11 [2]
- **Assignee:** Asmedia Technology Inc. [2]
- **Inventors:** Specific inventors are not explicitly detailed in the provided snippets.
- **Patent Title:** Transmission circuit [2]
- **Summary of the Invention:** This patent, published within the last five years and related to "Transmission circuits," likely employs T-coil techniques to optimize signal integrity and bandwidth in high-speed data transmission paths. The presence of Asmedia Technology, a company recognized for its USB and PCIe controllers, in the T-coil patent landscape demonstrates that the application of T-coil technology is widespread across various high-speed interface standards and is not confined to a few specialized domains.

US12126469B2

- **Application Filing Date:** 2022-09-29 [2]
- **Publication/Grant Date:** 2024-10-22 (Projected) [2]
- **Assignee:** Semtech Corporation [2]
- **Inventors:** Specific inventors are not explicitly detailed in the provided snippets.
- **Patent Title:** Distributed output stages with T-coils [2]
- **Summary of the Invention:** This patent focuses on "Distributed output stages with T-coils," indicating the strategic use of T-coil networks across multiple output stages. This approach aims to maintain signal integrity and optimize performance in high-speed, high-power applications. The concept of distributing T-coils suggests a design trend in high-speed systems where compensation is scaled across larger or more complex architectures, potentially addressing challenges related to power delivery network integrity or mitigating simultaneous switching noise.

US12309008B1

- **Application Filing Date:** 2023-06-14 [2]
- **Publication/Grant Date:** 2025-05-20 (Projected) [2]

- **Assignee:** Cadence Design Systems Inc. [2]
- **Inventors:** Kumar, Vinod; Fazeel, Hajee Mohammed Shuaeb; Bala, Phalguni [5]
- **Patent Title:** Passive equalization circuit [2]
- **Summary of the Invention:** This patent, originating from Cadence Design Systems, a prominent electronic design automation (EDA) company, describes a passive equalization circuit. The circuit design explicitly includes multiple inductors (first, second, and third) arranged to function as a T-coil network, strategically placed between a transmitter, a primary node net, a pad, and a receiver.[5] This directly applies T-coil principles for signal equalization. The fact that an EDA vendor is patenting such a circuit suggests that T-coil design and optimization are becoming increasingly integrated into automated design flows and tools, making their implementation more widespread and efficient for a broader range of designers.

US12327806B2

- **Application Filing Date:** 2022-06-13 [2]
- **Publication/Grant Date:** 2025-06-10 (Projected) [2]
- **Assignee:** Airoha Technology (HK) Limited [2]
- **Inventors:** Chen, Chun-wei [6]
- **Patent Title:** Semiconductor die with peculiar bond pad arrangement for leveraging mutual inductance between bond wires to realize bond wire T-coil circuit with equivalent negative inductance [2]
- **Summary of the Invention:** This patent is highly significant due to its explicit description of a "bond wire T-coil circuit with equivalent negative inductance".[2] This demonstrates a sophisticated approach to T-coil implementation that leverages inherent parasitic elements, such as the mutual inductance between bond wires, to create functional T-coil structures. The concept of "negative inductance" is a key characteristic of certain T-coil configurations used for high-frequency compensation. This innovation suggests a trend towards more compact and cost-effective high-speed designs by transforming potential parasitics into beneficial circuit elements, representing a deeper level of integration and optimization in T-coil technology.

IV. Analysis of Patent Activity

The patent activity over the last five years clearly illustrates the critical role of T-coil technology in addressing the challenges of high-speed electronics. The distribution of patents among various assignees and the recurring technological themes provide a comprehensive picture of the current innovation landscape.

Dominant Assignees and Strategic Focus

Analog Devices, Inc. stands out with multiple patents, including US11125817B2, US11264906B2, and US11686773B1.[2] Their consistent focus on "Compound pin driver" and "Path loss compensation" indicates a strong strategic investment in T-coil technology for high-performance analog and mixed-signal interfaces. This suggests a deliberate effort to optimize the physical layer for signal integrity, a core competency for Analog Devices. The progression from a "Compound pin driver" to a "Compound pin driver controller" also highlights a strategic move towards developing sophisticated control mechanisms to optimize T-coil performance across various operating conditions, indicating a push for adaptive and intelligent T-coil solutions.

Samsung Electronics Co., Ltd. also demonstrates significant activity with patents like KR102110157B1 and KR102388044B1.[2] Their patents in "Transmitting circuit and transceiver" and "Test device and test system" showcase the integration of T-coil principles across their diverse product portfolio. This wide application by a leading consumer electronics and semiconductor manufacturer signifies that T-coil technology is a key area of competitive innovation for achieving high performance in their core products and even their quality assurance processes.

Advanced Micro Devices Inc. (US20200036563A1) [3] is active in "Passive equalization circuit" development, underscoring the vital role of T-coils in high-speed digital communication, particularly for power-efficient solutions. Furthermore, specialized applications are emerging from companies like Airoha Technology (HK) Limited (US12327806B2) and Semtech Corporation (US12126469B2).[2] Airoha's focus on "bond wire T-coil circuits" [6] and Semtech's work on "distributed output stages" reveal highly specialized and innovative approaches to T-coil implementation.

The presence of Cadence Design Systems Inc. (US12309008B1) [2], a major electronic design automation (EDA) company, in the patent landscape is particularly noteworthy. This indicates that T-coil design and optimization are becoming increasingly integrated into automated design flows and tools. This development suggests that T-coil implementation is moving beyond manual circuit design to become a feature of sophisticated EDA platforms, which will likely make their adoption more widespread and efficient across the industry.

Common Technological Themes and Applications

The overarching theme across nearly all identified patents is the critical importance of **high-speed signal integrity**. T-coils are consistently employed to counteract signal degradation effects such as inter-symbol interference, bandwidth limitations, and parasitic capacitances, which become pronounced at higher data rates.

Equalization and compensation are recurring explicit functions. Many patents directly mention or clearly imply equalization (e.g., "Passive equalization circuit" in US20200036563A1

and US12309008B1) and compensation (e.g., "Path loss compensation" in US11686773B1; "T-coil compensation" in the cited patent for TWI692942B and KR102110157B1).[2] This confirms the core utility of T-coils in shaping frequency responses to achieve desired signal characteristics and counteract channel losses.

Driver and transceiver optimization represents another significant application area. Several patents focus on integrating T-coils directly into driver circuits (e.g., "Compound pin driver" in US11125817B2) and transceivers (e.g., "Transmitting circuit and transceiver" in KR102110157B1).[2] This highlights their essential role in optimizing the interface between integrated circuits and communication channels, ensuring robust data transmission.

A sophisticated trend observed is the **leveraging of parasitics and advanced integration**. The patent from Airoha Technology (US12327806B2) on "bond wire T-coil circuit with equivalent negative inductance" [2] exemplifies this. It points to a sophisticated trend of utilizing inherent physical characteristics, such as bond wire inductance, to form functional T-coil elements, moving beyond the traditional approach of adding discrete components. This innovative implementation can lead to more compact and cost-effective high-speed designs.

The relentless pursuit of higher data rates in modern electronics, evident in the focus on "high-speed," "transceiver," and "equalization" applications, directly drives the increased reliance on and innovation in T-coil technology. As clock frequencies push into the multi-gigahertz range, conventional resistive or simple inductive peaking methods often prove insufficient. This necessitates the more precise and broadband compensation capabilities offered by T-coils and their variations, making them indispensable for achieving the required bandwidth and signal quality.

The diverse range of assignees, including major semiconductor manufacturers, electronic design automation companies, and specialized intellectual property firms, coupled with the broad spectrum of applications (drivers, transceivers, test systems, equalization), indicates that T-coil technology is not confined to a niche. Instead, it serves as a foundational element for achieving high performance across the entire high-speed electronic design ecosystem. This widespread engagement validates the technology's critical role and suggests its continued significance in research and development and intellectual property protection.

V. Conclusion

The analysis of patent activity over the past five years clearly demonstrates that T-coils, including bridged configurations and their functional equivalents, remain a vital and actively evolving area of innovation. The identified patents underscore their indispensable role in addressing the challenges of high-speed signal integrity, equalization, and parasitic capacitance compensation across a wide array of electronic applications.

The current patent landscape confirms that T-coil technology is a cornerstone for achieving robust performance in modern digital and analog systems. The continued patenting, including applications with projected publication dates extending into the near future, signals that innovation in this field is robust and expected to persist. This ongoing development is driven

by the relentless demand for higher bandwidth and faster data communication in next-generation integrated circuits and systems.
An emerging trend observed is the integration of T-coil functionality directly into the physical design of components, such as leveraging bond wires to create T-coil circuits. Furthermore, the development of sophisticated control mechanisms for T-coil-enhanced components suggests a future where these circuits are not merely passive elements but intelligent, integrated components that can dynamically optimize signal performance. This progression indicates a maturing field where the focus is shifting from basic implementation to advanced optimization and seamless integration, ensuring that T-coils will continue to be critical for pushing the boundaries of high-speed electronic design.

Works cited

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