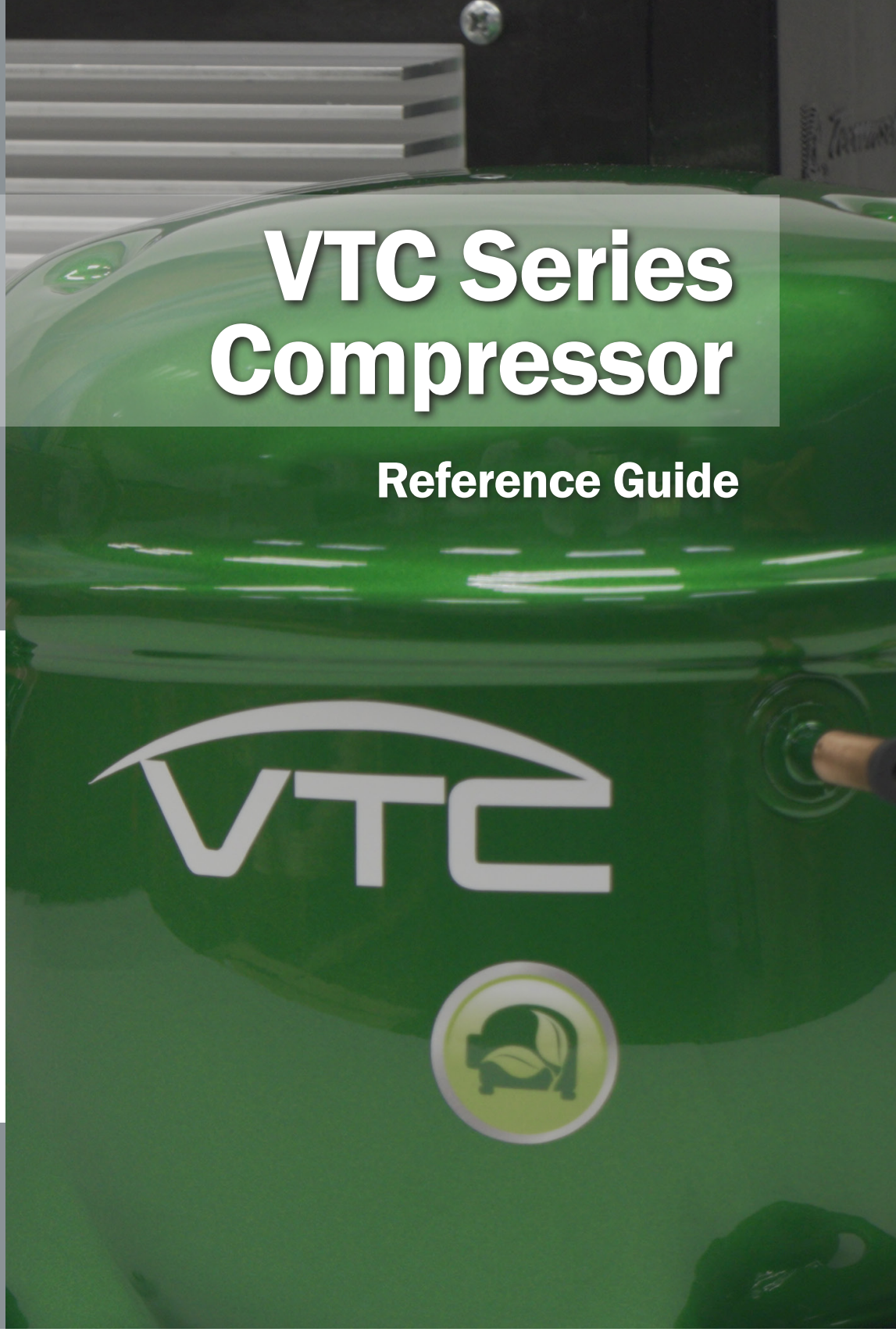
# VTC Series Compressor

## Reference Guide




Tecumseh

*Cooling for a Better Tomorrow™*

www.tecumseh.com

# VTC

## Built for Today. Ready for Tomorrow

Throughout its history, Tecumseh Products Company has been a leader in providing customers with efficient and reliable products for commercial and residential refrigeration and air conditioning applications. As a result, equipment manufacturers, wholesale distributors and service contractors continue to demand Tecumseh compressors, condensing units and genuine replacement parts for their specific needs. The VTC series compressor delivers best-in-class efficiency, smaller size, extended application envelope (L/MBP) and Tecumseh's industry known standard for reliability.

### GLOBAL VOLTAGE STABILIZATION

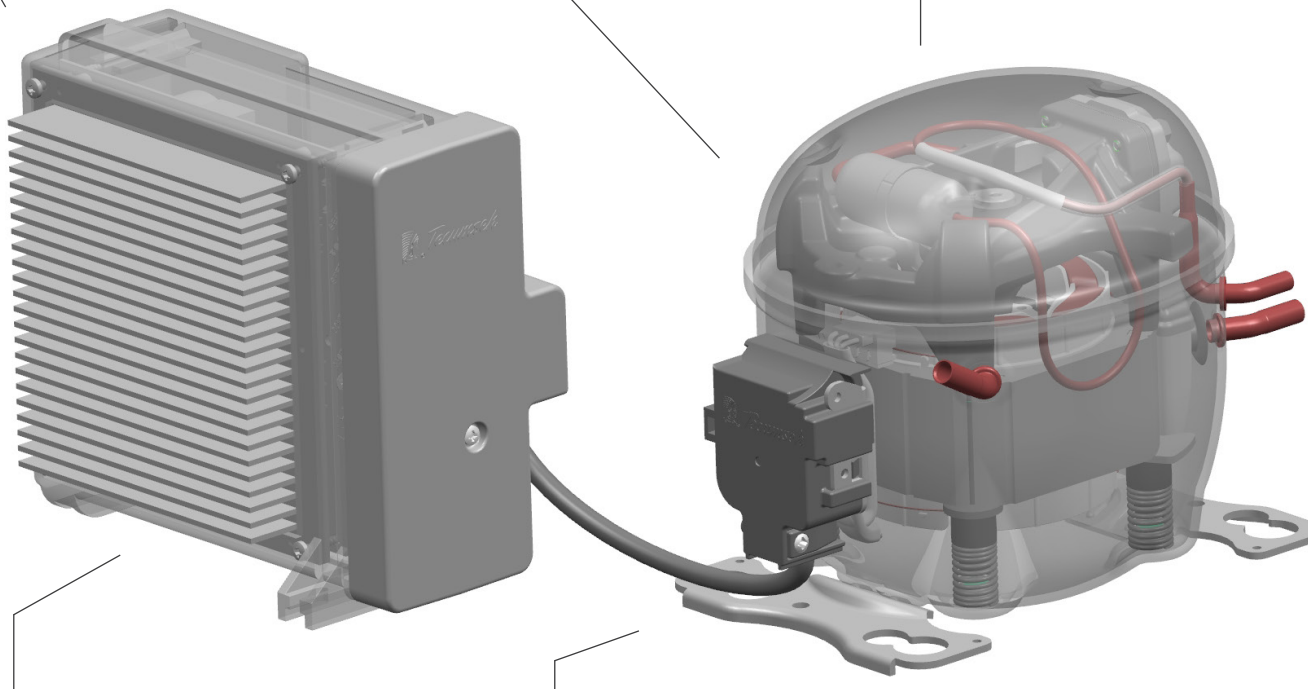
Tecumseh IntelliCI™ handles multiple voltage inputs of both 50 and 60 Hz. (see Inverter models on page 19) Under/over voltage protection is built-in.

### ECO-FRIENDLY

Optimized for use with eco-friendly hydrocarbon refrigerant R290 (propane).

### COMPACT SIZE

Delivers the same capacity as a larger displacement, single-speed compressor, making more room for refrigerated goods.



### REDUCED ENERGY CONSUMPTION

Dynamically matches the capacity of the compressor to the system's cooling demand.

### TEMPERATURE CONTROL

High speed compressor operation is used for fast pull-down while low speed operation is used to maintain cabinet temperature with minimal energy consumption.

# TABLE OF CONTENTS

# INTRODUCTION

## WHY VTC?

Tecumseh is pleased to announce the availability of the VTC platform, a variable speed (or variable capacity) compressor technology that brings to the refrigeration industry new levels of efficiency, sound, temperature stabilization and design versatility.

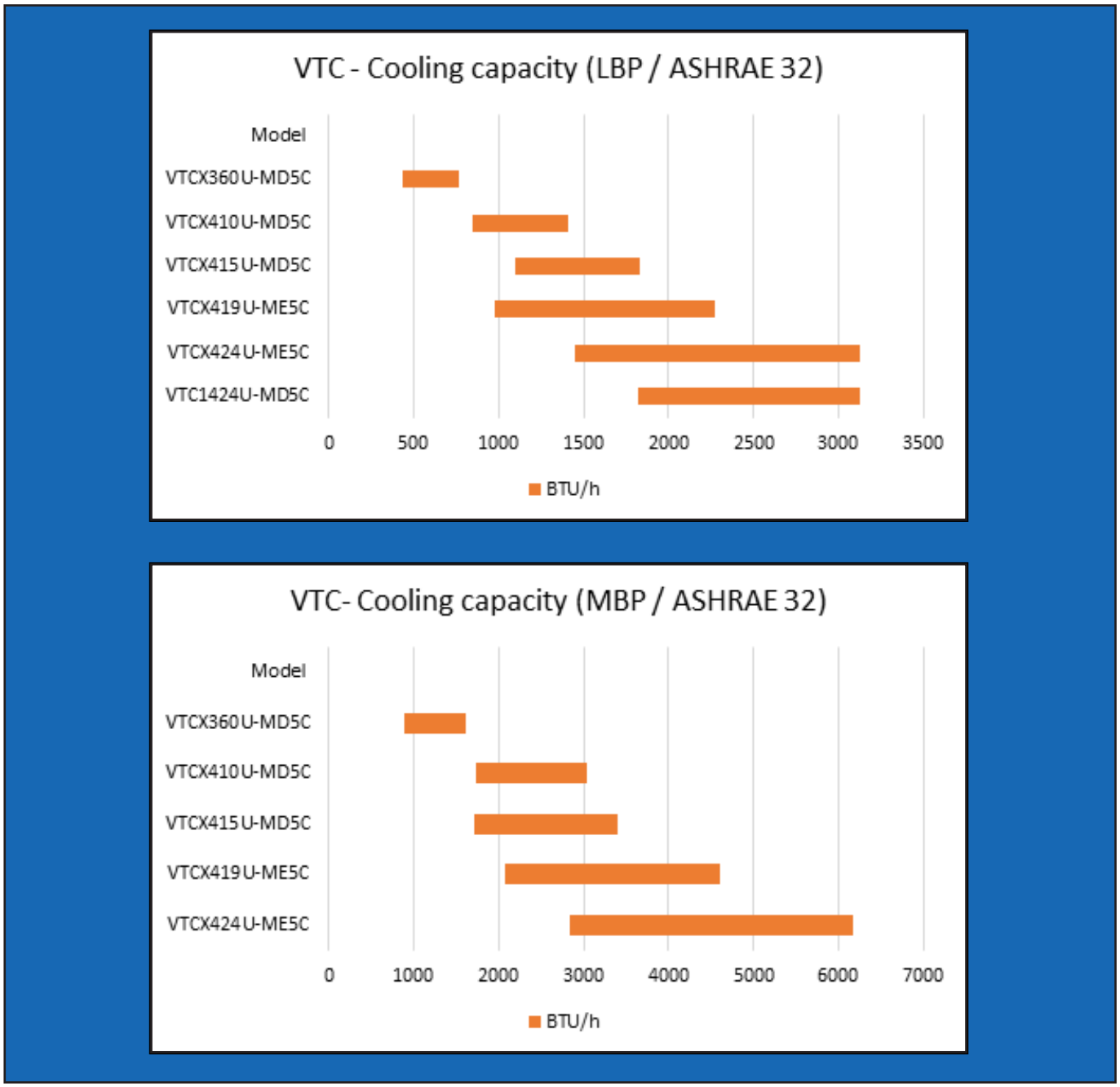
Although high efficiency and lower prices have been driving the commercial segments for fixed speed compressors, it is clear to see that a new trend is gaining momentum in the market: the variable speed compressors. Our VTC top premium product features low energy consumption and lower noise, and because of such differentials they can respond to the new market's needs, marked by new challenging regulation requirements.

The importance of lower energy consumption in commercial refrigeration equipment is very well known. Manufactures for commercial refrigeration segment in regions such as USA, Europe, Brazil and Asia are much more conscious about energy saving and are driving their purchasing decisions based on energy consumptions as well. With this factor and the reduction of global warming internationally in sight, we have designed the VTC variable speed compressor platform for optimum performance, using the eco-friendly refrigerant R290 (Propane).


Illustrative Image

## PRODUCT STRATEGY:

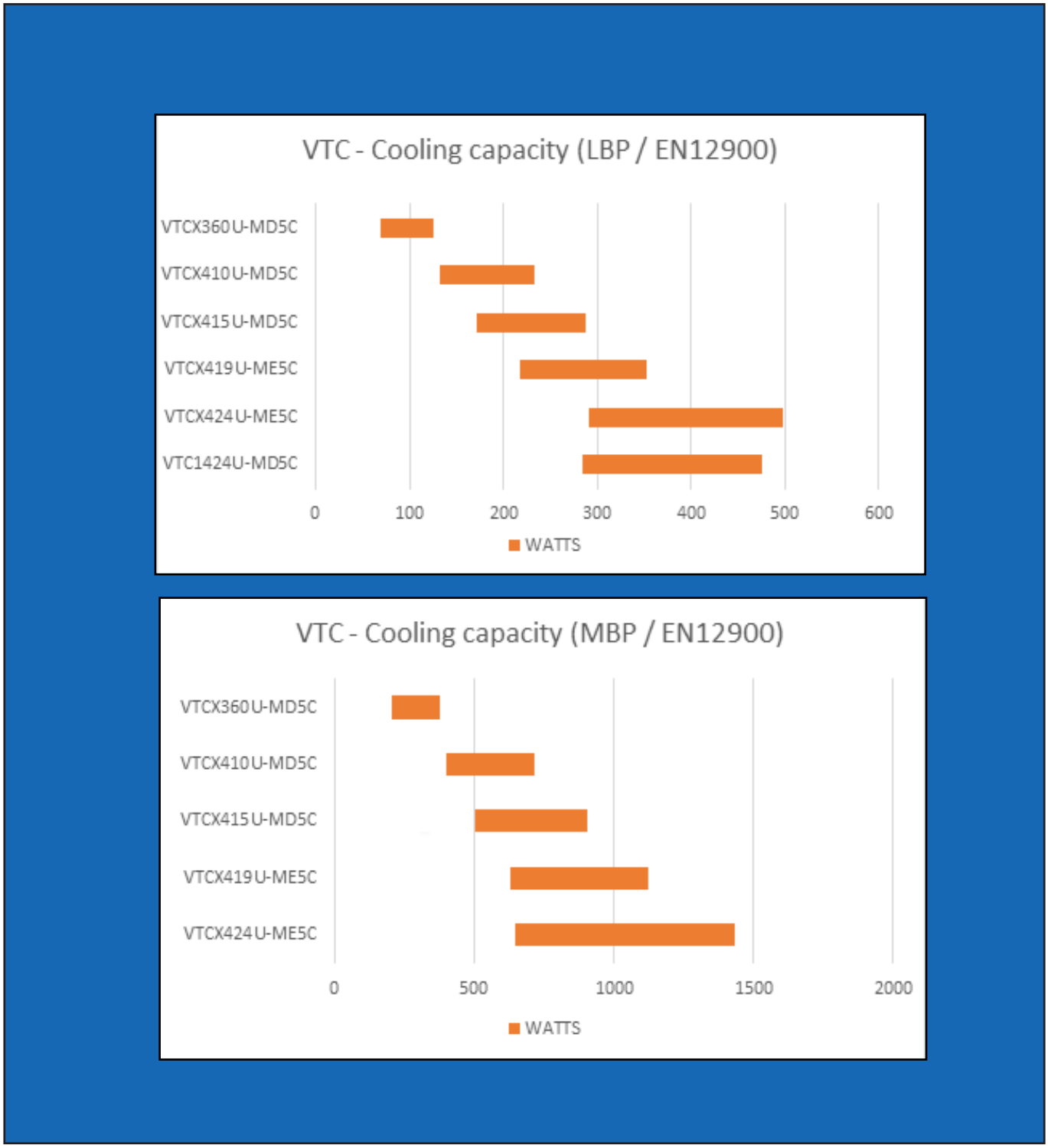
Tecumseh's VTC platform, a variable speed compressor technology, is designed to cover L/MBP applications. Models were launched for R290 refrigerant and cooling capacity ranges according to the charts below:




VTC 1424U - MD5C is designed for LBP capillary tube systems only

LBP - Evap. Temperature: -23°C (-10°F)
Condensing Temperature: 54,4°C (130°F)
Return Gas Temperature: 32.2°C (90°F)
Liquid Temperature: 32.2°C (90°F)
Ambient Temperature: 32.2°C (90°F)

MBP - Evap. Temperature: -6,7°C (20°F)
Condensing Temperature: 54,4°C (130°F)
Return Gas Temperature: 32.2°C (90°F)
Liquid Temperature: 32.2°C (90°F)
Ambient Temperature: 32.2°C (90°F)




VTC 1424U - MD5C is designed for LBP capillary tube systems only

LBP - Evap. Temperature: -35°C (-31°F)
Condensing Temperature: 40°C (104°F)
Return Gas Temperature: 20°C (68°F)
Liquid Temperature: 40°C (104°F)
Ambient Temperature: 32.2°C (90°F)

MBP - Evap. Temperature: -10°C (14°F)
Condensing Temperature: 45°C (113°F)
Return Gas Temperature: 20°C (68°F)
Liquid Temperature: 45°C (113°F)
Ambient Temperature: 32.2°C (90°F)

## VALUE PROPOSITION:

| Benefits | Features |
|---|---|
| Compactness | Weight: up to 35% lighter vs. current compressor platforms |
| Interchangeability | Same mounting footprint |
| | Same safety certifications |
| | Extended cooling capacities (with variable speed) |
| | Energy savings |
| | Industry standard connections |
| | Improved sound quality |
| | Standard oil type |
| Enhanced Efficiency | New brushless motor design concept (shorter in height) |
| Reliability | Reliable in all frequencies • |
| Refrigerant Versability | Optimized for use with eco-friendly R290 refrigerant (Propane) |

- Certified software
- Electronics control and protections
- Extended life
- Oiling lubrification in low speed

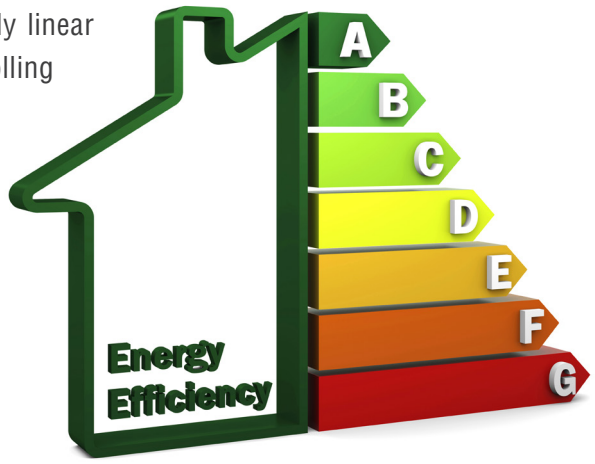
# VARIABLE SPEED INTRODUCTION

## VARIABLE SPEED TECHNOLOGY:

Variable speed, or variable capacity, compressor technology brings to the refrigeration industry new levels of efficiency, sound, temperature stabilization and design versatility. It has been developed and applied worldwide since the beginning of 2000 in air conditioning, refrigerators and freezers for home appliances and more recently for light commercial applications. All of these markets are growing year by year and becoming an important segment for compressor manufacturers. Within the next few years it is expected that all OEMs, including the small ones, will be offering high efficiency variable speed systems.

## WHAT IS VARIABLE SPEED TECHNOLOGY AND HOW DOES IT WORK?

Variable speed compressor works by connecting a motor control drive - "IntelliCI™"(Compressor Inverter) - to the compressor and then connecting the line input power from the utility to the inverter. The inverter will change the frequency and voltage to adjust power output of the compressor's motor enabling it to speed up or slow down according to the cooling capacity requested by the load. The cooling capacity is nearly linear with motor speed, so controlling the speed means controlling the capacity. On the other hand, the compressor power consumption is directly dependent of cooling capacity and the sound and vibration from the compressor are also directly related with speed. The ability to modulate the compressor's capacity enables many advantages of variable speed technology including improved efficiency and sound, because as the load is cooled down, the full capacity of the compressor is no longer necessary, until the load changes. So the speed can be reduced in order to reduce the capacity and the new capacity set point is just enough to replace the losses of the cabinet, thus reducing the power consumption and sound. This is the main objective of variable speed compressors: to reduce the cooling capacity as much it can, in order to reduce the power consumption. However, this technology also enables the opposite condition, so increase the speed over the "rated" speed to get extra capacity, if a fast pull down is required, but this also means extra power consumption. This strategy is justified just for short periods.



## IMPROVED EFFICIENCY:

The ability to adjust power output to the compressor, rather than merely on-off functionality in traditional systems, allows end users to achieve significant cost savings over the course of a year. In some cases, these savings add up to 40% of the overall annual energy costs, typically 15 to 20%. Variable speed technology enables this kind of efficiency for four main reasons.

1. Higher efficiency motor technology, when compared with single speed compressors based on induction motors.
2. Precise matching between thermal load and cooling capacity.
3. Less cycling on and off, using longer cycles on, at lower speeds.
4. Low amp gradual compressor motor startup, performing a soft start ramp.

In traditional fixed-speed systems the compressors are either on 100% or off completely. In those situations, the system will cycle the compressor on and off as needed to match the set point as close as possible.

This leads to power losses because the energy required to start up a non-variable speed compressor is higher than the energy required to gradually start a variable speed compressor and keep it running at a portion of full speed. This high efficiency operation during light-load conditions is the major efficiency advantage of variable speed technology.

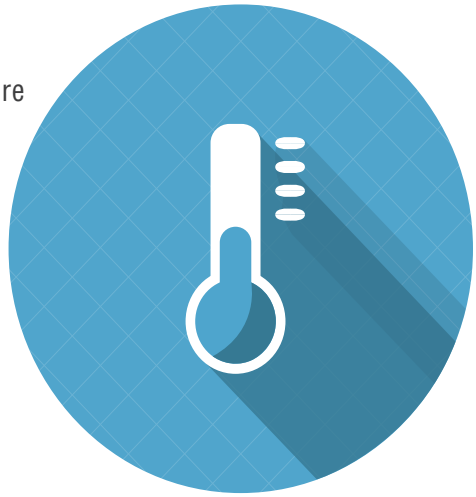
## IMPROVED THERMAL STABILITY:

The great thing about variable speed technology is its inherent ability to precisely match compressor's cooling capacity to required thermal load, regardless of the type of application: refrigerators, freezers, air conditioning, etc. Matching the cooling capacity and thermal load means better food conservation, due to the lower temperature variation.

These improved characteristics are achieved because of three main things:

1. Ability to use better temperature control strategy.
2. Less cycling on and off.
3. Extra capacity during reload or on hot weather conditions.

In the electronic thermostat of the application, if using a temperature controller based on Proportional or PI (Proportional Integrative) controllers with zero steady-state residual error, it is able to reduce the hysteresis band (fluctuation) between higher and lower temperature. Also, with less cycling and longer run times comes the added benefit of maintaining precise temperature control (roughly within one degree) whereas in traditional fixed systems temperatures can fluctuate, typically more than one degree.



Another way variable speed improves pull down time in commercial applications, is by providing extra capacity during food or beverage reload, or in extreme hot weather days—respectively. In these situations, a variable speed compressor is able to over speed faster than a traditional compressor would run and provide extra capacity.

## IMPROVED STARTABILITY:

Another great thing about variable speed technology is its improved ability to start the compressor even in poor condition, like low voltage. This is achieved by the combination of the inverter starting logic and the PMSM motor electromagnetic torque characteristic, that is able to provide flat torque over a wide speed range.

## IMPROVED RELIABILITY:

With the addition of power electronics control, variable speed technology is able to protect itself from failure in ways the traditional fixed single speed systems are not capable. The electronic inverter receives power input from the utility line before sending power to compressor, and the inverter acts as a “shield” to protect the compressor from harmful circumstances. Additionally the inverter is constantly monitoring and adjusting the power required from the compressor’s motor to ensure optimal compressor and system operation.

## VERSATILE APPLICATIONS:

Due to its cooling capacity modulation capability, variable speed technology brings performance benefit to commercial applications as well.

As the technology matures and applications proliferate, the benefits of electronic controlled variable speed will expand into other areas including advanced diagnostics, connectivity, energy use monitoring and demand response programs from utilities.

Even though the fundamentals of variable speed technology have been a part of the refrigeration industry for years, the opportunities for improving efficiency, comfort and reliability in commercial sites have never been better.

# VTC COMPRESSOR RANGE AND PERFORMANCE

## R290 COMPRESSOR PERFORMANCE - L/MBP

ASHRAE 32

| Model | Speed | LBP - Evaporating Temperature -23°C (-10°F) | | | | MBP - Evaporating Temperature -6.7°C (20°F) | | | | Displac. | Weight | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cooling Capacity | | Efficiency | | Cooling Capacity | | Efficiency | | | | |
| | RPM | W | Btu/h | EER | COP | W | Btu/h | EER | COP | CM³ | kg | lb |
| VTCX360U-MD5C | 2500 | 126 | 432 | 6.07 | 1.53 | 258 | 879 | 9.02 | 2.27 | 3.14 | 7.30 | 16.1 |
| | 3000 | 148 | 507 | 6.08 | 1.53 | 307 | 1047 | 9.10 | 2.29 | | | |
| | 3600 | 182 | 622 | 6.19 | 1.56 | 375 | 1279 | 9.15 | 2.31 | | | |
| | 4000 | 204 | 697 | 6.20 | 1.56 | 421 | 1436 | 9.12 | 2.30 | | | |
| | 4500 | 225 | 768 | 6.08 | 1.53 | 473 | 1615 | 8.99 | 2.26 | | | |
| VTCX410U-MD5C | 2500 | 248 | 848 | 5.91 | 1.49 | 506 | 1725 | 8.63 | 2.17 | 6.06 | 7.30 | 16.1 |
| | 3000 | 300 | 1023 | 6.03 | 1.52 | 607 | 2070 | 8.78 | 2.21 | | | |
| | 3600 | 351 | 1199 | 6.09 | 1.53 | 722 | 2465 | 8.82 | 2.22 | | | |
| | 4000 | 381 | 1300 | 6.07 | 1.53 | 797 | 2720 | 8.76 | 2.21 | | | |
| | 4500 | 413 | 1410 | 6.00 | 1.51 | 889 | 3032 | 8.62 | 2.17 | | | |
| VTCX415U-MD5C | 2500 | 314 | 1074 | 5.68 | 1.42 | 648 | 2210 | 8.23 | 2.07 | 7.84 | 7.30 | 16.1 |
| | 3000 | 383 | 1307 | 5.80 | 1.46 | 787 | 2689 | 8.45 | 2.13 | | | |
| | 3600 | 440 | 1502 | 5.71 | 1.44 | 915 | 3126 | 8.51 | 2.14 | | | |
| | 4000 | 459 | 1566 | 5.72 | 1.44 | 1003 | 3424 | 8.48 | 2.14 | | | |
| | 4500 | 517 | 1765 | 5.65 | 1.42 | 1144 | 3908 | 8.40 | 2.12 | | | |
| VTCX419U-ME5C | 2000 | 341 | 1163 | 5.30 | 1.55 | 667 | 2279 | 7.57 | 2.22 | 9.74 | 7.96 | 17.55 |
| | 2500 | 406 | 1387 | 5.54 | 1.62 | 813 | 2776 | 7.98 | 2.34 | | | |
| | 3000 | 471 | 1607 | 5.67 | 1.66 | 960 | 3279 | 8.20 | 2.40 | | | |
| | 3600 | 546 | 1865 | 5.72 | 1.68 | 1139 | 3891 | 8.29 | 2.43 | | | |
| | 4000 | 596 | 2034 | 5.72 | 1.67 | 1260 | 4305 | 8.28 | 2.42 | | | |
| | 4500 | 656 | 2241 | 5.68 | 1.66 | 1414 | 4827 | 8.21 | 2.40 | | | |
| VTCX424U-ME5C | 2000 | 434 | 1482 | 5.17 | 1.52 | 847 | 2893 | 7.19 | 2.10 | 12.47 | 7.96 | 17.55 |
| | 2500 | 530 | 1809 | 5.45 | 1.6 | 1044 | 3567 | 7.63 | 2.23 | | | |
| | 3000 | 616 | 2103 | 5.59 | 1.64 | 1234 | 4213 | 7.84 | 2.29 | | | |
| | 3600 | 714 | 2437 | 5.64 | 1.65 | 1457 | 4977 | 7.89 | 2.31 | | | |
| | 4000 | 779 | 2662 | 5.63 | 1.65 | 1608 | 5492 | 7.83 | 2.29 | | | |
| | 4500 | 867 | 2961 | 5.59 | 1.64 | 1803 | 6159 | 7.70 | 2.25 | | | |
| VTC1424U-MD5C | 2500 | 533 | 1818 | 5.24 | 1.54 | - | - | - | - | 12.47 | 7.45 | 16.42 |
| | 3000 | 640 | 2184 | 5.37 | 1.58 | - | - | - | - | | | |
| | 3600 | 724 | 2505 | 5.35 | 1.57 | - | - | - | - | | | |
| | 4000 | 784 | 2674 | 5.29 | 1.55 | - | - | - | - | | | |
| | 4500 | 916 | 3126 | 5.17 | 1.52 | - | - | - | - | | | |

LBP - Evap. Temperature: -23°C (-10°F)
Condensing Temperature: 54,4°C (130°F)
Return Gas Temperature: 32.2°C (90°F)
Liquid Temperature: 32.2°C (90°F)
Ambient Temperature: 32.2°C (90°F)

MBP - Evap. Temperature: -6,7°C (20°F)
Condensing Temperature: 54,4°C (130°F)
Return Gas Temperature: 32.2°C (90°F)
Liquid Temperature: 32.2°C (90°F)
Ambient Temperature: 32.2°C (90°F)

Oil Charge: 170ml
Oil Type: POE
Oil Viscosity: 10 cSt

Cooling: Fan
Motor Type: BLDC
Voltage: 220/240V

Information for internal reference only.
Input Command: Frequency
All models were tested with inverter model 030F0207
Certifications: VDE in process (will be concluded in Q2/19)

## R290 COMPRESSOR PERFORMANCE - L/MBP

EN12900

| Model | Speed | LBP - Evaporating Temperature -35°C (-31°F) | | | | MBP - Evaporating Temperature -10°C (14°F) | | | | Displac. | Weight | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cooling Capacity | | Efficiency | | Cooling Capacity | | Efficiency | | | | |
| | RPM | W | Btu/h | EER | COP | W | Btu/h | EER | COP | CM³ | kg | lb |
| VTCX360U-MD5C | 2500 | 70 | 240 | 4.62 | 1.16 | 205 | 700 | 8.06 | 2.03 | 3.14 | 7.30 | 16.1 |
| | 3000 | 82 | 280 | 4.61 | 1.16 | 240 | 818 | 8.16 | 2.06 | | | |
| | 3600 | 102 | 347 | 4.60 | 1.16 | 293 | 999 | 8.05 | 2.03 | | | |
| | 4000 | 115 | 391 | 4.56 | 1.15 | 331 | 1130 | 7.94 | 2.00 | | | |
| | 4500 | 126 | 429 | 4.46 | 1.12 | 379 | 1293 | 7.80 | 1.97 | | | |
| VTCX410U-MD5C | 2500 | 132 | 451 | 4.70 | 1.18 | 398 | 1358 | 8.09 | 2.04 | 6.06 | 7.30 | 16.1 |
| | 3000 | 155 | 527 | 4.77 | 1.20 | 462 | 1575 | 8.18 | 2.06 | | | |
| | 3600 | 194 | 663 | 4.91 | 1.24 | 563 | 1920 | 8.15 | 2.05 | | | |
| | 4000 | 218 | 745 | 4.92 | 1.24 | 635 | 2165 | 8.06 | 2.03 | | | |
| | 4500 | 233 | 795 | 4.76 | 1.20 | 717 | 2448 | 7.91 | 1.99 | | | |
| VTCX415U-MD5C | 2500 | 172 | 587 | 4.85 | 1.22 | 501 | 1710 | 7.73 | 1.95 | 7.84 | 7.30 | 16.1 |
| | 3000 | 220 | 752 | 5.01 | 1.26 | 613 | 2093 | 7.90 | 1.99 | | | |
| | 3600 | 247 | 844 | 4.98 | 1.25 | 724 | 2472 | 7.94 | 2.00 | | | |
| | 4000 | 260 | 889 | 4.90 | 1.23 | 798 | 2724 | 7.86 | 1.98 | | | |
| | 4500 | 288 | 982 | 4.81 | 1.21 | 907 | 3093 | 7.63 | 1.92 | | | |
| VTCX419U-ME5C | 2000 | 164 | 561 | 4.25 | 1.24 | 501 | 1711 | 6.86 | 2.01 | 9.74 | 7.96 | 17.55 |
| | 2500 | 218 | 745 | 4.57 | 1.34 | 627 | 2141 | 7.40 | 2.17 | | | |
| | 3000 | 264 | 901 | 4.71 | 1.38 | 752 | 2567 | 7.64 | 2.24 | | | |
| | 3600 | 308 | 1052 | 4.73 | 1.39 | 900 | 3075 | 7.67 | 2.25 | | | |
| | 4000 | 331 | 1131 | 4.69 | 1.37 | 999 | 3411 | 7.59 | 2.22 | | | |
| | 4500 | 353 | 1205 | 4.59 | 1.34 | 1121 | 3828 | 7.42 | 2.17 | | | |
| VTCX424U-ME5C | 2000 | 222 | 757 | 3.81 | 1.12 | 648 | 2213 | 6.37 | 1.87 | 12.47 | 7.96 | 17.55 |
| | 2500 | 291 | 995 | 4.34 | 1.27 | 811 | 2769 | 6.83 | 2.00 | | | |
| | 3000 | 349 | 1194 | 4.55 | 1.33 | 967 | 3301 | 7.02 | 2.06 | | | |
| | 3600 | 410 | 1400 | 4.57 | 1.34 | 1150 | 3929 | 7.05 | 2.06 | | | |
| | 4000 | 448 | 1531 | 4.51 | 1.32 | 1275 | 4353 | 6.99 | 2.05 | | | |
| | 4500 | 498 | 1699 | 4.41 | 1.64 | 1435 | 4902 | 6.89 | 2.02 | | | |
| VTC1424U-MD5C | 2500 | 284 | 968 | 4.67 | 1.37 | - | - | - | - | 12.47 | 7.45 | 16.42 |
| | 3000 | 339 | 1155 | 4.66 | 1.37 | - | - | - | - | | | |
| | 3600 | 404 | 1377 | 4.58 | 1.34 | - | - | - | - | | | |
| | 4000 | 436 | 1486 | 4.48 | 1.31 | - | - | - | - | | | |
| | 4500 | 476 | 1624 | 4.33 | 1.27 | - | - | - | - | | | |

LBP - Evap. Temperature: -35°C (-31°F)
Condensing Temperature: 40°C (104°F)
Return Gas Temperature: 20°C (68°F)
Ambient Temperature: 32.2°C (90°F)
Subcooling Temperature: 0K

MBP - Evap. Temperature: -10°C (14°F)
Condensing Temperature: 45°C (113°F)
Return Gas Temperature: 20°C (68°F)
Ambient Temperature: 32.2°C (90°F)
Subcooling Temperature: 0K

Oil Charge: 170ml
Oil Type: POE
Oil Viscosity: 10 cSt

Cooling: Fan
Motor Type: BLDC
Voltage: 220/240V

Information for internal reference only.
Input Command: Frequency
All models were tested with inverter model 030FO207
Certifications: VDE in process (will be concluded in Q2/19)

## R290 COMPRESSOR PERFORMANCE - L/MBP

ARI

| Model | Speed | LBP - Evaporating Temperature -23°C (-10°F) | | | | MBP - Evaporating Temperature -6.7°C (20°F) | | | | Displac. | Weight | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cooling Capacity | | Efficiency | | Cooling Capacity | | Efficiency | | | | |
| | RPM | W | Btu/h | EER | COP | W | Btu/h | EER | COP | CM³ | kg | lb |
| VTCX360U-MD5C | 2500 | 101 | 345 | 4.87 | 1.23 | 206 | 704 | 7.50 | 1.89 | 3.14 | 7.30 | 16.1 |
| | 3000 | 111 | 378 | 4.51 | 1.14 | 236 | 805 | 7.20 | 1.81 | | | |
| | 3600 | 141 | 480 | 4.73 | 1.19 | 293 | 999 | 7.32 | 1.84 | | | |
| | 4000 | 162 | 553 | 4.88 | 1.23 | 334 | 1141 | 7.40 | 1.87 | | | |
| | 4500 | 180 | 615 | 4.82 | 1.21 | 379 | 1295 | 7.35 | 1.85 | | | |
| VTCX410U-MD5C | 2500 | 199 | 679 | 4.97 | 1.25 | 397 | 1356 | 7.35 | 1.85 | 6.06 | 7.30 | 16.1 |
| | 3000 | 243 | 831 | 5.16 | 1.30 | 486 | 1661 | 7.56 | 1.91 | | | |
| | 3600 | 288 | 984 | 5.11 | 1.29 | 585 | 1998 | 7.48 | 1.88 | | | |
| | 4000 | 314 | 1072 | 5.03 | 1.27 | 647 | 2206 | 7.35 | 1.85 | | | |
| | 4500 | 342 | 1170 | 4.96 | 1.25 | 720 | 2459 | 7.21 | 1.82 | | | |
| VTCX415U-MD5C | 2500 | 251 | 858 | 4.90 | 1.23 | 505 | 1723 | 7.11 | 1.79 | 7.84 | 7.30 | 16.1 |
| | 3000 | 303 | 1033 | 5.05 | 1.27 | 619 | 2112 | 7.34 | 1.85 | | | |
| | 3600 | 357 | 1219 | 5.09 | 1.28 | 748 | 2555 | 7.40 | 1.86 | | | |
| | 4000 | 391 | 1335 | 5.06 | 1.28 | 832 | 2841 | 7.34 | 1.85 | | | |
| | 4500 | 432 | 1475 | 4.99 | 1.26 | 936 | 3196 | 7.21 | 1.82 | | | |
| VTCX419U-ME5C | 2000 | | | | | | | | | 12.47 | 7.96 | 17.55 |
| | 2500 | | | | | | | | | | | |
| | 3000 | | | | | | | | | | | |
| | 3600 | | | | | | | | | | | |
| | 4000 | | | | | | | | | | | |
| | 4500 | | | | | | | | | | | |
| VTCX424U-ME5C | 2000 | | | | | | | | | 12.47 | 7.96 | 17.55 |
| | 2500 | | | | | | | | | | | |
| | 3000 | | | | | | | | | | | |
| | 3600 | | | | | | | | | | | |
| | 4000 | | | | | | | | | | | |
| | 4500 | | | | | | | | | | | |
| VTC1424U-MD5C | 2500 | | | | | - | - | - | - | 12.47 | 7.45 | 16.42 |
| | 3000 | | | | | - | - | - | - | | | |
| | 3600 | | | | | - | - | - | - | | | |
| | 4000 | | | | | - | - | - | - | | | |
| | 4500 | | | | | - | - | - | - | | | |

Available upon request

LBP - Evap. Temperature: -23°C (-10°F)
Condensing Temperature: 48.9°C (120°F)
Return Gas Temperature: 4.4°C (40°F)
Ambient Temperature: 35°C (95°F)
Subcooling Temperature: 0K

MBP - Evap. Temperature: -6,7°C (20°F)
Condensing Temperature: 48.9°C (120°F)
Return Gas Temperature: 4.4°C (40°F)
Ambient Temperature: 35°C (95°F)
Subcooling Temperature: 0K

Oil Charge: 170ml
Oil Type: POE
Oil Viscosity: 10 cSt

Cooling: Fan
Motor Type: BLDC
Voltage: 220/240V

Information for internal reference only.
Input Command: Frequency
All models were tested with inverter model 030F0207
Certifications: VDE in process (will be concluded in Q2/19)

# COMPRESSOR NOMENCLATURE AND TUBE CONNECTIONS

## VTC COMPRESSOR MODEL NOMENCLATURE:

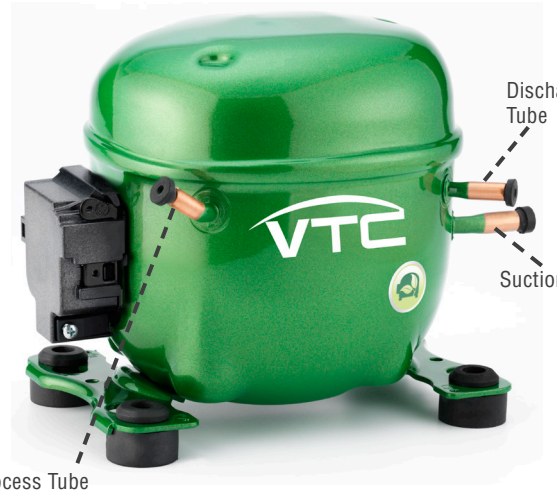
**VTCX415U-MD5C**

| VTC | X | 4 | 15 | U | - | MD | 5 | C |
|---|---|---|---|---|---|---|---|---|

| Compressor Family (First 3 digits) | Application | Digit Number | Cooling Capacity | Refrigerant | Voltage (V / RPM) | Inverter Control | Release Variant |
|---|---|---|---|---|---|---|---|
| VTC | X. L/MBP-HST<br>1. LBP-LST | Number of digits composing the cooling capacity | Corresponding to the two first figures of the cooling capacity (Btu/h). In this exemple total digits 4, with cooling capacity 15 means 1500 Btu/h at 3600 rpm. | U. R290 | MD. 250 / 2500 - 4500<br>ME. 250 / 2000 - 4500 | 5. Inverter Driven | C. |

Application Window
L/MBP : -35°C to -5°C (-35° F to +23°F)
LBP : -40°C to -10°C (-40°F to +14°F)

## VTC TUBE CONNECTIONS:




Nominal Internal Diameter - mm (in)

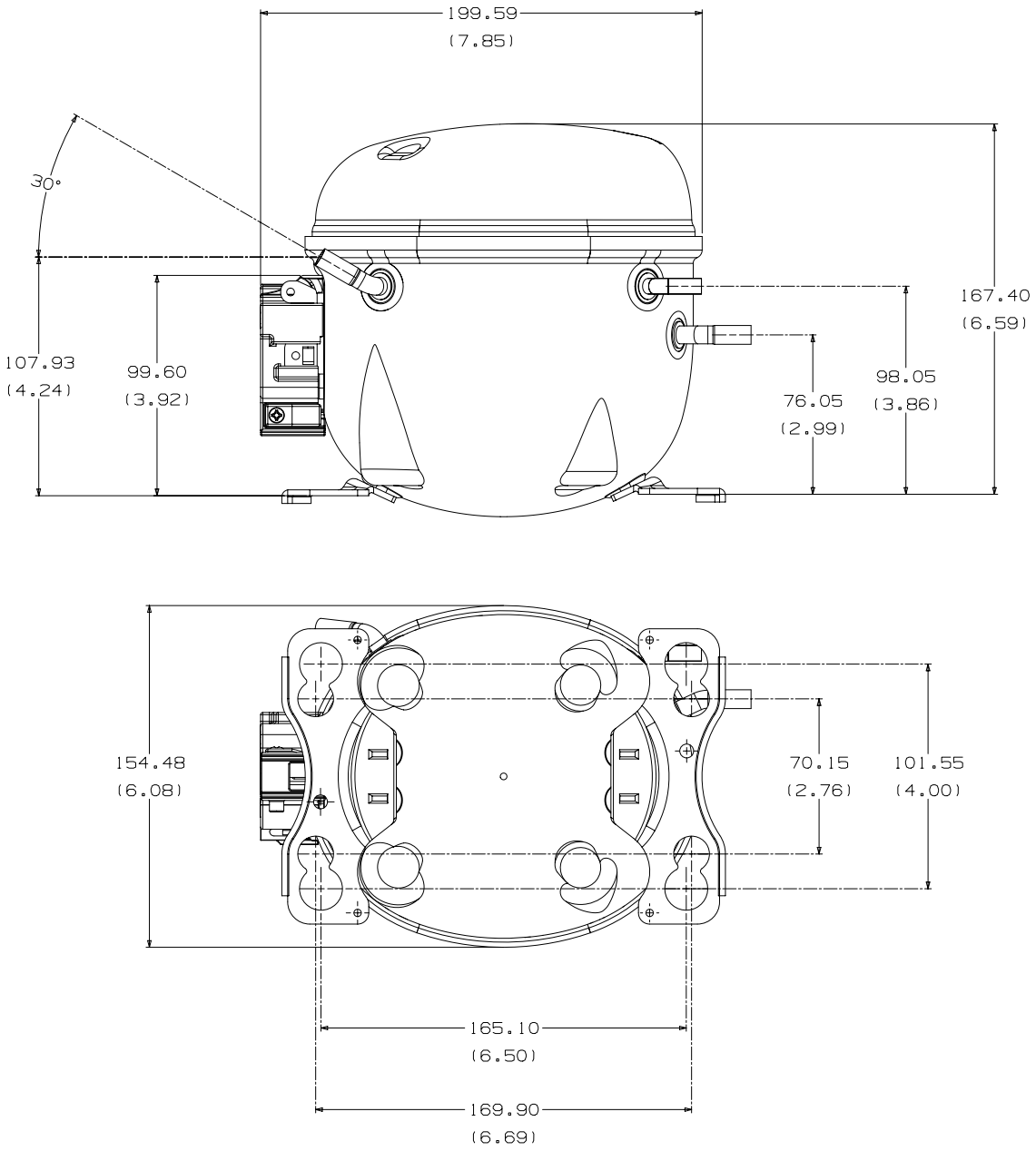
| Suction | Discharge | Process |
|---|---|---|
| 6.50 (0.256) | 4.96 (0.195) | 6.50 (0.256) |

Tolerance ± 0.05 mm (0.002 in) in all columns

# COMPRESSOR DIMENSIONS

## COMPRESSOR DIMENSIONS - mm (in)

*Universal Model:*



# TECUMSEH IntelliCI™

## INTRODUCTION:

A variable speed compressor, in opposition to a single speed compressor, is known to provide energy savings due to its ability to match the load demand closely to the power delivered by the pump. This matching is achieved by using an electronic inverter that can be understood under two perspectives: hardware and firmware (software embedded in inverter).

The hardware is the physical portion of the inverter, composed by two main stages – the power processing and the control circuitry. The power processing is responsible for energy conversion from the mains network input to the power delivered to the compressor. For inverters connected in the mains network, the typical power processing solution is accomplished by an input AC to DC converter (the rectifier), and an output DC to AC converter (the inverter). The inverter changes its output frequency to increase or decrease the motor's speed and so, the cooling capacity.

The second portion of the hardware, the control stage, is composed mainly by a special kind of microprocessor, called microcontroller (usually referred as MCU - Micro Controller Unit). A MCU has a microprocessor (CPU) core combined with several peripherals embedded in the same integrated circuit. These peripherals give to the MCU digital and analogic input and output capabilities. Besides the MCU, the control stage is also composed by the low voltage DC power supply and sensors – like: voltage, current and temperature – for control and protection purposes. The hardware structure is represented on Figure 1.

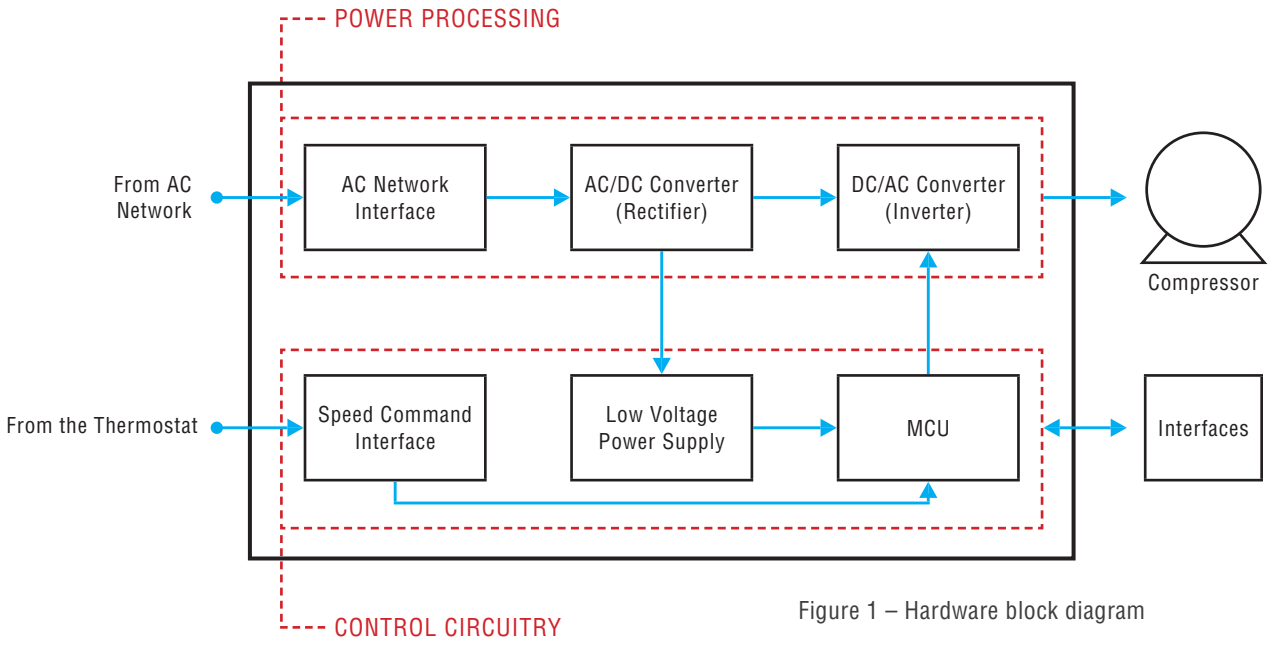



Figure 1 – Hardware block diagram

On the other hand, the firmware (the software embedded in the MCU memory) is responsible for three main tasks: motor control, protections and user interface. Typically for this kind of application the motor control can be accomplished by two technologies:

- Six steps or trapezoidal: does not depend on the motor mathematical model and requires less motor parameters to operate properly. For these reasons, the strategy demands less programming memory and complexity. However, once the motor electrical current shape is like a trapezoid, there are higher harmonic components injected into the motor.

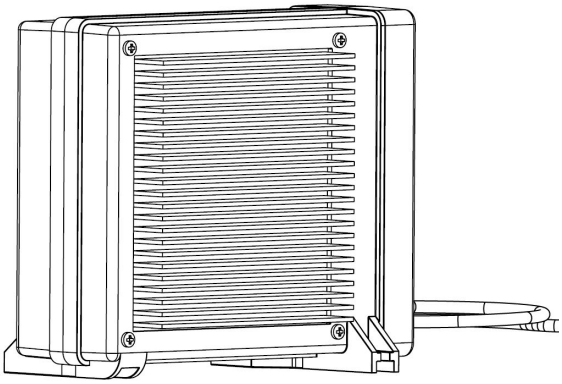
- Vector control or Field-Oriented Control (FOC): Vector control is a variable-frequency drive control method in which the sinusoidal stator currents of a three-phase AC electric motor are expressed as two orthogonal components that can be visualized as two vectors. One of them defines the magnetic flux of the motor and the other defines the electromagnetic torque. This is done to represent an AC electrical machine as a DC machine, which is easier to control. FOC is used to control AC synchronous motors (like permanent magnet brushless DC – BLDC or permanent magnet synchronous motor - PMSM) and asynchronous motors (such as induction motors). It was originally developed for high-performance motor applications, like tool machines and robots, that need to operate smoothly over the full speed range, generate full torque at zero speed and have high dynamic performance including fast acceleration and deceleration. However, it is becoming increasingly attractive for lower dynamic performance applications (such as compressors) due to FOC, the motor size, vibration and power consumption are reduced when compared to traditional six steps technology. The IntelliCI™ uses this technology in benefit of these improvements.

The next important firmware function is protection. Digital systems have the ability to manage a variety of protections in order to increase the compressor and inverter reliability and life. Using sensors embedded in the inverter only, reliability can be achieved by monitoring several motor parameters. This is a completely different situation from the protection typically used in single speed compressors – overload protectors – that only senses the motor Amps and housing temperature, with long delay to reset (resume).

Finally, the last function of the firmware is the user interface that is responsible to match the compressor inverter with the application, usually an electronic thermostat. Typically, this interface is accomplished by two techniques: speed command signal or serial channel. The speed command signal is a square waveform (0 to 5V, for instance) whose frequency is proportional to motor speed. It is very simple, robust, compatible with the most off-the-shelf thermostats, but is a one-way communication. The serial channel, on the other hand, is more advanced, precise and flexible. It can be implemented as a two-way communication channel. That means the inverter is able to send messages to the electronic thermostat, in case of a fail detection or when any other limits are reached. However, to work with a digital communication channel it is necessary to establish a software protocol between the thermostat and inverter. This integrated design is only possible considering a customer partnership.

## COMPRESSOR INVERTER:

Tecumseh IntelliCI™ was designed to provide efficient control and monitoring of a four pole Permanent Magnet Synchronous Motor (PMSM) installed in a hermetic compressor, using sensorless FOC technique. It includes several features:



- 600 W, 900 W and 1000 W input power
- Global voltage coverage (85 – 140 or 170 – 260 VAC)
- Automatic input voltage detection (85 – 140 and 170 – 260 VAC)
- 50Hz and 60Hz input frequency operation
- 2500 – 4500 rpm speed range (MD voltage code)
- 2000 - 4500 rpm speed range (ME voltage code)
- Locked rotor detection
- Under/Over DC bus voltage shutdown
- Over current shutdown
- Inverter overheating shutdown
- Isolated speed command input to interface with electronic thermostats
- Tecumseh Adaptive Logic (TAL) for applications with conventional “On/Off” thermostat
- RPM skip capability to avoid mechanical resonance
- Thermal trip input

When connected to an electronic thermostat, the inverter will provide speed as specified by the speed command input unless one of the following limits are exceeded: current limit, voltage limit or temperature limits inside the inverter. During normal operation, the inverter receives the speed command by means of a square wave signal with frequency proportional to desired compressor’s speed, as in Figure 2.

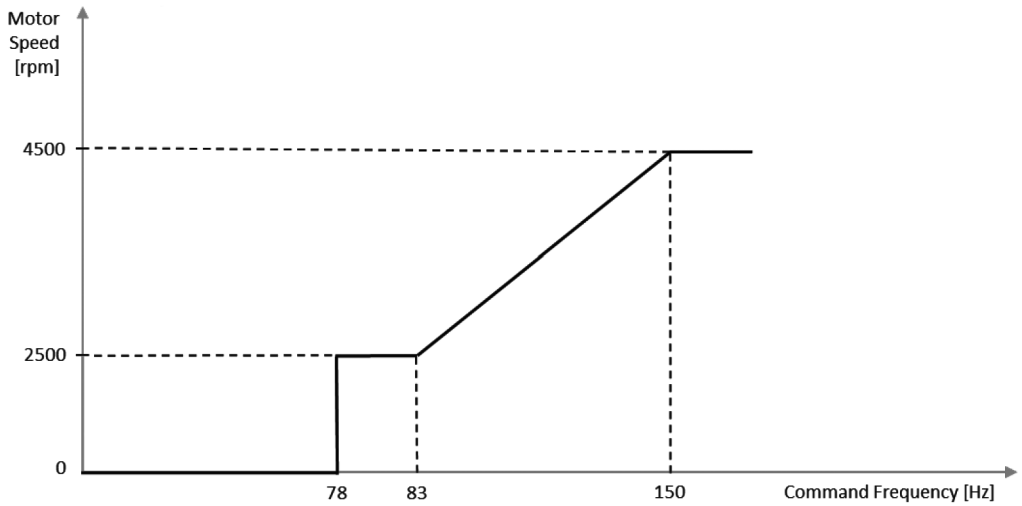



Figure 2 – Command input x motor speed, e. g. for VTCX360U-MD5C, VTCX410U-MD5C, VTCX415U-MD5C and VTC1424U-MD5C

During the compressor's start up, for the initial 30 seconds the inverter will impose 2500 rpm in order to guarantee the proper oiling before changing the speed according to speed command input. The acceleration ramp and slow down rates are 100 rpm/s for any speed change process. Depending on the compressor speed, due to slow deceleration rate, it may take up to 40 seconds to stop the compressor after receiving the stop command from the thermostat.

The inverter has two options for thermostats, one to utilize each type commonly found in the market. It can handle frequency control and also the traditional on/off command, by switching the mains voltage by an electromechanical device.

Ranges from 85 to 90V and 170 to 180V the inverter limits the compressor speed. From 90 to 135V and 180 to 260V the inverter operates normally. However, for supply voltages lower than 85V, from 135 to 170V (030F0207,228 model's only) and higher than 260V, the inverter does not operate, according to Figure 3.

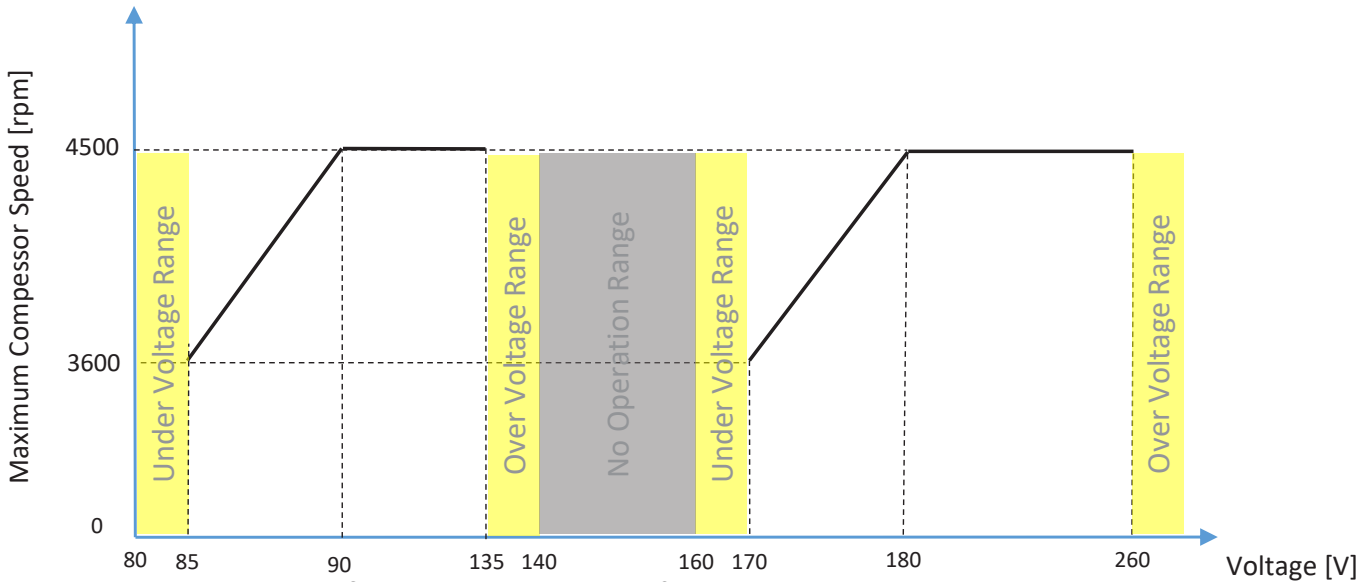



Figure 3 – Speed limitation according to AC mains voltage (030F0207, 228 model's only)

# INVERTER MODELS

## Model Specifications:

| Inverter Model | Input Command | Voltage (V) |
|---|---|---|
| 030F0207 | Frequency / Fixed Speed | 115 - 127 or 220 - 240 |
| 030F0216 | Frequency / TAL | 115 - 127 |
| 030F0217 | Frequency / TAL | 220 - 240 |
| 030F0218 | Frequency / TAL | 85 - 260 |
| 030F0222 | Frequency / TAL | 220 - 240 |
| 030F0223 | Frequency / TAL | 220 - 240 |
| 030F0226 | Frequency / TAL | 85 - 260 |
| 030F0227 | Frequency / TAL | 220 - 240 |
| 030F0228 | Frequency / TAL | 115 - 127 or 220 - 240 |
| 030F0229 | Frequency / TAL | 85 - 260 |
| 030F0230 | Frequency / TAL | 85 - 260 |

## FEATURES:

- Sensorless sinusoidal (FOC) motor control
- Line voltage: global coverage
- Electronic protections by Class B software according to UL 60335-2-34 with Annex AA
- Max input power: 600W, 900W and 1000W

## SOFTWARE PROTECTIONS: (Detection & Shutdown)

- Under/Over voltage
- Over current
- Output short circuit
- Output phase loss
- Locked rotor
- Controller over heating
- Start up fail
- RPM resonance skip capability

# TAL™

## TECUMSE ADAPTIVE LOGIC:

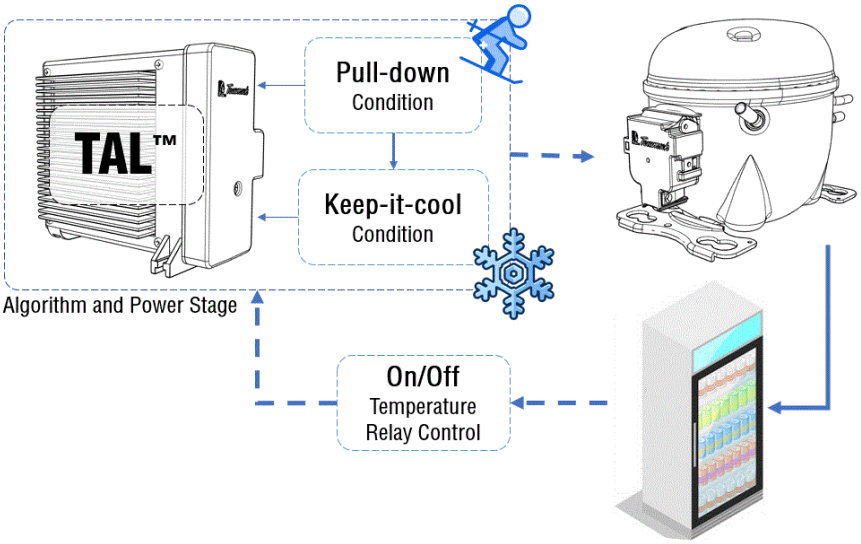
Tecumseh offers an adaptive logic embedded in our inverters which can determine the best rpm according to the thermal load and ambient temperature variation without any additional changes to the refrigeration system.

The TAL™ interface connector is controlled by an “On/Off” thermostat. TAL™ technology is based on an artificial intelligence algorithm. Ideally designed for quick and direct replacement of fixed speed compressors without any system changes or parameters tuning.

Some of the TAL ™ features are:

- Rapid temperature pull-down
- Rapid temperature recovery after energy faults
- Thermal load temperature maintenance
- Robustness against ambient temperature variation
- Self-adapting refrigeration capacity algorithm

Another feature embedded in the firmware is the RPM skip capability, to avoid system’s mechanical resonance. Under this condition, the inverter will skip up to five pre-selected frequency ranges. The default configuration considers only the natural frequency of the compressor. However, natural frequency of the system (compressor applied in the application) can be factory programmed upon customer request.



# WIRING DIAGRAMS

## Variable speed thermostat:

- Input: AC mains network, according to inverter's version and speed command, Figure 6.
- Output: Compressor connection via cable 040F0269
- Speed Command: Inverter receives RPM reference from an electronic thermostat.
- Thermal Trip: Optional input for the customer provided thermal protector. Leave jumper, if protector not in use.

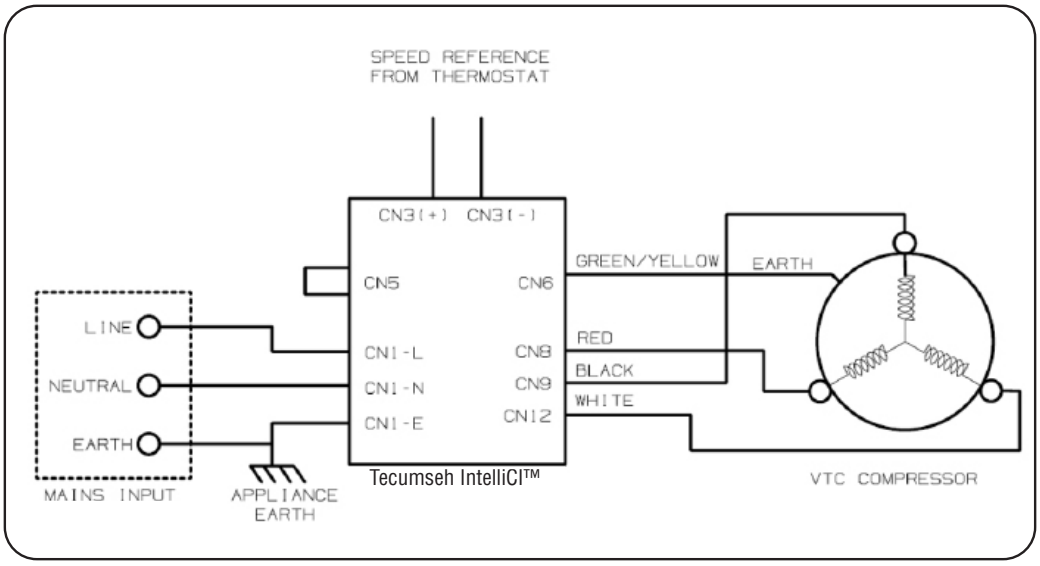



Figure 4 – Typical wiring diagram when operating with variable speed thermostat

The speed command reference from electronic thermostat to VTC inverter is a square waveform 0 to 5V, 50% duty cycle, frequency range from 83 to 150Hz (see Figure 5 where T is the period in seconds and the frequency is defined f=1/t, in hertz).

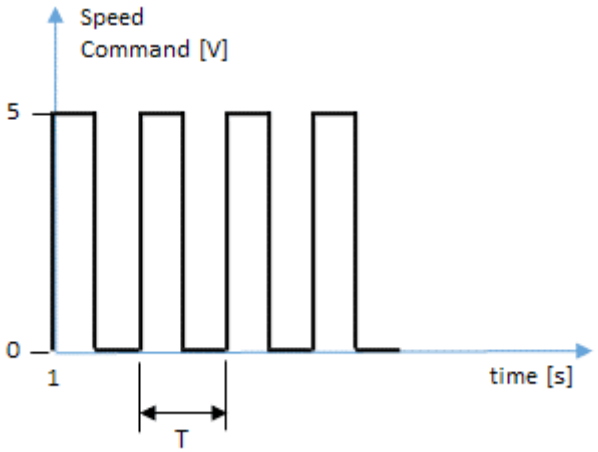



Figure 5 – Square waveform for speed command

## Typical on/off thermostat:

- Input: AC mains network, according to inverter's version and speed command, Figure 5
- Output: Compressor connection via cable 040F0269
- Speed Command: Inverter receives on/off signal from thermostat through conection CN9 (TAL).

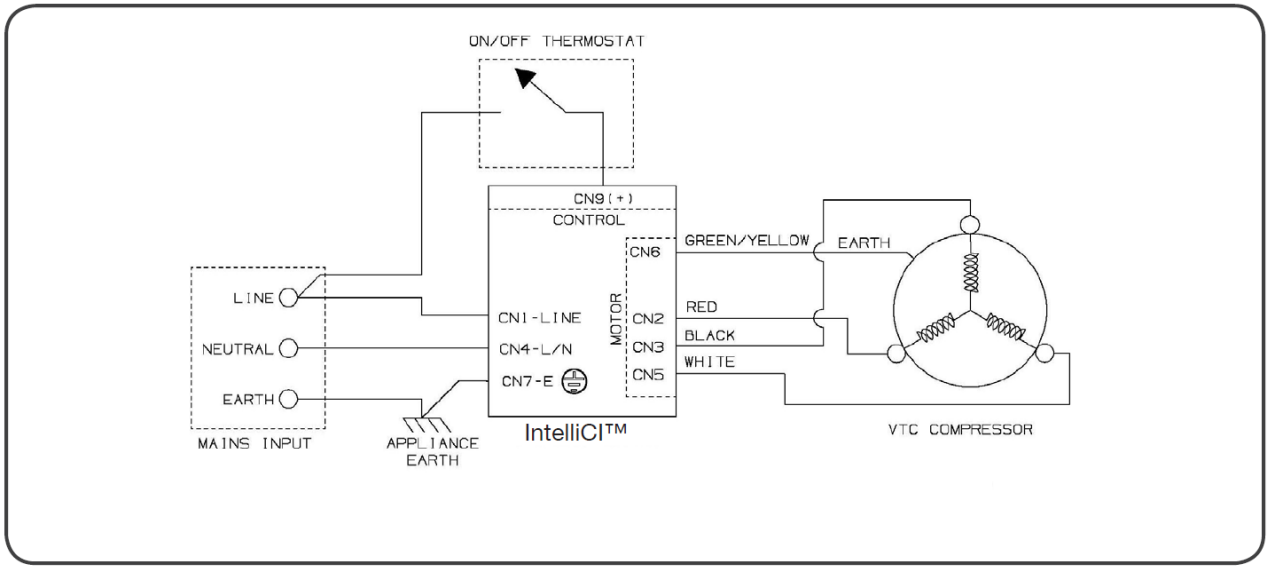



Figure 5 - Typical wiring diagram when operating with on/off thermostat

# CONNECTIONS

## COMPRESSOR:

A three-phase connection supplies power to the VTC compressor. There is a cluster terminal to avoid phase misconnection between the inverter and the compressor wiring, and the recommended position of the cluster terminal is indicated in Figure 7 and 8.

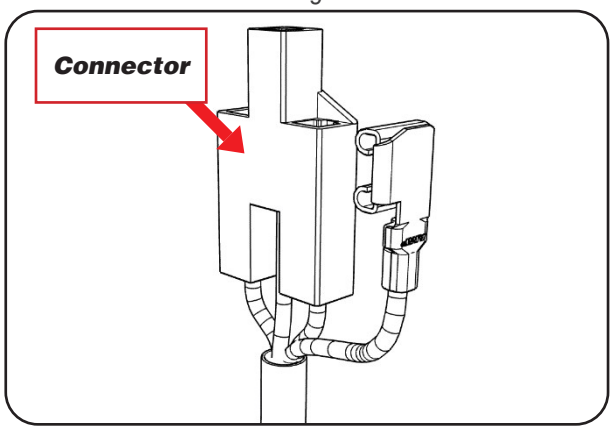



Figure 7 – Cable and three-phase connector

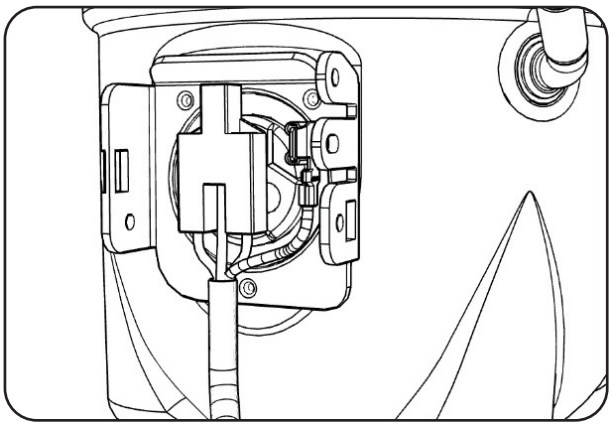


Figure 8 – Compressor complete connection

## Connector specification:

The cluster terminal block used in the VTC inverter output connection is an Amphenol 1380145-2 or Tyco 1380145-1 (see Figure 8). Plastic material is PBT Valox 310-SE0. The cable terminals are the Tyco 1599105 compatible with 18 AWG cables. This connector is supplied with the VTC inverter and must not be modified. Any modification can damage the compressor.

## Cable specification:

The output cable of the VTC inverter is comprised of three individual cables, each one with a distinct color to identify each motor phase. The cable colors and the related connector pins position are described in Table 1. All the cables are 18 AWG stranded UL approved cable with PVC insulation rated for 105°C and 600V. This cable is supplied with the VTC inverter and must not be modified. Any modification can damage the compressor or increase the EMI level.

| Cable Color | Hermetic Terminal Position |
|---|---|
| Black | Top |
| Red | Left |
| White | Right |

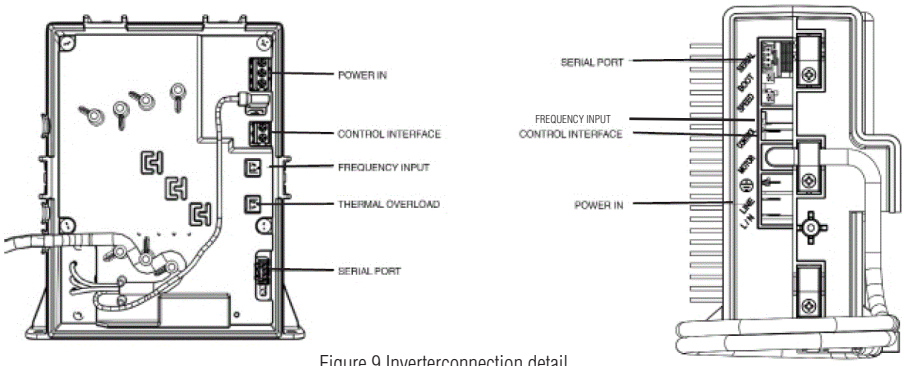
Table 1 – Compressor connection

The cable 040F0269 is part of the inverter and cannot be modified by the customer, there are restrictions for its length and wire leads sequence. If two leads are exchanged, the motor will run in opposite direction and the compressor oil pump will not work.

All mating connectors are specified in the installation instruction documents 600A1572 and 600A1759.

## Inverter:

Inverter connections (as seen in figure 9) can be viewed in greater detai in the installation instruction documents 600A1572 and 600A1759.




030F207, 228

Figure 9 Inverterconnection detail

030F0216, 217, 218, 222, 223

# FAULTS

## Fault conditions:

Fault conditions are monitored continuously to protect the compressor, the inverter and also the mains power supply. Upon detection of a fault, the motor is shut down and the fault is indicated by a flashing internal light emitting diode (LED) and by the serial port available on board. The serial port reports continuously operational parameters such as: speed “RPM”, AC mains voltage “V”, current “A”, inverter’s temperature in Celcius degree “C” and fail. To use this resource, refer to document 600A1438.

The main faults monitored by the inverter are:

- Start up Fail: If the compressor fails to start. (1 Flash)
- Under/Over Voltage: if the rectifier’s output voltage exceeds the upper or lower limit the compressor will be turned OFF. (Under 2 Flashes Over 3 Flashes)
- Over Current: If the DC bus current exceeds the current trip threshold the compressor will be turned OFF. (4 Flashes)
- Inverter overheating shutdown: If the temperature on the inverter printed circuit board, where the temperature protection sensors are placed, exceeds the upper limit, the compressor will be turned OFF. (5 Flashes)
- Locked Rotor: After ten consecutive start fails, LR will be indicated. (6 Flashes)
- Phase Loss detection: If one of the three motor phases are not connected or missed, the inverter will detect and the compressor will be turned OFF. (8 Flashes)
- FOC Plausibility Check Failure: The inverter checks the FOC (Field Oriented Control) module functionality periodically by using a plausibility check on some of its output variables. (9 Flashes)
- Compressor housing overtemperature: if the compressor housing reaches a high temprature, the compressor is powered off (optional).

# VTC and IntelliCI™ DIMENSIONS

## Compressor and inverter basic dimensions:

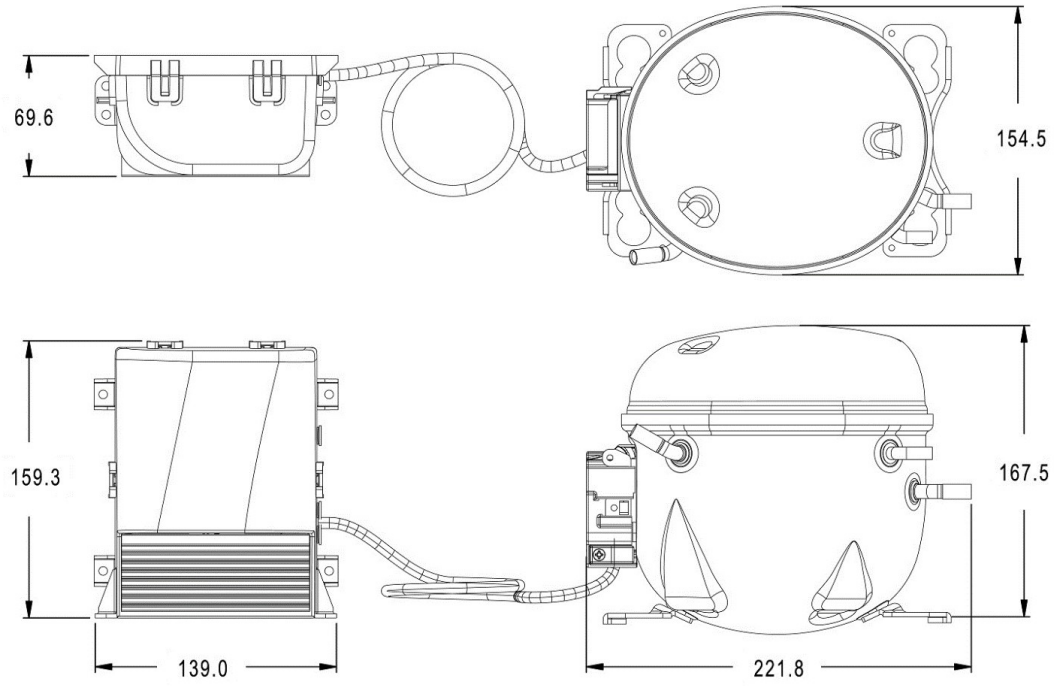



Figure 11 – Compressor and inverter dimensions (mm)

## Compressor footprint:

Figure 11 and 12 shows the dimensions of the VTC compressors. There is no provision for a top mounted evaporating tray.

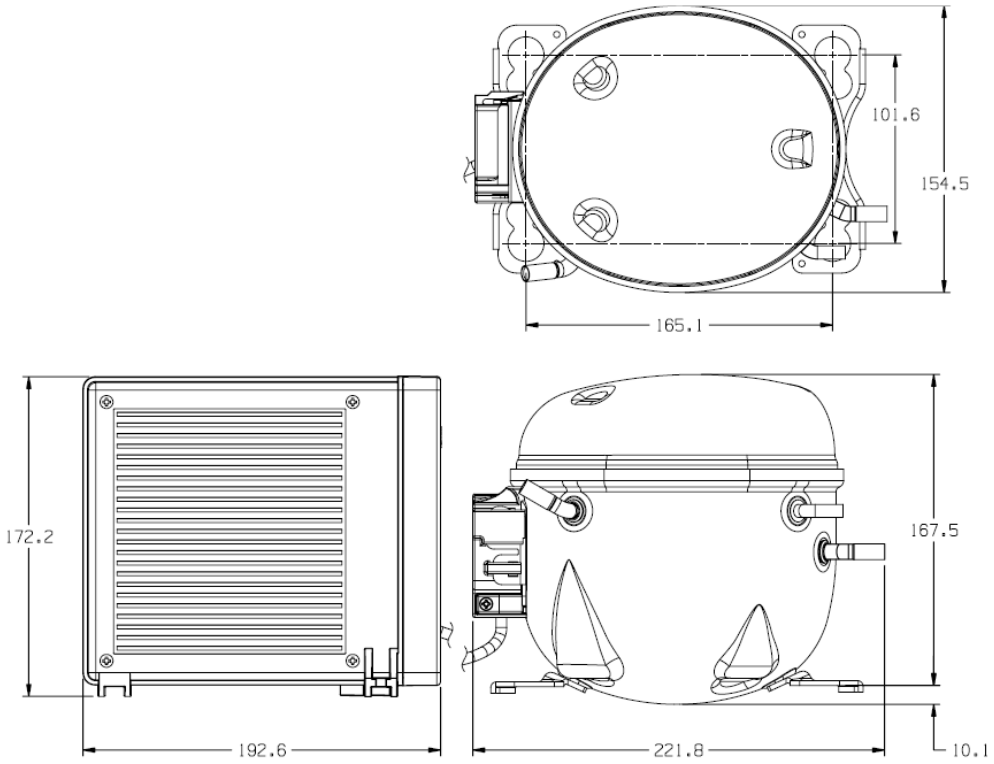



Figure 12 – Compressor and inverter dimensions (mm)

# VTC LABELING

## Compressor Label:

The VTC compressor label is placed on the compressor side as shown in Figure 10. The label has information about the part number, compressor ratings and refrigerant type. Refer to the label section for more details.

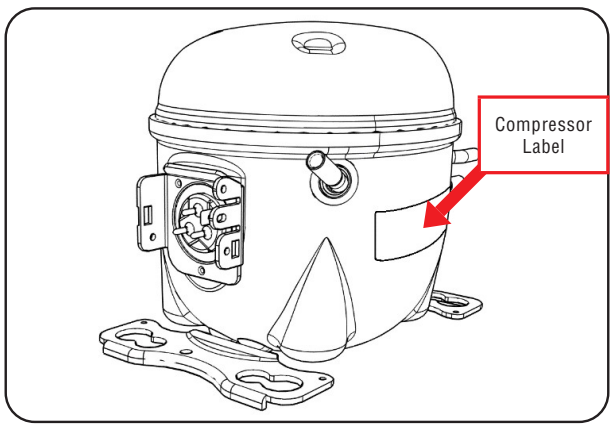
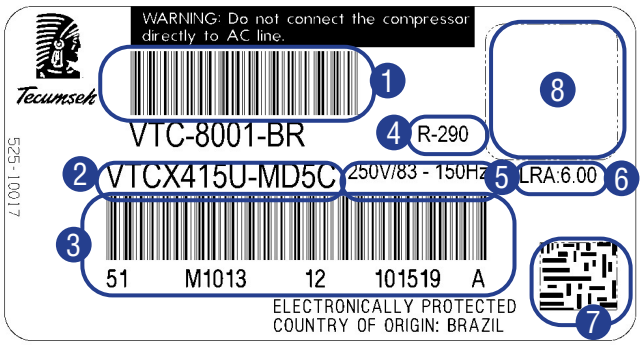


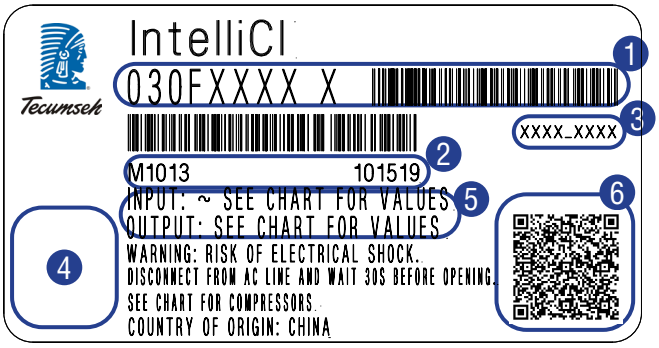

Figure 10 – Compressor label location

## Compressor label detail:

For more information about compressor ratings refer to the specific VTC compressor datasheet.




1. Compressor BOM code
2. Compressor part number
3. Compressor production date and serial number
4. Refrigerant specification
5. Compressor rated voltage and frequency range
6. Compressor maximum phase current
7. Compressor part number and serial number(datamatrix coded)
8. Area reserved for flammable gas symbol (yellow colored)




1. Inverter part and revision number (human readable and bar coded)
2. Inverter production date and serial number
3. Inverter software number and revision
4. Area reserved for agency approval
5. Inverter ratings (see inverter ratings section below for details)
6. Inverter QR code

| Inverter Model | Input Values | Output Values |
|---|---|---|
| 030F0207 | 85-260V / 50-60Hz / Max 7.0A / 600W | 250V / 83-150Hz / Max 5.0A |
| 030F0216 | 115-127V / 50-60Hz / Max 7.0A / 600W | 250V / 83-150Hz / Max 2.2A |
| 030F0217 | 220-240V / 50-60Hz / Max 4.5A / 600W | 250V / 83-150Hz / Max 2.2A |
| 030F0218 | 85-260V / 50-60Hz / Max 7.0A / 600W | 250V / 83-150Hz / Max 2.2A |
| 030F0222 | 220-240V / 50-60Hz / Max 4.5A / 1000W | 250V / 66-150Hz / Max 4.2A |
| 030F0223 | 220-240V / 50-60Hz / Max 7.0A / 900W | 250V / 66-150Hz / Max TBD |
| 030F0226 | 85-260V / 50-60Hz / Max 7.0A / 600W | 250V / 83-150Hz / Max 2.2A |
| 030F0227 | 220-240 / 50-60Hz / Max 4.5A / 1000W | 250V / 66-150Hz / Max 4.2A |
| 030F0228 | 85-260V / 50-60Hz / Max 7.0A / 600W | 250V / 83-150Hz / Max 5.0A |
| 030F0229 | 85-260V / 50-60Hz / Max 7.0A / 600W | 250V / 83-150Hz / Max 2.2A |
| 030F0230 | 85-260V / 50-60Hz / Max 7.0A / 600W | 250V / 83-150Hz / Max 2.2A |

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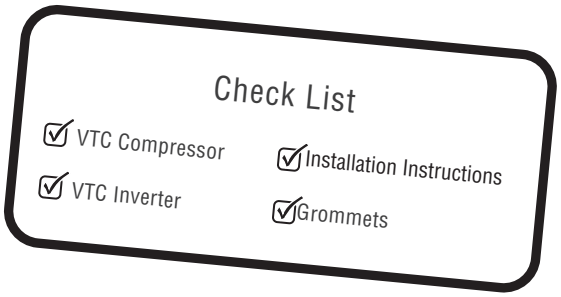
# VTC PACKAGING

## WHAT IS IN A COMPRESSOR SINGLE PACK?

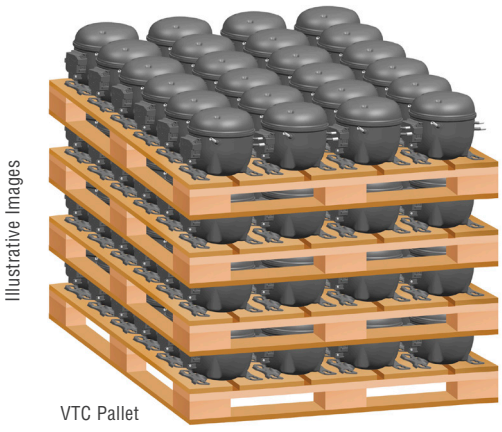


VTC Inverter

Installation Instructions

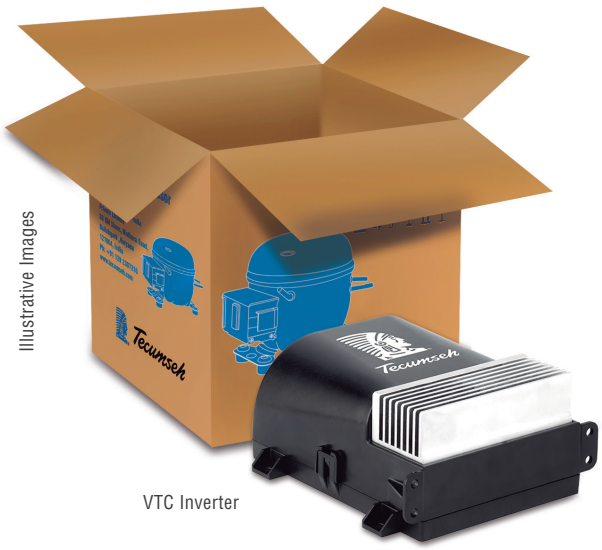
## WHAT IS IN A COMPRESSOR MULTIPLE PACK?

NM 96 Compressors per Pallet
- 24 compressors per layers
- 4 layers per pallet



VTC Pallet

## WHAT IS IN A INVERTER SINGLE PACK?



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