



# THERMAL RF SOLUTIONS

VOL. 1



# Radio Frequency Isolation at Temperature!

The need for combined RF-thermal testing has increased, especially for devices like tightly integrated multi-antenna systems (e.g., beamforming arrays or MIMO antennas). In such systems, the performance of electronic components like phase shifters and RF amplifiers is closely linked to overall radiation characteristics, making temperature variations critical. This integrated testing is also beneficial for devices operating in extreme temperatures, safety-critical devices, and those subject to regulatory requirements.

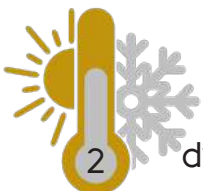
The RF properties affected by temperature include the radiation pattern degradation in beamforming arrays, leading to energy radiated in unwanted directions and reduced system gain. Frequency detuning is another challenge, where RF components' frequency or bandwidth drifts with temperature changes, potentially causing recognition issues for signals. Mechanical failures due to extreme temperatures, such as stresses and strains causing fatigue at material boundaries and the formation of cracks in electrical paths, are common issues affecting RF device performance.

There is no one-size-fits-all test solution for RF-thermal testing. DVTEST offers three types of systems, each with their own benefits.

This product guide will compare several different methodologies - all available from DVTEST.

## Types of Systems

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## Next Gen, High-Quality 100db Thermal RF Test Enclosure



### NEW and Improved

The NEW TSE 2.0 utilizes proven double wall dbSAFE architecture to provide one of the best RF environments on the market.

New and improved waveguide Air Inlets and Exhausts eliminate thermal response on the exterior of the unit and a larger inner to outer wall dimensions allows for more insulation opening up even more extreme temperature possibilities.



### PMI Foam

Polymethacrylimide foam, is a lightweight, rigid material with excellent thermal and mechanical properties. In radio frequency applications, PMI foam's low dielectric constant allows RF signals to pass through with minimal interference, while its low loss tangent ensures minimal energy loss during transmission. In thermal applications, it serves as effective rigid insulation.



## ThermoElectric RF Enclosures



### Thermal Testing without Complex Facility Requirements

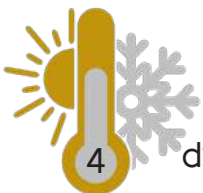
Most thermal testing options require complex facility preparations and services – liquid nitrogen supply, oil free – clean dry compressed air, etc. For testing scenarios that do not require extreme cold temperatures (i.e.  $-5^{\circ}\text{C}$  and upward) ThermoElectric Enclosures are an excellent choice.

These type of enclosure utilize an Air-to-Air thermoelectric cooler assembly that uses impingement flow to transfer heat. It offers dependable compact performance by cooling objects via convection. Heat is absorbed and dissipated through high density heat exchangers equipped with air ducted shrouds and brand name fans. The heat pumping action occurs from custom designed thermoelectric modules that achieve a high coefficient of performance (COP) to minimize power consumption.



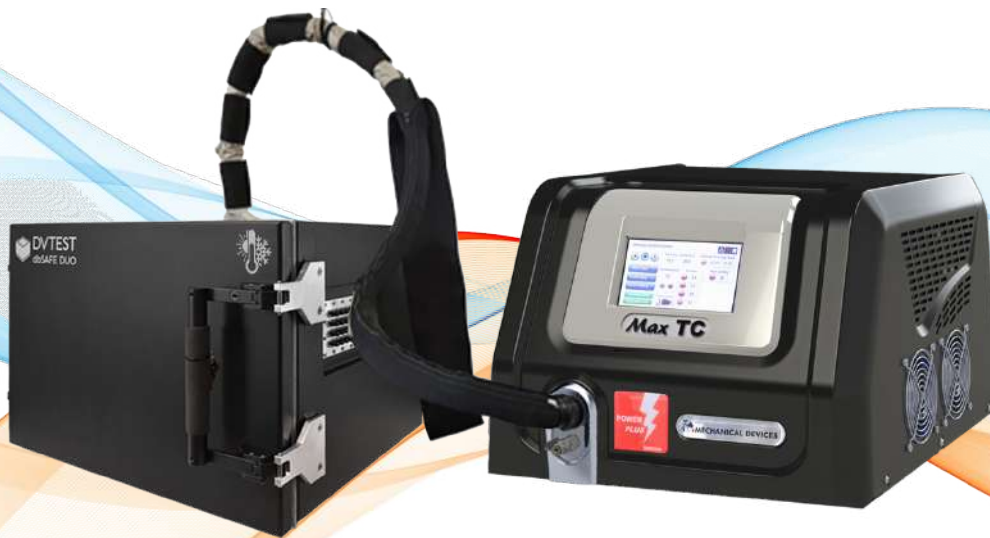
### Advantages of ThermoElectric Enclosures

- Environmentally Friendly
- Solid State Operation
- Silent Operation
- Compact Design
- Precise Temperature Control
- Energy Efficiency
- No Vibration



# Direct Contact Temperature Forcing System

## DVTEST and Mechanical Devices System



### Direct Contact Temperature Forcing System

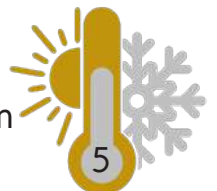
State of the art direct contact temperature forcing system paired with the industry leading RF enclosure, allows manufacturers to easily and accurately perform IC testing over temperature in a controlled RF environment. The system is capable of RF shielded testing at extreme temperatures of **-75 °C to +200 °C**.

### dbSAFE DUO for Thermal Testing

The dbSAFE DUO utilizes a double wall aluminum structure to provide the best RF enclosures on the market, offering greater than 100dB isolation. The offset I/O panels, passivated coating, enhanced absorber and dual gasketing minimizes crosstalk and improves the isolation of the enclosure beyond the capability of conventional single walled enclosures.

### Max TC Power Plus from Mechanical Devices

Mechanical Devices thermal control units allow for temperature forcing across a range of device sizes and types, low to high power dissipation, in socket or soldered to board. Mechanical Devices thermal units stimulate the DUT to temperature precisely and consistently, by direct contact with a powerful thermal head offering temperature stability of  $<0.5^{\circ}\text{C}$ , fast time to temperature and are fully programmable for automation.



# RF Enclosure + Environmental Chamber

## DVTEST + CINCINNATI SUB-ZERO

Integration of RF enclosures into environmental chambers not only streamlines testing procedures but elevates the entire testing paradigm. The resulting RF-capable environmental chambers is a highly efficient platform for wireless device testing across a broad spectrum of environmental challenges.

### Value Proposition:

- Retrofittable on existing environmental chambers (Integration of the technologies is reversible)
- Wide install base of thermal systems
- Conducts **TWO** types of tests at once
- Low cost
- High Heating/Cooling Capacity compared to forced air systems

For this solution the DVTEST enclosure is configured specifically for integration within the environmental chamber.

High performance waveguide fan modules ensure stable airflow

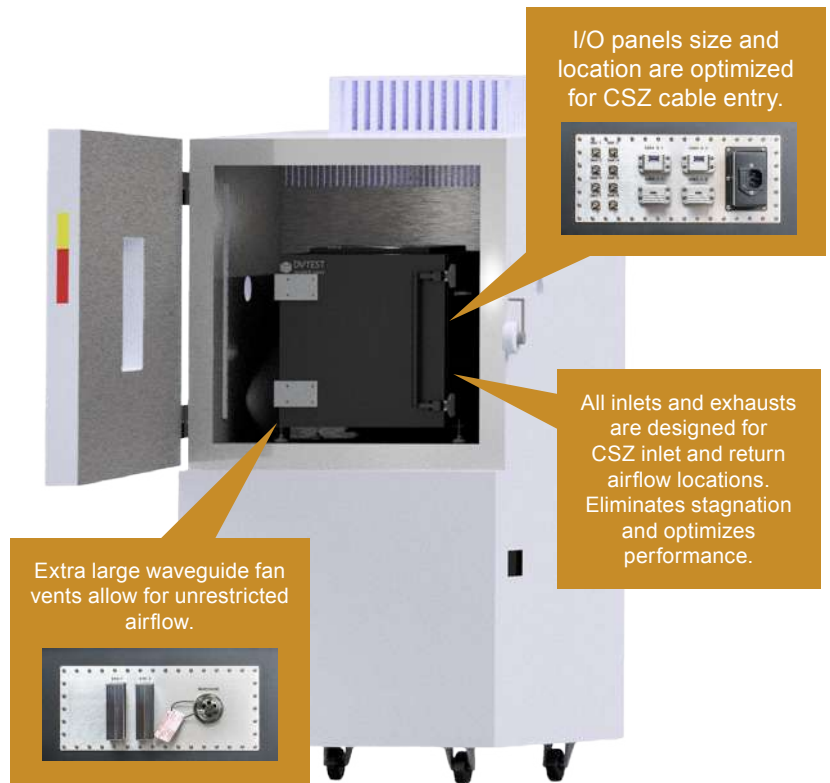


I/O panels size and location are optimized for CSZ cable entry.

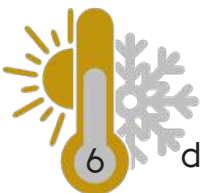


All inlets and exhausts are designed for CSZ inlet and return airflow locations. Eliminates stagnation and optimizes performance.

Extra large waveguide fan vents allow for unrestricted airflow.



Please contact factory for custom sizing, additional options, and unique design application ideas.



# Thermal Product Selection Guide



| dbSAFE TSE 2.0                                                                       | dbSAFE TEC                                                                                                | Direct Contact                                                                                   | Enclosure + Chamber                                             |                                                                   |
|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-------------------------------------------------------------------|
| Front, Top Load and Dual Cavity                                                      | Front and Top Load                                                                                        | Front Load                                                                                       | Front Load                                                      | Loading Style                                                     |
| Double                                                                               | Double                                                                                                    | Single or Double                                                                                 | Single                                                          | Chassis Wall Type                                                 |
| Versatile RF thermal solution for smaller UUTs; provides fast temperature response . | Suitable for limited temperature ranges; does not require compressed air , nitrogen or other facilities . | Suitable for ICs/ antennas on evaluation board. Required special footprint for proper operation. | Suitable for larger/multiple UUTs. Typically longer test times. | Use Case                                                          |
| > 90 db                                                                              | > 90 db                                                                                                   | > 80 db                                                                                          | > 80 db                                                         | Shielding Effectiveness<br>(Isolation spec measured at each seam) |
| ●                                                                                    | ●                                                                                                         | ●                                                                                                | ●                                                               | Tri-Shield®<br>MIL-DTL-5541F Process                              |
| 0.3 - 18                                                                             | 0.3 - 18                                                                                                  | 0.3 - 18                                                                                         | 0.3 - 18                                                        | Standard Frequency Range (GHz)                                    |
| ●                                                                                    | ●                                                                                                         | ●                                                                                                | ●                                                               | Extended Frequency Range (up to 60 GHz)                           |
| -80 C to +120 C                                                                      | -10 C to +80 C                                                                                            | -80 C to +120 C                                                                                  | -60 C to + 120 C                                                | Temperature Range                                                 |
| 120/220 VAC, 20 & 30 AMP, Clean Dry Compressed Air                                   | 120/220 VAC, 15 AMP                                                                                       | 120/220 VAC Mechanical Devices System                                                            | Existing CSZ Chamber, Suitable AC Power                         | Facilities Required                                               |
| All                                                                                  | All                                                                                                       | Chipset on board                                                                                 | All                                                             | UUT Type                                                          |
| ●                                                                                    | ●                                                                                                         | ●                                                                                                | ●                                                               | Suitable for internal fixturing                                   |
| Forcing unit can be programmed                                                       |                                                                                                           | Mechanical Devices unit can be programmed                                                        | Thermal chamber can be programmed                               | Programmable                                                      |
|                                                                                      |                                                                                                           |                                                                                                  | Optional                                                        | Humidity Control                                                  |





## Performance Matters.

### The Enclosure is an Integral Part of the Measurement Solution.

A high quality, repeatable environment reduces setup, calibration and test time, and delivers results that can be counted on being accurate – ultimately reducing costs and shortening test times.



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