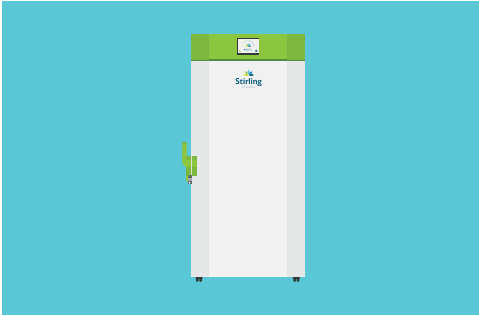


# STIRLING ULTRACOLD STAYS AHEAD OF NEW HIGH-EFFICIENCY ULT FREEZERS



## FREE-PISTON STIRLING ENGINE VS. NEW VARIABLE-SPEED COMPRESSOR TECHNOLOGY

Some ultra-low temperature (ULT) freezer manufacturers have turned to new variable-speed compressor systems, sometimes referred to as inverter compressors, to compete with Stirling Ultracold's energy-efficient ULTs. While this new technology has improved energy-efficiency ratings, it hasn't solved most of the failure modes inherent in compressor-based systems; some even introduce potentially new reliability risks to consider.

### FAR FEWER MOVING PARTS AND SYSTEMS = FAR FEWER OPPORTUNITIES TO FAIL

Stirling engine-powered ULTs have very few moving parts, which use gas bearings to eliminate contact, heat and wear. In contrast, variable-speed cascade compressor systems are even more complex than their fixed-speed counterparts:

- Oil lubrication is still needed to reduce metal-to-metal friction and wear at multiple points of rotation in each compressor.
- Variable speeds apply continuous changes to torque, friction and lubrication profiles during compressor operation.
- Some variable-speed ULTs have an additional system to keep the oil cool and prevent further component wear.

**Stirling doesn't need to add special systems to cool oil; because we never have — and never will — need oil in our system.**

### FULLY ADAPTIVE MODULATION VS. ON-OFF CYCLING

Despite what you might have heard, variable-drive compressor systems still cycle on and off to help regulate temperatures, which:

- Increases internal component and motor wear
- Increases steady-state temperature variation

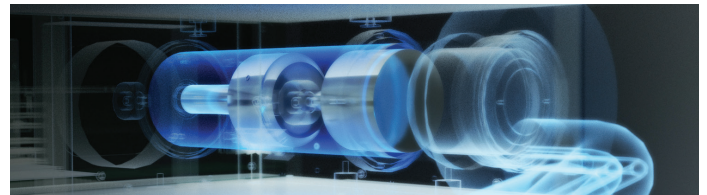
Stirling uses fully adaptive, modulating technology, which completely eliminates on-off cycling for better temperature performance over the widest range of operating conditions. That includes real-time temperature recovery after door openings, where Stirling freezers are among the fastest to recover in the industry.

### VARIABLE-DRIVE COMPRESSOR SYSTEM CYCLE



The last thing you want to see in your ULT freezer is a pulse.

### STIRLING ULTRACOLD



With its continuously modulated piston and displacer, the design of the free-piston Stirling engine is dramatically different from reciprocating compressors that regulate temperature with on-off cycles.

## FIELD-PROVEN OVER TIME VS. NEWER TECHNOLOGY

The free-piston Stirling engine has a proven track record of success in ULT applications, having been in commercial field use twice as long as variable-speed compressor ULT technology.

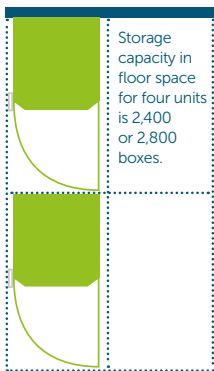
STIRLING ENGINE	VARIABLE-SPEED TECHNOLOGY
<p><b>12+ years of commercial use in the field</b></p> <ul style="list-style-type: none"> <li>Installed base of over 17,000 ULT units</li> <li>More than 260 million hours of runtime operation</li> </ul>	<p><b>6 or fewer years of commercial use in the field</b></p>

## MORE STORAGE IN LESS SPACE

Compressor-based ULT systems are larger and take up valuable lab space. Stirling freezers have a smaller footprint, with a much smaller clearance for door swings — allowing for more freezers in a given area.

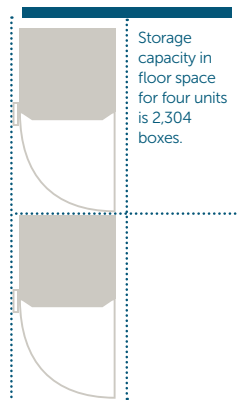
With its compact top-mount engine design, customers also get more storage capacity per ft<sup>2</sup>/m<sup>2</sup> of floor space. Stirling upright ULT freezers can store 600 sample boxes in a smaller footprint than any comparable ULT freezer. And they can be configured for up to 700 boxes — increasing sample storage density even more and allowing customers to store up to 70% more samples than other upright ULTs in a given floor space.

### Stirling Ultracold ULT 4 ULT Freezers



In the overhead view configuration shown, the same number of Stirling freezers store up to 47% more samples per square foot/meter.

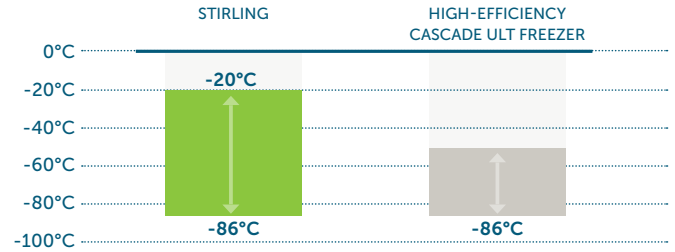
### High-efficiency compressor-based ULT 4 ULT Freezers



## WIDEST TEMPERATURE RANGE

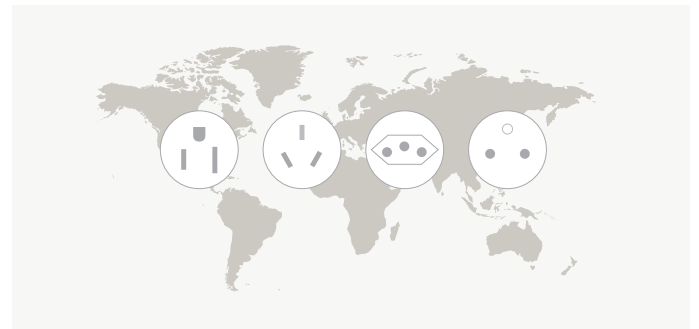
Unlike the limited temperature range of compressor-based models, the -20°C to -86°C range of Stirling ULTs gives customers the flexibility to use the freezer for a broader

range of applications and biogenic materials, including as a backup unit to house samples that can be safely stored at warmer temperatures.



## WIDER RANGE OF VOLTAGE INPUTS TO PLUG IN ANYWHERE

By simply changing power cords, any Stirling engine-powered ULT can automatically switch across a wide voltage range, including standard outlets from 110 to 240 volts, so customers can operate their freezer anywhere in the world without electrical modifications. Other high-efficiency ULTs may need voltage boosters or expensive add-ons to maintain voltage equilibrium and are more susceptible to brownouts, voltage/frequency variations and surges.



## BEST ENERGY EFFICIENCY AND SMALLEST CARBON FOOTPRINT PER SAMPLE

Since our SU780XLE upright freezer has the top ULT ENERGY STAR® efficiency rating and stores more samples than comparably sized models, labs get the industry's best energy savings and smallest operating carbon footprint per sample capacity.

But Stirling Ultracold's sustainability benefits don't end there. Not only have all of our ULT freezer models been energy-efficiency leaders from day one, but they all use EPA-approved 100% natural refrigerants and are manufactured in a zero waste facility. Other ULT manufacturers may have one or two "high-efficiency" models, but continue to sell their line of inefficient models with large operating carbon footprints.