MAKING MODERN LIVING POSSIBLE

SALT Drive Systems

Increase oil & gas production
Minimize energy consumption

www.danfossdrives.com

VLT® THE REAL DRIVE

What is **SALT?**

- **Minimize power consumption**
- **Reduce mechanical failures**
- **Enhance production**
- **Lower equipment costs**

Sensorless Artificial Lift Technology (SALT) is a patented methodology that uses a sensorless vector variable frequency drive (VFD) with built-in pump-off software. It is the most advanced artificial lift system control on the market, outperforming all existing artificial lift controllers.

A Danfoss VLT® Series drive designed specifically for oilfield applications uses the relationship of the motor's rotor to the stator to determine load and regulate speed. A global leader in variable frequency drive technology, Danfoss offers innovative and technologically advanced products backed by a superior service and technical support network. With $4 billion in annual sales revenues, the Danfoss name and VLT trademark are synonymous with quality and reliability. Danfoss maintains local service through a global presence with manufacturing, sales and service centers worldwide.

Unlike standard pump-off controllers, which shut off the pump during periods of low production, SALT reduces the pump speed, maintaining and maximizing production while reducing energy consumption and mechanical stress.

SALT also provides warning capabilities for conditions such as pump off, paraffin buildup, gas pockets, failure to recover, and maximum and minimum loads. These warnings, as well as information regarding the number of strokes per day, inferred production and gas purges are all maintained in a log that reports pump activity from the previous **thirty days**. All of this functionality is built directly into the drive, eliminating the need for an external surface or pump card. SALT also eliminates the need for dynamic braking, which not only reduces equipment costs, but also simplifies installation and maintenance.

SALT is a versatile technology that offers significant advantages to all types of down-hole pumps, including beam, progressive cavity and submersible pumps. It can even be used to automate surface pumps, providing level control and event notification.

An example with SALT applied to a rod pump:

Assumptions

- 5000-ft. well depth
- 1.75-inch pump
- 120-inch stroke operating at 8 strokes per minute
- Rod # 76
- Rod Grade D

	Pump-off Controller	SALT
Peak Polish Rod Load	17,300 lbs	14,900 lbs
Peak Gear Box Torque	454 Kin-lbs	320 Kin-lbs
Polish Rod Power	13.5 HP	4.9 HP
Rod Loading	85.5%	70.1%

Conclusions

Without salt...

- 16.1% higher peak polish rod load
- 41.8% higher gear box load
- 175% higher polish rod power
- 21.9% higher rod loading
- 25% higher electrical usage
- 5–10% lower production

Applying SALT to a rod pump dramatically reduces power consumption as well as rod and gearbox loading. SALT can be used with standard pump-off controllers if a dynamometer is desired. SALT can also be programmed for a slow downstroke to reduce rod compression.

SALT **Advantages**

Ease of use

SALT has been designed specifically to be user friendly. It takes as little as 15 minutes to set system parameters during initial setup procedures. Basic information and control components are displayed prominently on the front of the unit, providing instant access to system status. Additional levels of control and data retrieval are available using a variety of access methods.

A panel located on the front of each SALT unit provides immediate access to basic control capabilities and status information

SALT was the first system to provide automatic variable speed based on power savings, fluid levels, pump fillage, overloading, underloading, rod compression, gas, sand and other variables. Many now try to copy SALT, but none have the experience and dedication to match it.

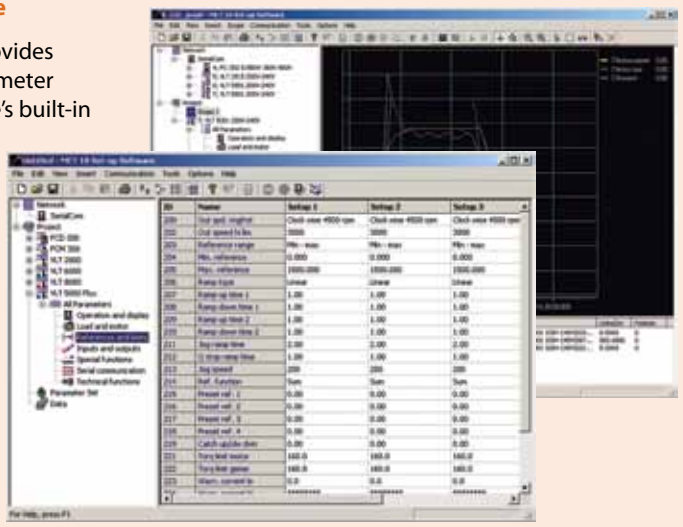
Multiple levels of control

Keypad

With onboard help and an intuitive menu structure, the SALT keypad provides graphical information and access to all parameter settings. These settings can be uploaded to and downloaded from the keypad, which greatly simplifies restart procedures and minimizes downtime in service situations. LED indicators provide basic status information and dedicated buttons enable one-touch access to commonly used functions.

MCT 10 PC software

MCT 10 software provides PC access to all parameter settings via the drive's built-in USB or RS485 ports. MCT 10's Windows-based interface allows extensive, centralized control for streamlined programming and monitoring.



Serial communication

SALT includes as standard the Modbus RTU protocol, which allows third-party telemetry or SCADA access to configure, monitor and control from remote locations.

SALT Advantages

Increase production

In any well, the higher the casing pressure, the less fluid is allowed into the well bore. Any time the pumping system is stopped, the pressure increases, reducing flow into the well. SALT maintains minimum intake pressure to the well by varying the speed to match the well's productivity, thereby minimizing the shutdowns that reduce well productivity.

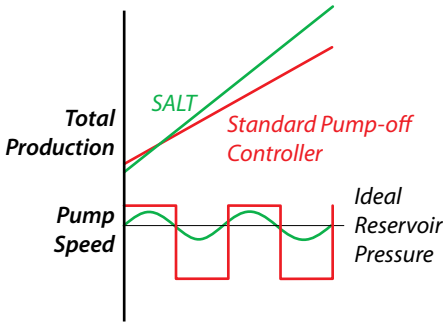
SALT automatically adjusts speed to match the variable fluid volumes caused by:

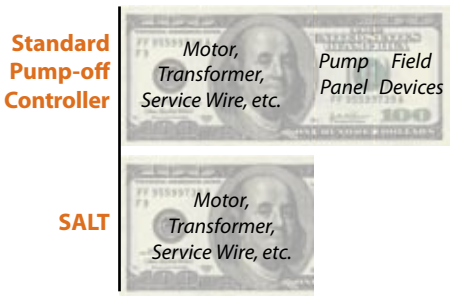
- Changes in reservoir level
- Shutdown of adjacent wells
- Artificial stimulation methods such as water floods, "Huff and Puff" steam or CO_2 injection
- Pump wear

Upon pump-off (under load), SALT does not stop but rather slows the pump until fluid levels have recovered. This greatly increases production. SALT eliminates shutdowns and their resulting periods of well recovery and pump-down. Maintaining consistent fluid production results in optimal flow from the reservoir into the well, maximizing its production capacity. On rod pumps, SALT will dynamically vary the pump speed within each stroke to maximize efficiency, regulate rod stress and maintain the appropriate average strokes per minute based on reservoir level.

The use of a VFD allows operating the motor above base speed. This allows for a faster pump-down of high fluid levels.

When a gas pocket is detected on a submersible pump, SALT increases to maximum speed to purge the gas through the pump. If this fails, the pump is slowed to minimum speed to let the gas pass while allowing the fluid level to increase. The system will then repeat the process until the gas is eliminated.





Lower equipment costs

Using SALT on any pump system can reduce or, in some cases, eliminate altogether the costs related to equipment. In addition, its sophisticated control technology is designed to be easy to implement, installing in less than ¼ of the time required for traditional pump-off controllers. The result is a more efficient, reliable and streamlined installation.

SALT increases system efficiency, allowing the use of smaller motors and transformers. It also allows the use of more efficient and less expensive NEMA B motors on rod pumps, in place of NEMA D motors.

SALT replaces the standard pump panel and requires no field end devices, such as load cells, encoders or pump cards. On submersible pumps, SALT completely eliminates the need for bottom-hole pressure sensors and their related costs and maintenance requirements. In fact, SALT's ability to automatically optimize the fluid level and prevent cavitation is superior to bottom-hole pressure control.

A maximum speed change does not require any mechanical changes. The use of a VFD allows operating the motor at any speed, including above base speed.

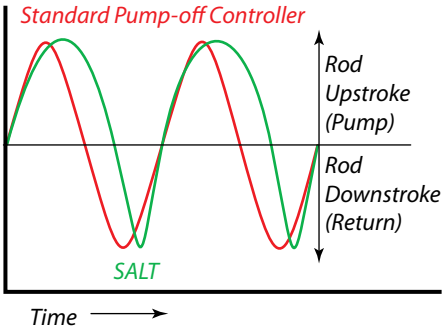
For progressive cavity pumps, SALT offers a unique sand-purge algorithm that allows the pump to run at full speed—limited only by the set load limit—when sand enters the pump. This allows the pump to attempt to clear the sand before the pump seizes.

Another substantial benefit for progressive cavity pump installations is SALT's DC-injection braking feature, which holds the motor after a stop by applying DC voltage to it. This eliminates the need for a mechanical brake to minimize rod backspin.

SALT Advantages

Reduce mechanical stress

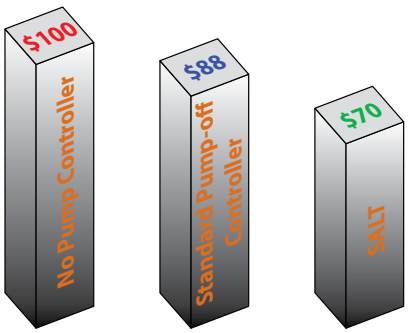
On rod pumps, even Mark type units, SALT reduces or eliminates rod overloading and compression by dynamically adjusting pump speed within each stroke. As SALT regulates down the pump strokes per minute based on reservoir levels, mechanical stress is reduced. For example, operating at 6 SPM 24 hours per day is less taxing than operating at 8 SPM 20 hours per day. Furthermore, SALT soft starts do not exceed the load limits of the rod or gearbox even if the pump is stuck due to solids or mechanical problems. In fact, by slowing the unit down rather than stopping entirely, SALT eliminates altogether the potential for solids to fall back into the pump.



Four-quadrant control for rod pumps provides adjustable speeds and load limits within portions of each stroke. This function can be used to eliminate rod float and rod compression, allowing the use of fiberglass rod. SALT decreases speed during peak mechanical loads, eliminating peak load setting violations.

Traditional pump-off controllers cause wide temperature and pressure variations in the pump motor. Because SALT operates continuously, motor temperature and pressure are more consistent, prolonging the longevity of submersible pump motors.

For progressive cavity pumps, SALT is programmed to never exceed the maximum torque on the rod string, greatly reducing the chance for stress and breakage. SALT also has a unique sand-handling algorithm that allows the pump to run without overstressing the rod string when sand enters the pump. This allows the pump to attempt to clear the sand without shutting down and causing additional problems.



Minimize energy consumption

Traditional pump-off systems allow fluid to flow back down through the pump every time the pump shuts off. By operating the pump continuously, SALT eliminates this problem altogether. Fluid that has already been produced does not have to be produced again. Upon gas detection, SALT increases speed to pass the gas through the pump. If this fails, the pump is slowed to minimum speed to let the gas pass while allowing the fluid level to increase. The system will then repeat the process until the gas is eliminated.

SALT provides a power factor of .97, eliminating the need for power correction and the power losses associated with such equipment. SALT's soft start and load limit features also reduce peak demand charges by as much as 50% when compared to standard pump-off controllers.

SALT is able to benefit from the affinity laws of pumps, which state that power is proportional to the cube of speed change. Essentially, this means that even a small reduction in speed results in a substantial reduction in power needed to run the pump. As SALT automatically reduces pump speed when reservoir levels are low, there is a significant energy savings associated with reducing centrifugal pump speed.

SALT reduces the excess power delivered to rod pumps by slowing down during peak demands. Any excess energy delivered to the rod pump is then retained as mechanical energy instead of being converted back to electrical energy. Since the excess energy is kept within the system instead of returning to the power grid, less energy from the power grid is required for the next peak demand. This patented system reduces kilowatt usage by 22% or more. In unbalanced systems, the kilowatt usage is reduced even further.

Control Panel and Display

Specialized data tracking

- Categories specific to oilfield applications
- Easy access to relevant information

Active selection indication

- LEDs illuminate active buttons and conditions

Quick Menus

- Quick Menu provides access to commonly used parameters
- Personalized Quick Menu allows the user to group desired parameters for quick access
- Changes Made Menu lists parameters unique to your application

Helpful buttons

- Info (on-board manual)
- Cancel (undo)
- Alarm log (quick access)

Other benefits

- Removable during operation
- Upload and download parameter sets from one drive to another via the keypad

Special Monitoring Readouts

- Torque (ft/lbs)
- Motor voltage*
- Motor current*
- Transducer (PSI)
- Day 2 strokes
- Day 2 run hours
- Day 2 pump-offs
- Pump fillage (%)
- Speed (strokes per minute or polished rod RPM)
- Status

Full 30-day log of:

- Number of strokes
- Number of faults
- Number of pump-offs
- Number of running hours
- Number of purges
- Number of recovery faults
- Number of waxings
- Number of stalls
- Number of switch losses
- Number of production barrels

** Either down-hole or surface motor, depending on the pump type*

Parameter Information

Basic Parameters

Progressive Cavity Pumps

- Motor data
- Gear reduction
- Minimum speed (RPM)
- Maximum speed (RPM)
- Pump fillage
- Restart delay
- Load limit
- Behavior at pump-off
- Fault handling
- Speeds (polished rod RPM)

Electric Submersible Pumps

- Motor data
- Transformer Ratio
- Minimum speed (Hz)
- Maximum speed (Hz)
- Pump fillage
- Restart delay
- Current limit
- Behavior at pump-off
- Fault handling
- Transformer step-up ratio

Beam Pumps

- Motor data
- Minimum speed (strokes per minute)
- Maximum speed (strokes per minute)
- Pump fillage
- Restart delay
- Load limit
- Behavior at pump-off
- Fault handling

Built-in Diagnostic Information

Drive Alarm History

If an alarm occurs, the following is recorded in the drive:

- Time of event
- Reference
- Current
- DC bus voltage
- Motor voltage
- Frequency

SALT Event Log

In addition, SALT logs the last 10 pump-offs and waxing warnings and maintains a 30-day history of:

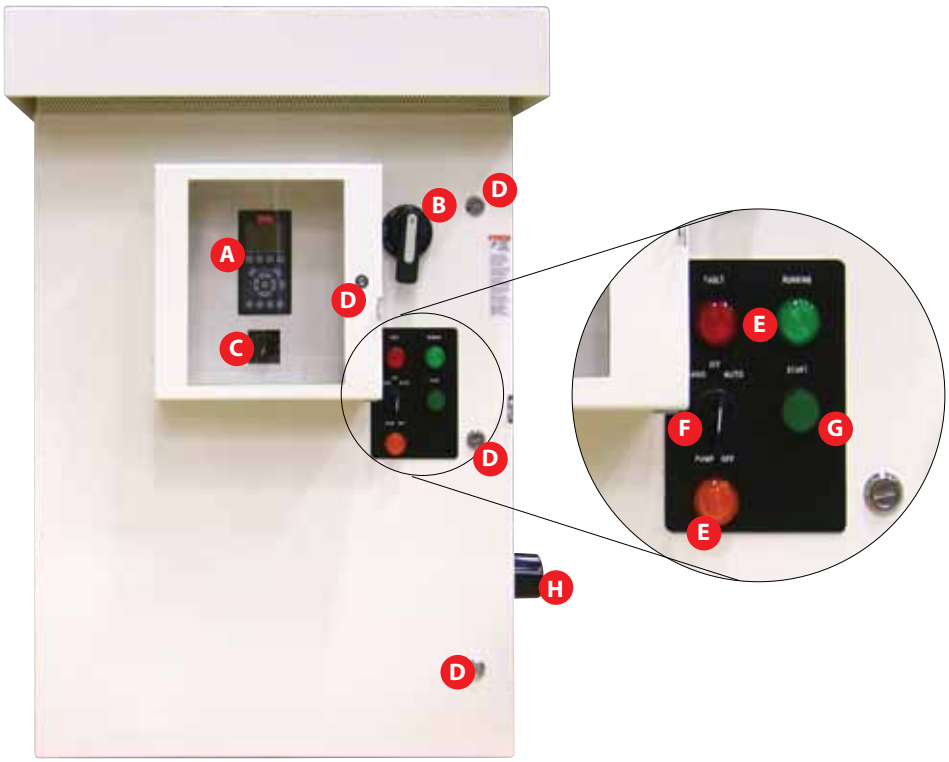
Beam Pumps

- Strokes per day
- Pump-offs per day
- Running hours
- Stall faults
- Waxing warnings
- Recovery faults
- Faults
- Daily fluid production

Progressive Cavity and Electric Submersible Pumps

- Pump-offs per day
- Gas/sand purges per day
- Running hours
- Stall faults
- Recovery faults
- Faults
- Daily fluid production

System Configuration and Components



- **A** *DRIVE DISPLAY AND CONTROL PANEL*
- **B** *DISCONNECT SWITCH*
- **C** *SPEED POTENTIOMETER*
- **D** *QUARTER TURN LATCHES*
- **E** *PILOT LIGHTS*
- **F** *H-O-A SWITCH*
- **G** *START PUSHBUTTON*
- **H** *SURGE ARRESTOR*

Standard Package Specifications

	High Overload			Normal Overload				
	HP	Amps	kVA	HP	Amps	kVA	Frame	Panel No.
240 VAC	5	17	6	5	17	6	A5	174H8528
	7.5	24.2	8.7	10	30.8	11.1	B1	174H8529
	10	30.8	11.1	15	46.2	16.6	B1	174H8530
	15	46.2	16.6	20	59.4	21.4	B2	174H8531
	20	59.4	21.4	25	74.8	26.9	C1	174H8532
	25	74.8	26.9	30	88	31.7	C1	174H8533
	30	88	31.7	40	115	41.4	C2	174H8534
	40	115	41.4	50	143	51.5	C2	174H8535
	50	143	51.5	60	170	61.2	C2	174H8536
500 VAC	5	8	6.5	5	8	6.5	A5	174H8501
	8	11	8.8	8	11	8.8	A5	174H8502
	10	15	11.6	10	15	11.6	A5	174H8503
	15	21	16.6	20	27	21.5	B1	174H8504
	20	27	21.5	30	34	27.1	B1	174H8505
	25	34	27.1	30	40	31.9	B2	174H8506
	30	40	31.9	40	52	41.4	B2	174H8507
	40	52	41.4	50	65	51.8	C1	174H8508
	50	65	51.8	60	77	63.7	C1	174H8509
	60	80	63.7	75	96	83.7	C1	174H8510
	75	105	83.7	100	130	104	C2	174H8511
	100	130	104	125	160	127	C2	174H8512
	125	160	127	150	190	151	D3	174H8513
	150	190	151	200	240	191	D3	174H8514
	200	240	191	250	302	241	D4	174H8515
	250	303	241	300	361	288	D4	174H8516
	300	361	288	350	443	353	D4	174H8517
	350	443	353	450	540	430	E2	174H8518
	450	540	430	500	590	470	E2	174H8519
	500	590	470	550	678	540	E2	174H8520
	550	678	540	600	730	582	E2	174H8521
	600	730	582	650	780	621	F3	174H8522
	650	780	621	750	890	709	F3	174H8523
	750	890	709	900	1050	837	F3	174H8524
	900	1050	837	1000	1160	924	F3	174H8525
	1000	1160	924	1200	1380	1100	F4	174H8526
	1200	1380	1100	1350	1530	1219	F4	174H8527

Optimally sized NEMA Type 3R enclosure

- UL/cUL listed
- White polyester powder finish with low solar absorption
- Integrated solar shield above top of enclosure
- Lifting eyes
- Frame mounting at 100 HP and below; foot mounting at 125 HP and above
- Operation in ambient temperatures of 0° to 50° C
- Relative humidity 5%–95% (IEC 60 721-3-3); Class 3K3 (non-condensing) during operation
- Back-channel cooling for heatsink significantly reduces contaminant infiltration
- Main power circuit breaker with through-door operator
- Drive input fuses
- Externally mounted surge arrestor (ANSI/IEEE C62.11-1993)

VLT AutomationDrive

- 200–240 VAC, 380–500 VAC
- 1–1350 HP
- Standard language pack
- Class A2 RFI filter
- Standard cable entries
- Sensorless Artificial Lift Technology (SALT) patented oil & gas pump control
- Through-panel mounting kit

Available Options

Cold Weather Kit

- Extends the range of operation into ambient temperatures from -10° to 50° C
- Fused control transformer
- Heater and fan with thermostatic control for high/low temperature control

Extreme Cold Weather Kit

- Extends the range of operation into ambient temperatures from -40°C to 50° C
- Fused control transformer
- Heater and fan with thermostatic control for high/low temperature control

Heat Trace Kit

- Fused control transformer
- 15-amp, single-pole GFI Breaker (mounted in lock box on door)
- Six-place terminal block for customer wiring

Control I/O Terminal Strips for customer connections to:

- Two drive relays (6 terminals) [01, 02, 03, 04, 05, 06]
- 10V power (1 terminal) [50]
- 24V power (1 terminal) [12]
- Common (1 terminal) [20, 55, 39]
- One analog output (1 terminal) [42]
- One analog input (1 terminal) [53]
- High PSI digital input (1 terminal) [11]
- Auto start (1 terminal) [19]
- Manual reset required output (1 terminal) [08]
- Modbus RTU port (2 terminals) [68, 69]

Chart Recorder

- Two-pen chart recorder mounted in door
- NEMA Type 3R window kit

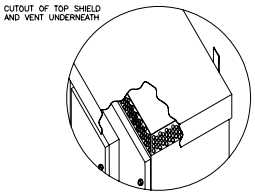
Sine Wave Filters

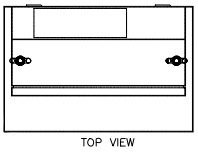
- Provide sinusoidal phase-to-phase motor voltage
- Reduce motor insulation stress and switching acoustic noise from the motor
- Reduce bearing currents, especially in larger motors
- Greater motor longevity through lower dV/dt stress
- Reduced electrical discharges in the motor, prolonging bearing life
- Prevent flashover in motor windings

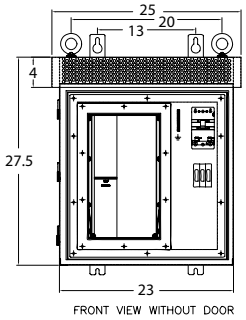
Dimensions

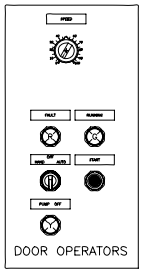
A5 Frame Size

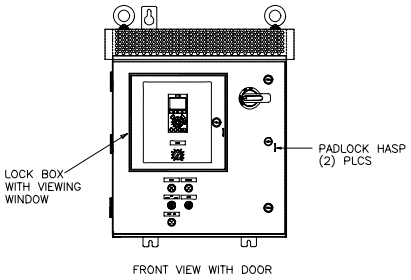
Approximate weight: 116 lbs.
Dimensions given in inches

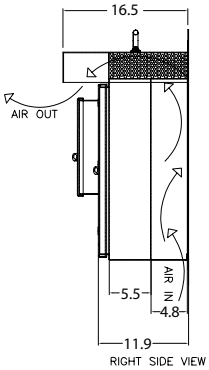


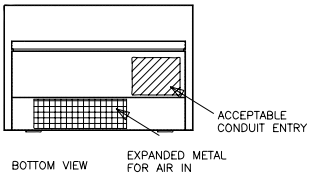






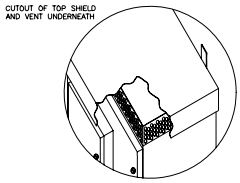


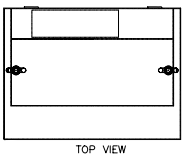


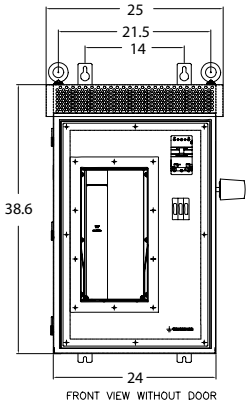


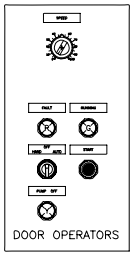
B1 Frame Size

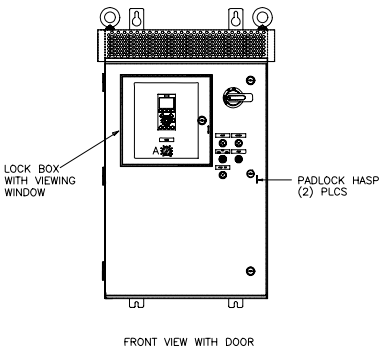
Approximate weight: 181 lbs.
Dimensions given in inches

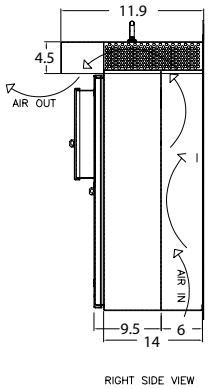


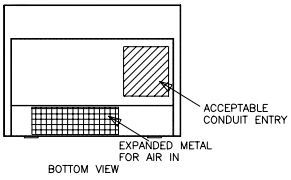








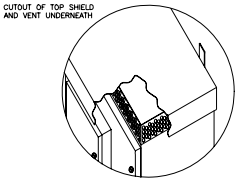


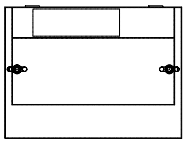


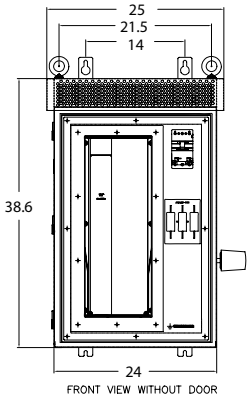
Dimensions

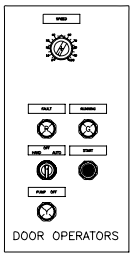
B2 Frame Size

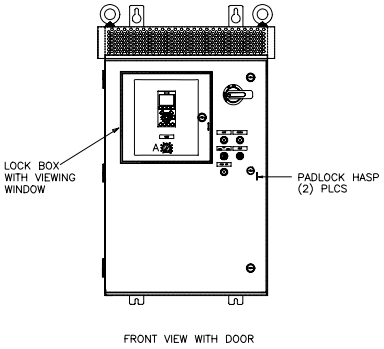
Approximate weight: 190 lbs.
Dimensions given in inches

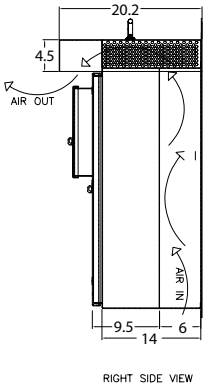


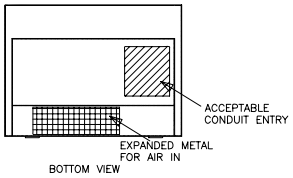






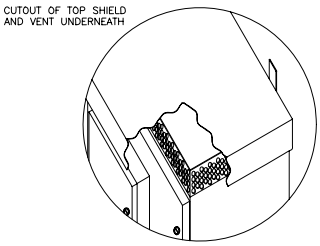


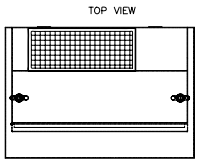


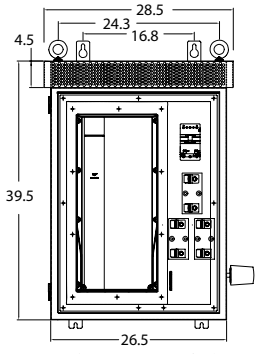


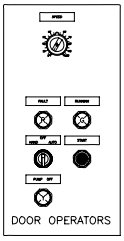
C1 Frame Size

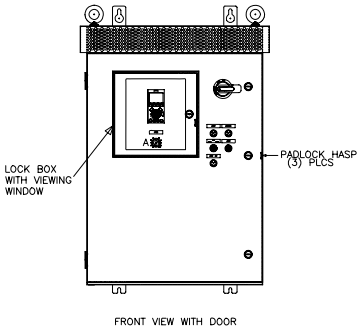
Approximate weight: 239 lbs.
Dimensions given in inches

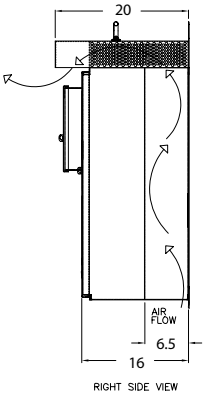


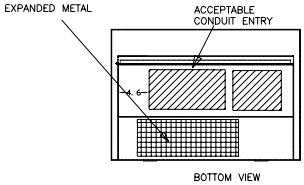








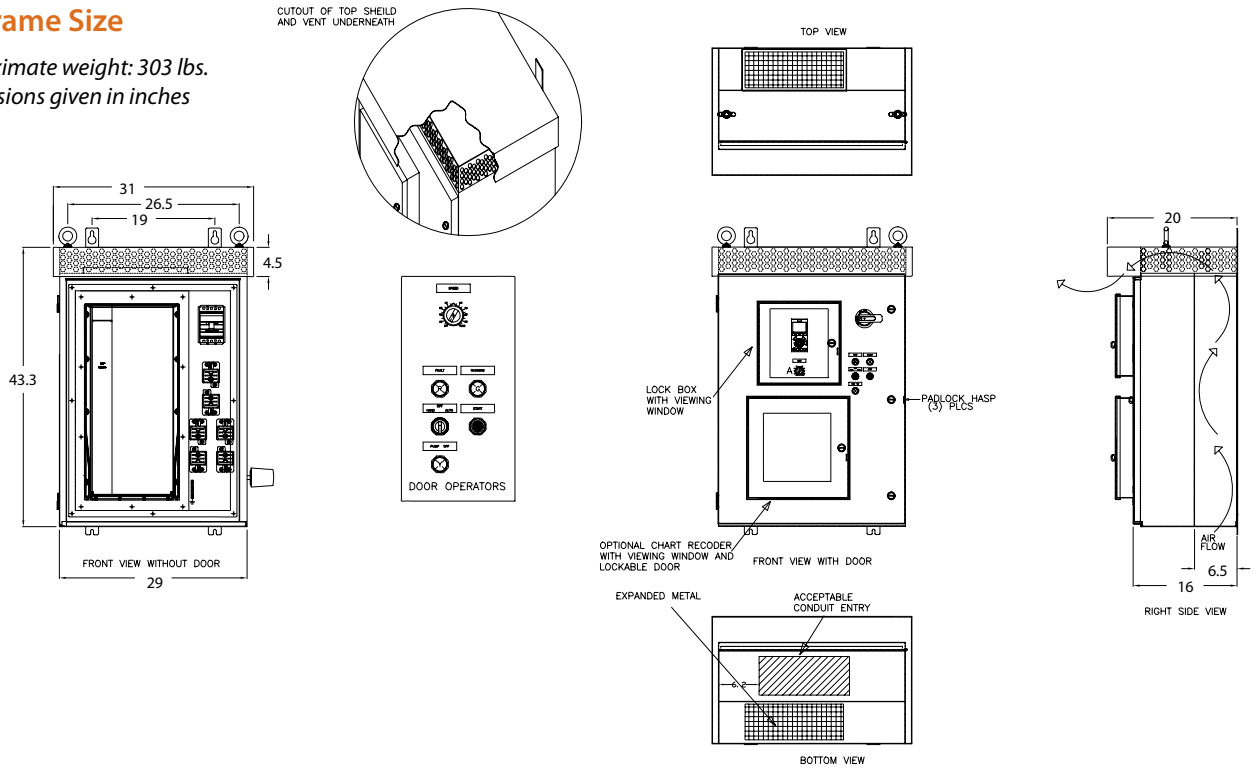




Dimensions

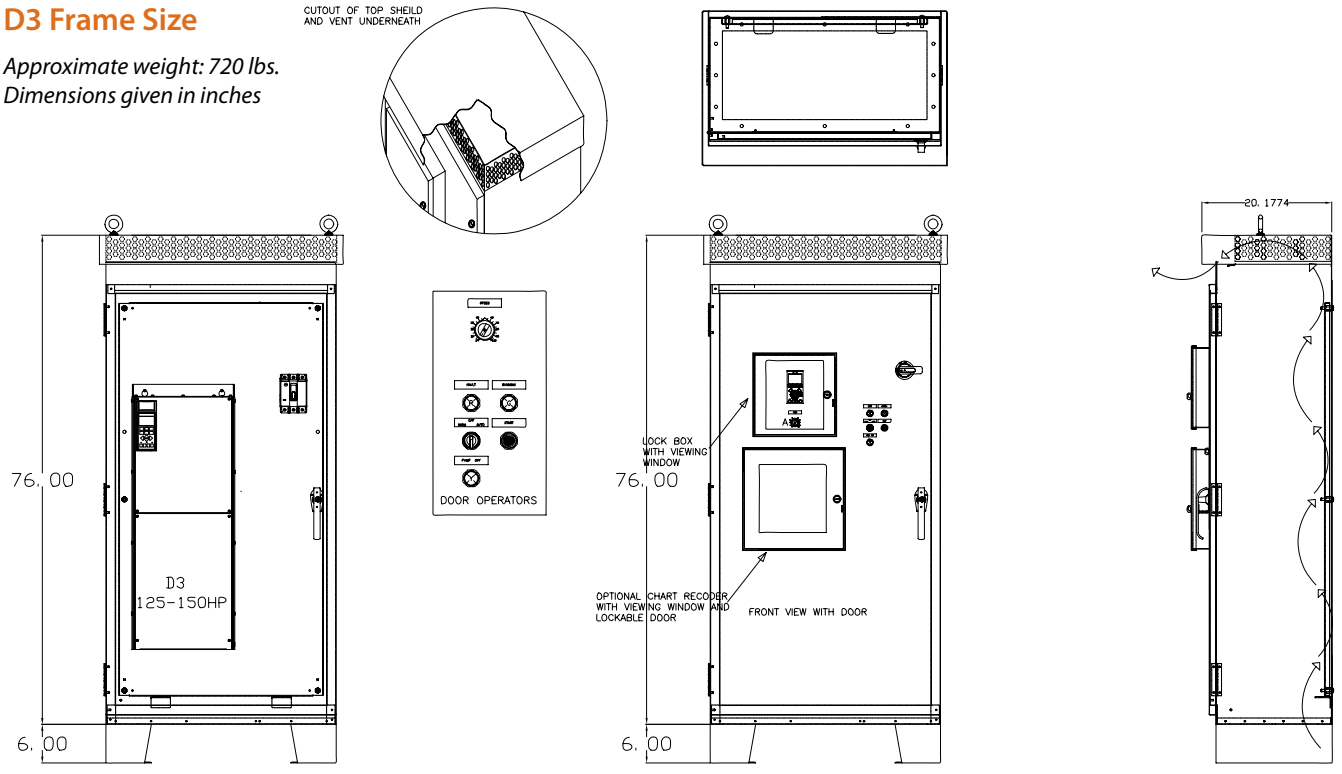
C2 Frame Size

Approximate weight: 303 lbs.
Dimensions given in inches



D3 Frame Size

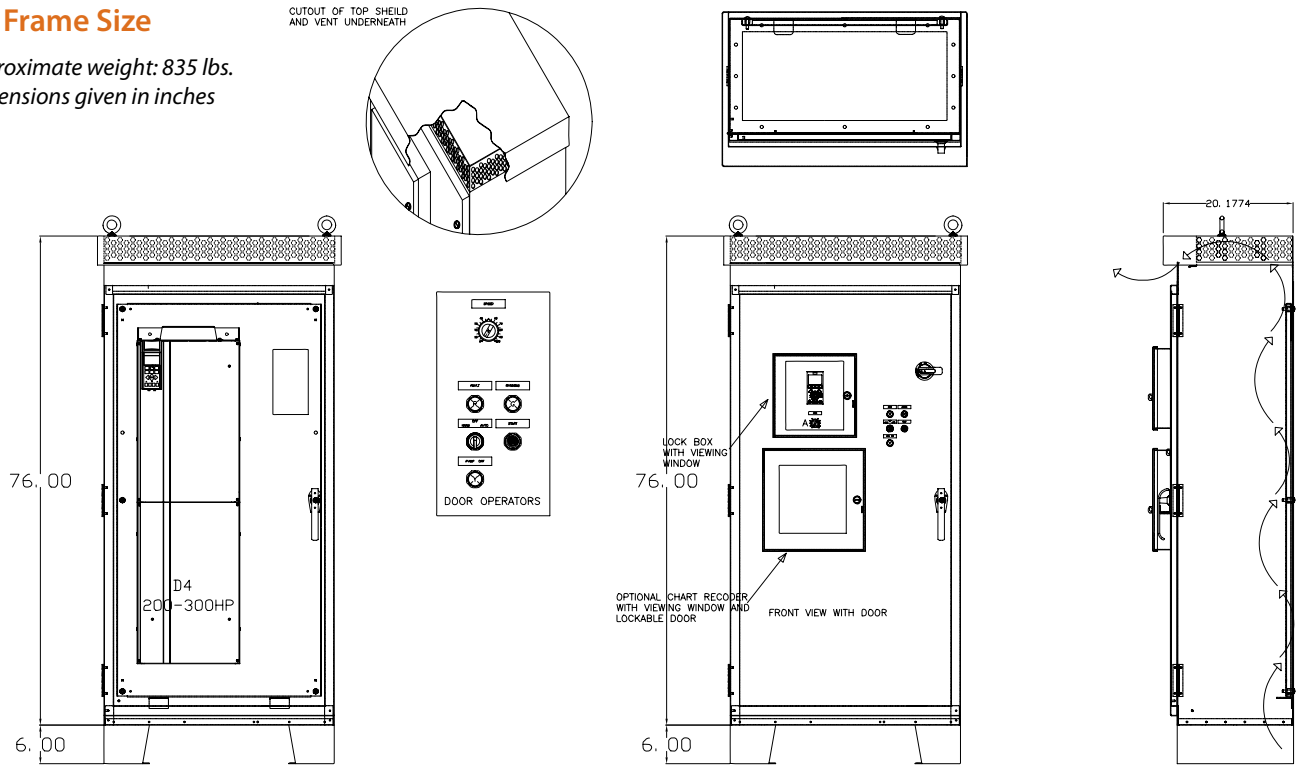
Approximate weight: 720 lbs.
Dimensions given in inches



Dimensions

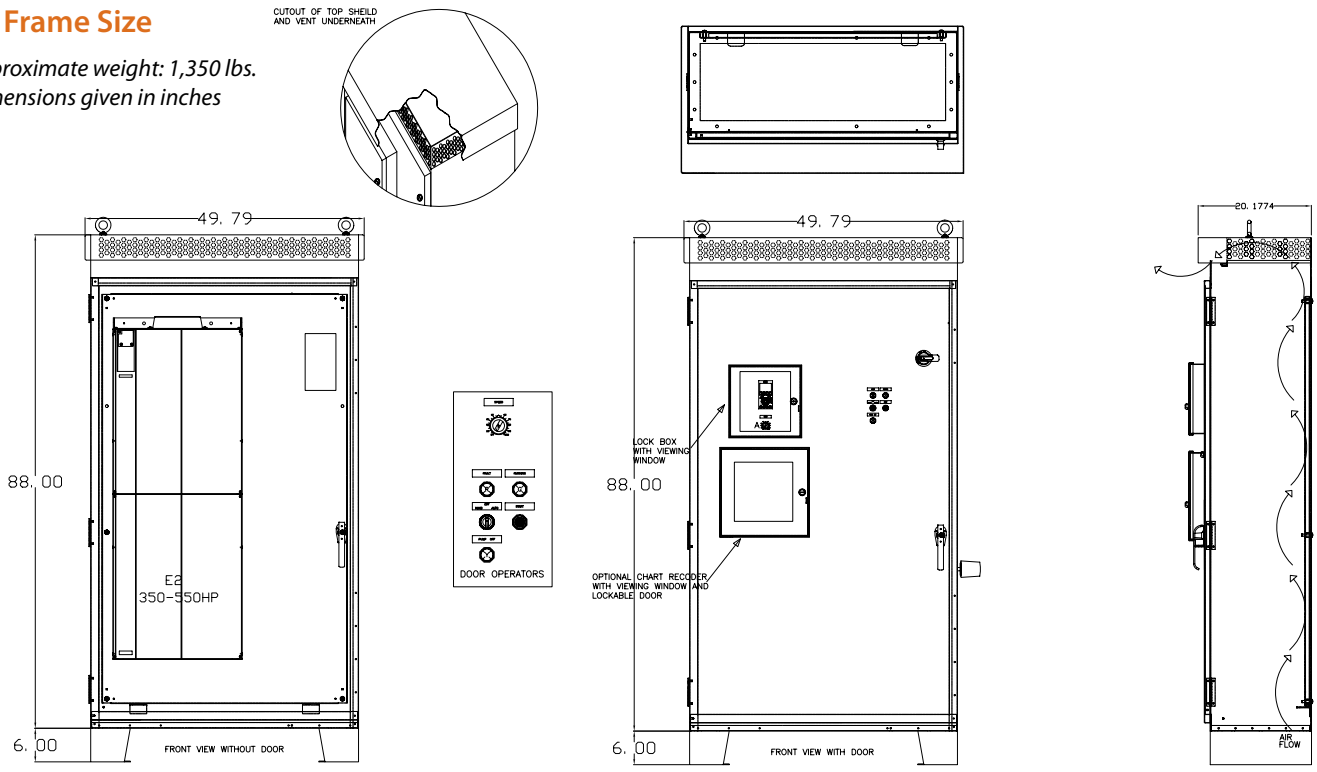
D4 Frame Size

Approximate weight: 835 lbs.
Dimensions given in inches



E2 Frame Size

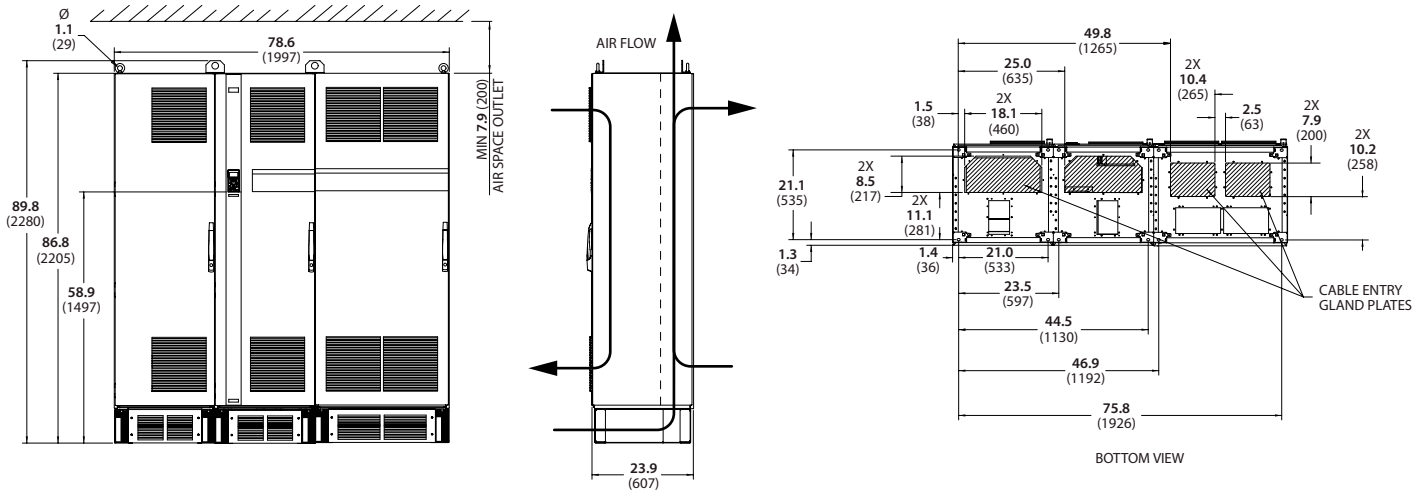
Approximate weight: 1,350 lbs.
Dimensions given in inches



Dimensions

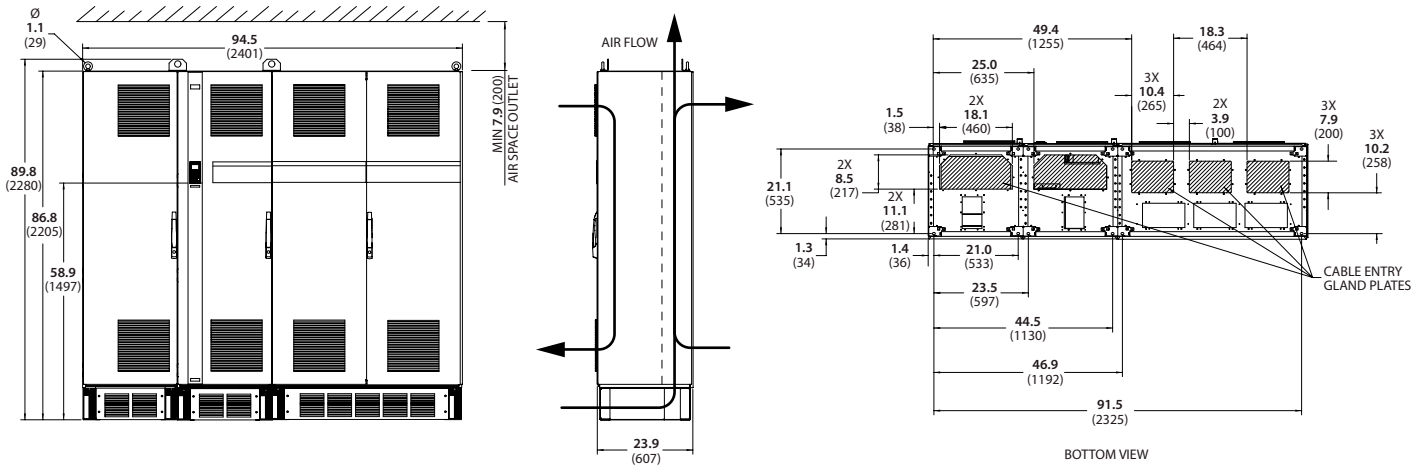
F3 Frame Size

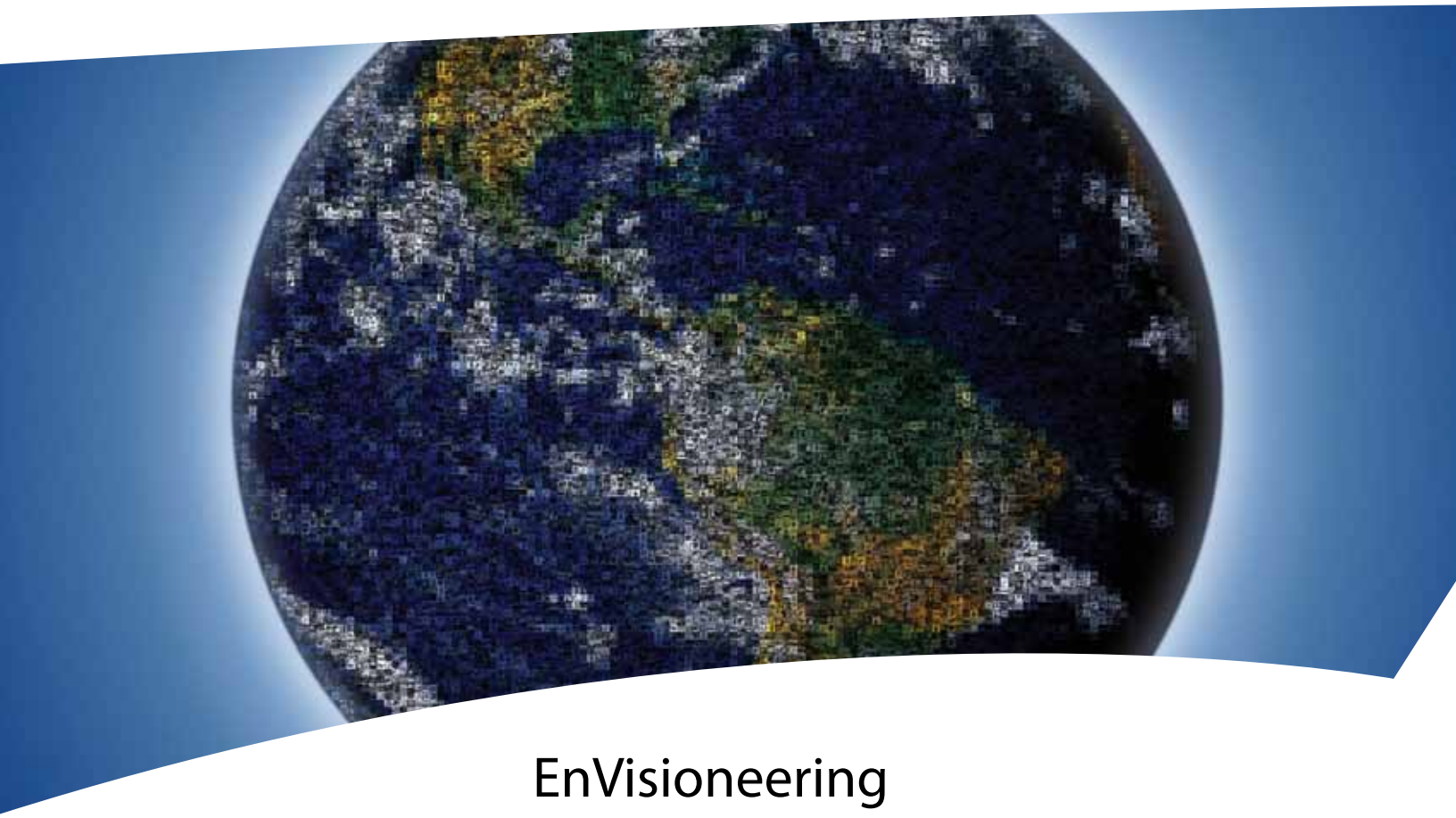
Approximate weight: 2,214 lbs.
Dimensions given in inches (mm)



F4 Frame Size

Approximate weight: 2,748 lbs.
Dimensions given in inches (mm)





EnVisioneering

As a world leader in components and solutions, Danfoss meets our customers' challenges through "EnVisioneering." This approach expresses our views on engineering innovation, energy efficiency, environmental responsibility and sustainable business growth that create strong customer partnerships. This vision is realized through a global production, sales, and service network focused on refrigeration, air conditioning, heating and water, and motion control. Through EnVisioneering, Danfoss is Making Modern Living Possible.

Danfoss "EnVisioneering":

- Engineered solutions to improve performance and profitability
- Energy efficiency to meet higher standards and to lower operating costs
- Environmental sustainability to provide a financial and social payback
- Engaged partnerships to foster trust, reliability, and technological superiority

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