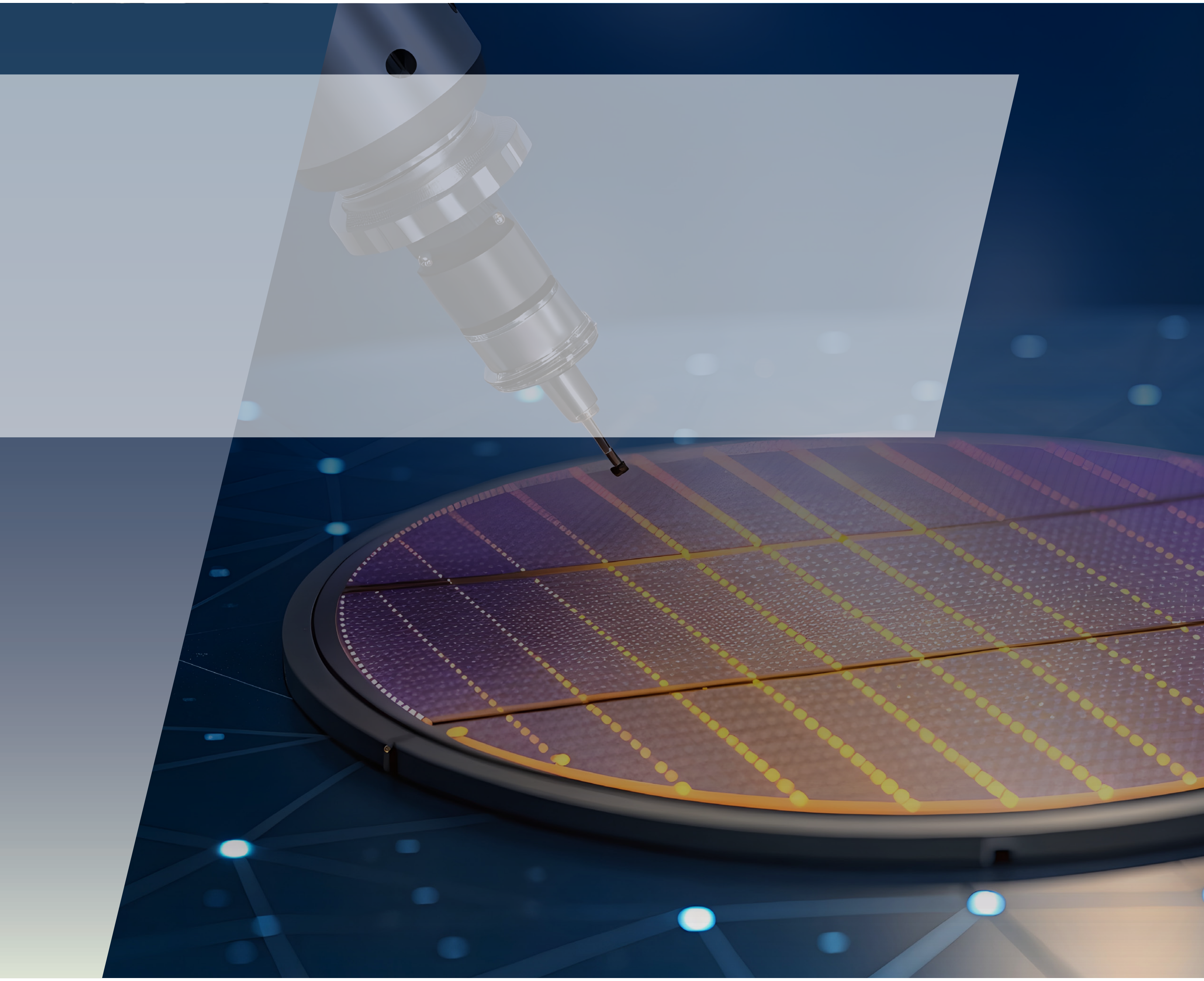
Standex DETECT Electronics

RF REED RELAYS FOR SOC TESTERS

Reliable Multi-GHz and High-Speed Digital Signal Switching in Semiconductor Test Systems



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- AEC-Q200
- IEC 60810-4
- IEC 60601-1
- IEC 62109-1/2
- IEC 60664-1
- ISO 6469-3
- IEC 60255-27
- UL listed
- RoHS, REACH

Introduction

System-on-Chip (SoC) testers used in semiconductor test and measurement must route a wide variety of signals with high precision, repeatability, and speed. These systems support DC parametric measurements, functional testing, high-speed digital interfaces, and RF characterization, often within the same test sequence.

SoC testers rely on multiple tightly coupled subsystems, including pin electronics, instrumentation, calibration resources, and signal switching networks. Signal switching is implemented using relay matrices or distributed routing on load boards and probe cards. The electrical performance and reliability of these switching elements directly affect measurement accuracy, test coverage, and overall test throughput.

This application note discusses the role of RF-capable reed relays in SoC testers, outlines the key switching requirements for multi-GHz and multi-Gbps signals, compares alternative switching technologies, and explains why RF reed relays are commonly used in specific SoC tester switching layers such as instrument multiplexing, RF path selection, calibration loops, guard and isolation switching, and low-leakage measurement routing, where high isolation, low leakage, and stable signal integrity are required.

Switching Requirements in SoC Test Systems

SoC testers must switch thousands of signals across a wide range of electrical domains. Typical requirements include:

- DC and low-frequency analog signals for parametric measurements
- High-speed digital signals, often operating at multi-Gbps data rates
- RF signals in the multi-GHz range for wireless and mixed-signal SoCs
- High channel density, especially on load boards and probe cards
- Long operational life, often hundreds of millions of switching cycles

Relays are used to connect and disconnect test instruments to DUT pins, isolate sensitive measurements, reconfigure signal paths between test modes, and route high-speed or RF signals without degrading signal integrity.

As data rates and frequencies increase, switching parasitics such as capacitance, inductance, and impedance discontinuities become critical. Even small variations in relay geometry or PCB transitions can introduce reflections, insertion loss, or crosstalk that negatively impact test results.

RF and High-Speed Digital Signal Considerations

High-speed digital signals share many characteristics with RF signals. A digital signal operating at several gigabits per second contains harmonic content well beyond its fundamental clock frequency. As a result, the switching path must support bandwidths well into the multi-GHz range to preserve rise time, edge integrity, and timing margins.

From a switching perspective, RF and high-speed digital signals have different impedance requirements. RF signal paths are typically single-ended and controlled around 50 Ω. High-speed digital interfaces are usually differential and require controlled differential impedance, tight skew control, and low mode conversion. Parallel and memory interfaces are topology-dependent and are not universally 50 Ω end-to-end.

Beyond impedance control, both RF and fast digital signal paths require:

- Low insertion loss across the intended bandwidth
- Minimal reflections caused by impedance discontinuities
- Low parasitic capacitance, particularly across open contacts
- Stable performance over temperature and lifetime

Switching components that perform well at DC or low frequencies may fail to meet these requirements once signal edge rates and frequencies increase.

Switching Technology Options for SoC Testers

Several switching technologies are used or evaluated in SoC test systems. Each presents advantages and tradeoffs.

Electromechanical Relays (Armature-Based)

Traditional electromechanical relays can handle high currents and voltages and are suitable for power routing or stress testing. However, their larger size, slower switching speed, and limited high-frequency performance make them less suitable for dense, high-speed SoC test architectures.

Solid-State Relays and Semiconductor Switches

Solid-state switching devices offer fast switching speeds and no mechanical wear. However, they inherently introduce on-resistance, off-state leakage, and parasitic capacitance. These characteristics reduce isolation, increase insertion loss, and can distort low-level analog or high-speed signals, limiting their usefulness in precision SoC testing.

MEMS Switches

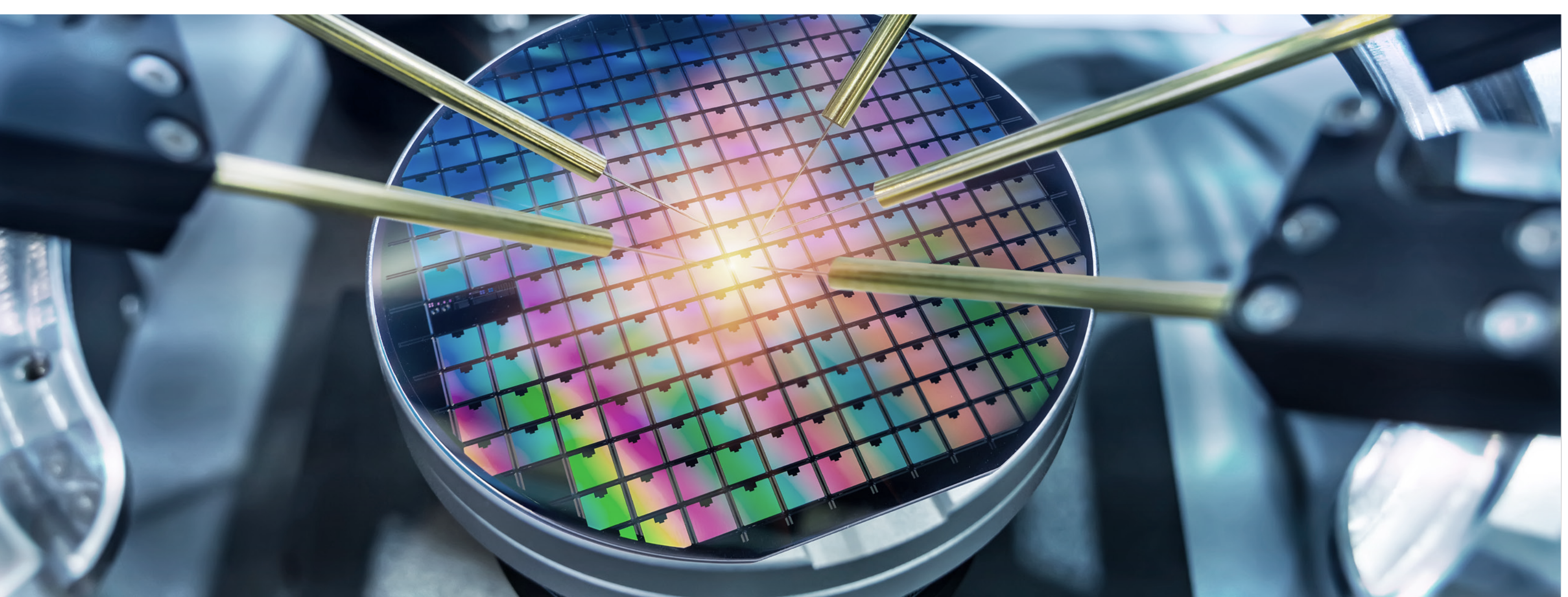
MEMS switches can provide good RF performance and small form factors. However, challenges remain around long-term reliability, hot-switching robustness, current handling capability, and cost.

RF Reed Relays

RF reed relays combine mechanical metal-to-metal contacts with compact geometry and fast actuation. Their hermetically sealed contacts provide:

- Very low on-resistance
- Extremely high off-state insulation resistance
- Low and stable parasitic capacitance
- Excellent signal linearity
- Long operational life under signal-level loads

Modern RF reed relays are specifically engineered with controlled-impedance signal paths and internal shielding, enabling reliable operation for multi-GHz RF signals and multi-Gbps digital data.



Why RF Reed Relays Are Well Suited for SoC Testers

RF reed relays closely approximate an ideal switch for signal-level applications. When closed, the signal path is a continuous metal conductor with minimal resistance and distortion. When open, the physical air gap and low capacitance provide excellent isolation. This behavior is particularly important for RF measurements and high-speed digital validation, where leakage, nonlinearity, or parasitics can corrupt results.

Key advantages include:

- High signal integrity for both RF and fast digital signals
- Excellent isolation between channels in dense relay matrices
- Fast switching speeds, supporting high test throughput
- Very long operational life under signal-level and cold-switching conditions
- Compact packages, enabling high channel density

These characteristics make RF reed relays suitable for both entry-level SoC testers and highly complex, multi-site test platforms.

Design Considerations for RF Reed Relays in SoC Testing

Achieving reliable RF and high-speed digital performance requires careful relay design.

Signal Path Geometry

The characteristic impedance must remain consistent from PCB entry, through the relay, and back to the PCB. Changes in geometry or dielectric environment can cause reflections and insertion loss.

Package Materials

Ceramic substrates and thermally stable mold compounds help maintain dimensional stability and consistent electrical performance over temperature.

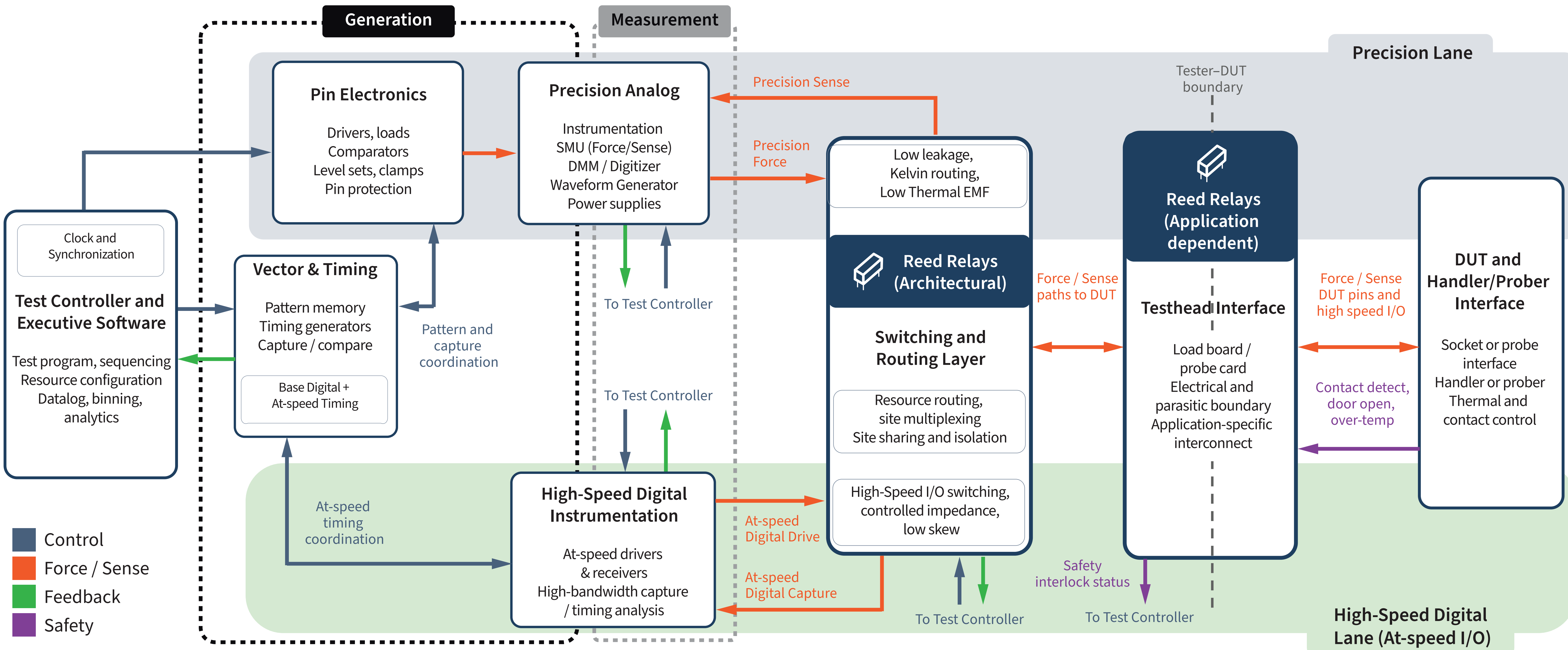
Shielding

Internal electrostatic shielding reduces capacitive coupling and improves isolation at higher frequencies. Magnetic shielding prevents interaction between coils in dense layouts.

Lead Configuration

Surface-mount lead styles are optimized to minimize parasitics and integrate with controlled-impedance PCB layouts.

SoC Test Architecture Example



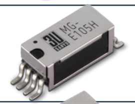
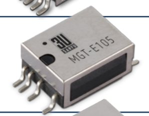
RF Reed Relay Solutions for SoC Test Use Cases

Standex / Sanyu offers a portfolio of RF reed relays designed to address the full range of SoC test requirements, from compact high-frequency switching to dense matrix architectures.

Signal-level switching performance supports -3 dB bandwidths up to 8 GHz, depending on package style and geometry. Selected series are capable of supporting high-speed digital data transfer with stable eye behavior for high-speed digital data rates up to the ~6 to ~9 Gb/s range under defined test conditions.

This performance is enabled by very low open-contact capacitance (~0.2–0.5 pF), stable contact resistance in the tens of milliohms, and compact electrical length with controlled signal geometry.

When implemented with appropriate PCB interconnect design, these reed relays provide a reliable solution for multi-GHz RF path selection and multi-Gb/s digital switching in complex SoC test systems.

Relay Series	Typical SoC Test Use Case
CRF Series 	Multi-GHz RF signal routing, high-speed digital channels requiring lowest insertion loss
U Series 	Ultra-compact load boards, multi-GHz RF and high-Gbps digital switching where space is critical
C Series 	High-density surface-mount relay matrices for mixed RF, digital, and analog SoC testing
M Series 	General-purpose SoC pin electronics, functional test paths, and mixed-signal routing. Available as Normally Open contact in 1A and 2A Form
MT Series 	Differential signal switching for high-speed serial interfaces. Available in a Changeover Form 1C and 2C
MH Series 	Very high channel-count relay matrices and dense ICT/FCT style SoC test systems. Extra small relay, available in a Changeover Form 1C

Across these series, emphasis is placed on controlled impedance, low insertion loss, high isolation, long life, and consistent performance in high-density layouts.

Conclusion

As SoC devices continue to integrate RF, high-speed digital, and precision analog functions, the demands placed on test system switching components continue to increase. While alternative switching technologies exist, RF reed relays remain a proven and widely adopted solution due to their unique combination of signal integrity, reliability, switching speed, and density.

By understanding the electrical and mechanical challenges of SoC testing and designing relays around these constraints, Standex / Sanyu provides RF reed relay solutions that enable accurate, repeatable, and high-throughput semiconductor testing across a broad range of applications.

For When it Matters - The Right Design, at the Right Time, at the Optimal Cost.

At Standex Electronics, we believe in: Collaborative innovation with our customers

- Collaborative innovation with our customers
- Delivering the right design, at the right time, at the optimal cost
- Acting as an extension of your engineering team
- Living our promise: **Innovate | Consult | Engineer | Deliver** — when the stakes are high, Standex Detect delivers.

To learn more about how Standex Detect can support your projects with innovative sensing, switching, and relay technologies, visit standexdetect.com or contact our engineering team to discuss your specific application needs.

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