

Copeland Scroll Digital™

10 Years of Scroll Digital
- A Success Story



Copeland Scroll™



“10 Years of Scroll Digital Success”

Introduction

2016 marks the 10th anniversary of the launch of Copeland Scroll Digital compressors for refrigeration applications. What a journey it has been since its official introduction in 2006! It may be a surprise to some, but since launching in 2006, digital scroll sales have seen a mean annual growth rate of more than 30% in Europe – and this over a period when there has been parallel attention to alternative forms of modulation, such as inverter driven compressors. In the last few years Scroll Digital has found its own sweet spot in modulating refrigeration applications and is now widely accepted in food service and food retail applications. The whole idea of developing this technology was to keep things simple for customers while providing the main benefits of modulating capacity: precise temperature control and energy efficiency. Based on the sales figures, Emerson is proud to say that customer expectations have been met.

The need for Modulation

One of the biggest challenges operators face in refrigeration applications is to match the capacity to demand. When not done properly the fluctuations in demand for cooling due to varying load and ambient conditions can take its toll on food quality and this can cause huge losses for the customer. Without modulation, one of the main way to cater to the fluctuating demand is to switch compressors on and off. This leads to high wear on the system components and results in expensive maintenance and replacement costs. Placing a properly matched modulating compressor in a traditional compressor rack system or condensing unit avoids such issues by delivering the precise cooling capacity required, helping to save energy and prevent food spoilage. While there are several ways to vary capacity, scroll digital modulation technology comes with its own benefits and has become a valued technology. With a modulation range that spans from 10% to 100% Digital Scroll offers the broadest modulation range in the industry and can be controlled directly via the system controller without the need of an external inverter or a slave controller.

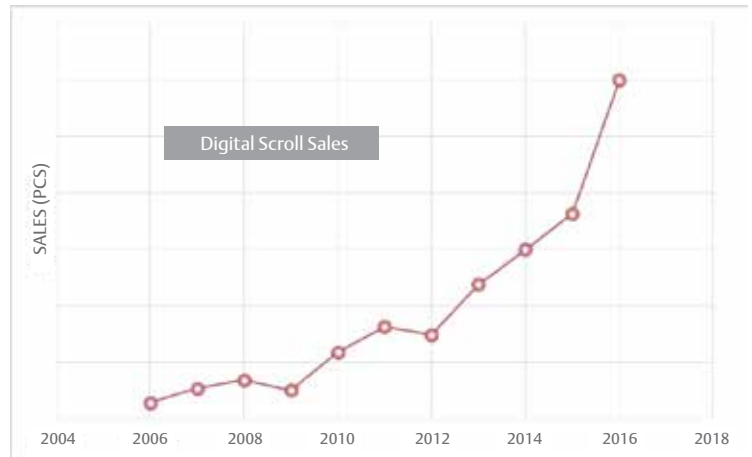
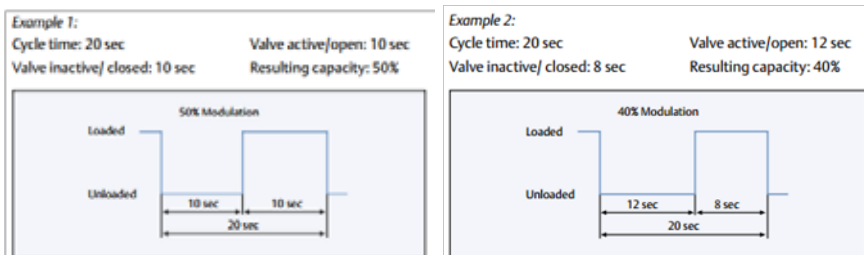
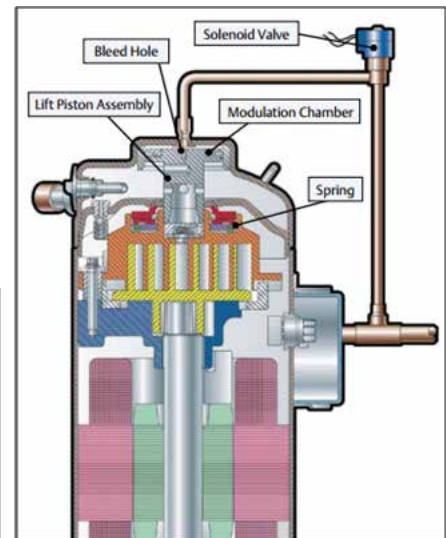


Fig. 01

What is Digital Modulation?

Copeland Scroll Digital technology is a modulation solution that can be easily and quickly implemented into any existing system design as no other components are required.

The modulation is achieved with a cycle time based PWM (Pulse Width Modulation) control of a solenoid valve that operates a piston fitted rigidly to the upper scroll. This piston is actuated by gas pressure. The solenoid opens to allow the modulation chamber to communicate with suction via the external tube. Discharge pressure on the lower side of the piston forces it upwards, bringing with it the upper scroll – there is no compression. When the solenoid closes, pressure builds up in the modulation chamber. A small bleed hole speeds the pressure build up in the chamber. The upper scroll moves down to its normal contact position – compression resumes. Copeland Scroll Digital technology thus provides continuous, stepless modulation from 10% to 100% with no operating envelope restriction.



Compressor capacity is controlled by modulating the solenoid valve input over time.

Fig. 02

The Product Range

The modest range of two medium temperature scroll digital compressor models introduced in 2006 has now been extended to a boastful platform consisting of 7 medium temperature models covering refrigeration capacities from 5 to 25 KW per compressor and 4 low temperature models covering 4 to 13 KW. The recent launch of digital compressors in the larger “Summit” platform saw the existing range expanded until 15HP in medium temperature and 13 HP in low temperature applications (see Fig 03). Based on high customer demand, while on one side Emerson worked on extending and expanding the complete range, the physical attributes and features of these models were also improved. Some of the new generation models like ZBD57KCE and ZBD29KCE were introduced recently in 2015 to replace the predecessor models thus reducing compressor weight up to 30% and the dimensions significantly while giving the same capacity output at relatively better efficiency. The summit digital* K5 models were launched specifically taking into account the trend which has seen many end users moving from centralized

supermarket refrigeration systems to distributed systems of less than 40 KW each. When used in combination with a fixed capacity scroll of the same size the new 10 HP medium temperature ZBD76K5E compressors gives an output of around 36 KW which when needed could be modulated from 2 KW to 36 KW depending on the capacity required. The same configuration can also be done with the 15 HP ZBD114K5E compressor along with a fixed ZB76K5E compressor to obtain larger modulation range between 2.5 KW and 44 KW.

In addition, as part of Emerson’s support for compliance with targets to reduce global warming, the entire range has been released for use with the latest alternative HFC and HFO refrigerant blends. These already provide for more than 50% reduction in global warming potential. The trend will be continued with new HFO A2L’s which will enter the commercial refrigeration space soon and will take the GWP level down to below 150 mark and create a platform of future proof solutions.

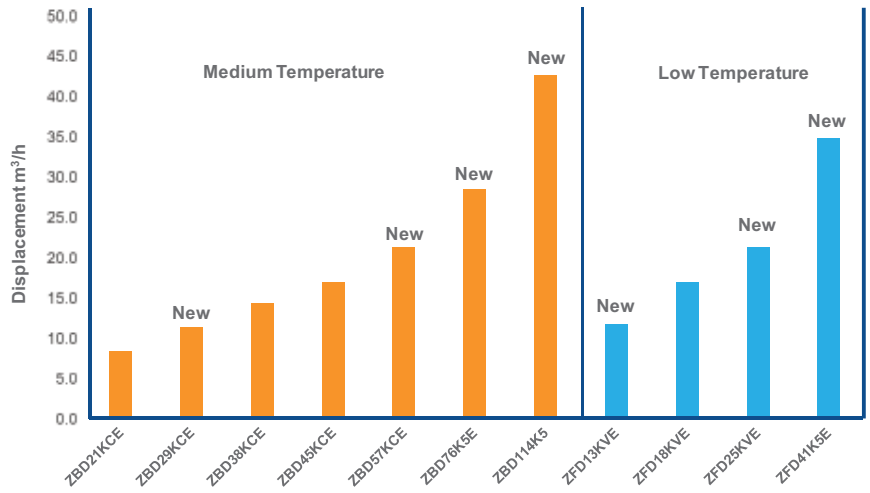


Fig 03. – Medium and Low Temperature Scroll Digital Range

Advantages of Digital Technology

While the benefits of a digital Scroll compressors are many, below is a list of the main benefits which have been highly recognized by the customers in past.

- Simplicity** is the key for ease of design implementation resulting in short time-to-market and low applied cost at the system design level. The following point makes it much more simpler versus other options in the market:
 - Digital scrolls are simple to be used in the field as they are identical to the standard compressors but for the addition of the unloading solenoid valve.
 - There is no impact on the system’s mechanical balance as found with inverter technology (vibration and resonance phenomenon).
 - Digital scrolls avoid excessive sound and pressure pulsation associated with high speed operation in variable speed solutions: no frame or piping redesign work is necessary.
 - Inverters are often still perceived as a complex technology requiring higher technical expertise.
 - Frequency ranges need to be defined in function of compressor manufacturers specifications – and this changes from one model to another which creates complexity.

- Precise temperature control:** With precise and stable system control Digital modulation allows temperatures to be controlled within +/- 0.5 degrees Celsius. Due to practically stepless modulation it’s easier to reduce the cycles (See Figure 04) in the system and keep a close control on the suction pressure and the discharge temperature. In today’s increasingly competitive foodservice, supermarket and transport industries, this provides the assurance that operators are maintaining the highest quality of perishable food items. Precise temperature and pressure control also allows for a true steady state of operation, better enabling the benefits of lowering condensing temperatures to improve the efficiency of the entire system when combined with an electronic expansion valve.

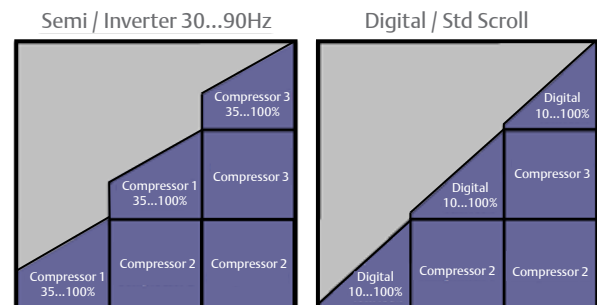


Fig. 04

- Reduced power and energy consumption:** By matching the refrigeration load requirements from 10% to 100%, digital compressor technology consumes only the energy needed to meet the load. Reduced compressor cycling saves energy from in-rush startup currents and persistent consumption from running at full capacity. This also enables operators to increase the evaporating set point, resulting in lower energy consumption and minimized defrost cycles. Compared to other methods of modulation, digital compression is much more energy efficient and less costly to implement. When compared with Inverter technology digital modulation provides better efficiency above 50-60% modulation depending upon the application and model. This is particularly true at lower condensing temperatures where the system runs for more than 80% of the time in Europe. A theoretical comparison, based on the published software data, between a semi-hermetic compressor with inverter and Scrolls digital compressor at a condition of -10°C Evap, 30°C condensing shows this finding below.

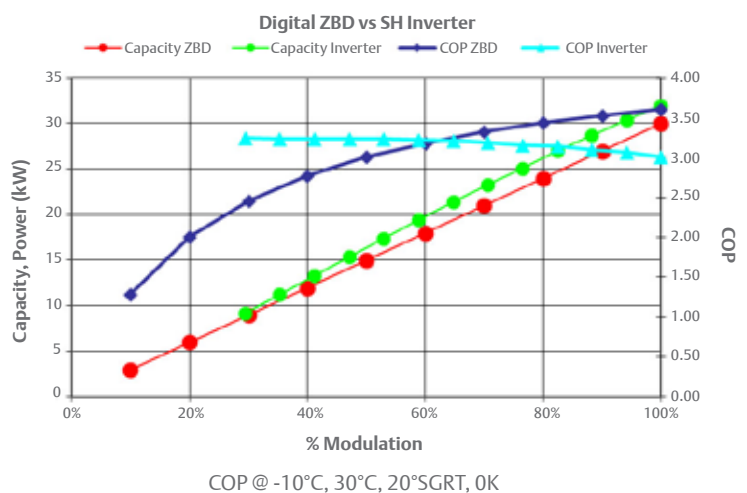


Fig. 05

4. **Increased system reliability:** Thanks to 70% fewer moving parts and robust construction, Scroll technology itself is well known to be much more reliable compared to semi-hermetic compressors technology. While Digital scrolls, being based on the same scroll design, inherits the reliability features, it also provides additional advantages compared to traditional modulation methodologies. Digital modulation greatly reduces cycling rates, which results in significantly less refrigeration system wear and tear. This not only extends the life of compressors but also reduces component failure points in rack systems such as tubes and contactors when running at 100% capacity.
5. **Digital retrofit capability:** One digital compressor can be used as the lead compressor when paired with fixed capacity scroll or semi-hermetic compressors on a parallel rack. Digital modulation fills in the gaps in even on uneven parallel rack applications with the help of active oil management, allowing refrigeration system capacity to fluctuate to meet the load requirements in a supermarket. This supplements the existing rack to dramatically improve the system's load matching capability. Operators can experience the benefits of digital compression by installing a single compressor on a traditional rack system. Digital technology allows stores to dramatically reduce compressor cycling, from cycling frequencies in the hundreds to the tenths.
6. **New refrigerant friendly:** Digital technology is already available for the emerging class of low GWP refrigerants be it the transition refrigerants R407A/F or the new emerging HFO A1 Blends R448A/R449A, R450A and R513A. Digital scrolls have been qualified and released with these new refrigerants in order to help the customers in meeting the GWP targets set by F Gas regulation. In future Emerson will continue to work with new HFO A2L blends to ensure compatibility with the next generation of refrigerants.
7. **No restriction on operating envelope:** Unlike variable speed compressors there are no limitations or restrictions on the operating envelope of a digital scroll compressor irrespective of the modulation load and refrigerant being used. Based on the compressor rotations per minute (RPM) an inverter driven compressor has various limits that have to be respected in order to run the system safely whereas a Scroll digital works within the same operating limits as standard scrolls and hence allows the customer to run the compressors at extreme operating conditions as well as and when needed. With the new generation of digital scrolls the design changes have allowed for even larger operating envelopes than the previous one and can go up to 5°C higher in condensing temperatures.
8. **Small dimension and footprint:** There is an increasing trend to move from large format supermarkets and hypermarkets to more centrally localized convenience stores. Smaller store formats puts a huge constraint on refrigeration space as well due to high land costs and the need to store as much food possible in the available space. This calls for a compact refrigeration systems be it either a compressor rack or condensing units.

The Digital Scrolls range is very well complemented with a broad range of standard scroll models. For each Digital Scrolls there is an equivalent standard scroll model which makes it very suitable for rack applications consisting of 4-5 compressors in general where one is a digital model. As compared to a semi-hermetic compressor, a rack built with scroll compressors can be up to more than 50% lighter in weight and much compactor in dimensions and overall footprint. A Scroll rack containing one modulating and 4 standard compressors could be 30% or shorter in the overall length and almost 50% or shorter of the width of an equivalent capacity rack built with one digital and 3 standard Semi hermetic compressors. (See Fig. 06)

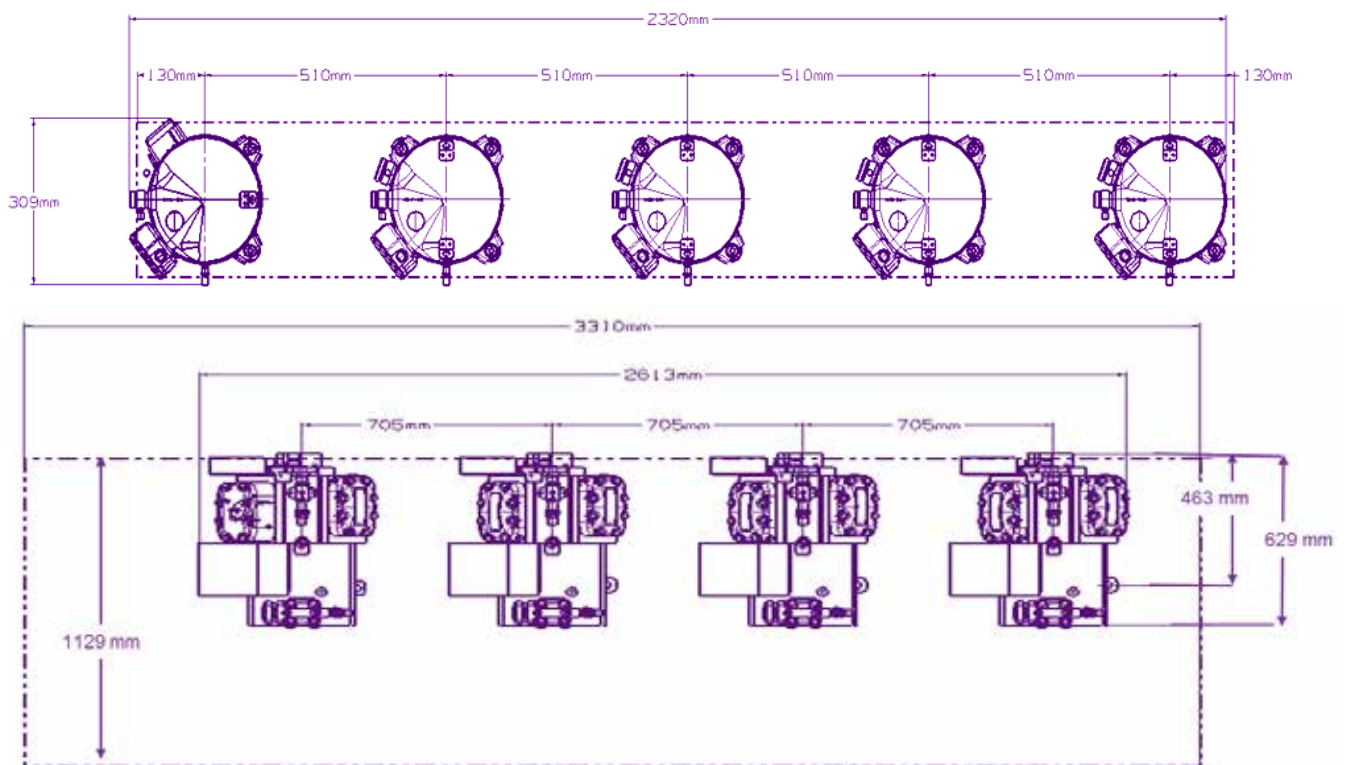


Fig. 06

Applications

The wide range and flexibility for implementation makes digital scrolls fit for any application where a modulating load is required. Combined with one or more standard scrolls it can either be used in a rack application or in a condensing unit. It also fits well into units with only one digital scroll inside. Below are some examples of typical applications:

1. Rack Application:

a. Supermarket

End User: Gama Supermarket, Unide Group

Location: Logroño- Spain

Installer: Comercial Hosteleria Maybe

OEM: Compactos Frigoríficos, Grupo Disco

Details: Gama Supermarket store is situated in Logroño in an area which has around 2000 inhabitants around. To solve problems with neighbors and customers Gama needed to reduce the noise of the equipment and heat that they contributed to the surroundings and also wanted to substantially improve the energy efficiency of the existing refrigeration system and rationalize the cooling capacity of services to fluctuating demand. A mini pack from Compactos with Scroll digital compressors inside, enabled precise temperature control of food and provided the right degree of cooling capacity demanded. This coupled with high energy efficiency and low noise level of performance, became the best possible solution for Gama. With the installation of the mini packs with Digital Scroll the energy consumption of the supermarket was minimized and monthly savings were achieved up to 46% on the electricity bill, with an average annual saving of 27%.



b. Restaurant - Garabato

End User: Restaurant & Tapas Bar Garabato

Location: Albacete, Spain

Installer: José Bernad

OEM: Compactos Frigoríficos, Grupo Disco

Details: The customer needed to serve a total of sixteen cold rooms ranging from 300 W to 4,150 W, which when combined come to a total of 20,500 W. The number and diversity of services required locating the refrigeration equipment in a small terrace outside, but the noise restrictions in urban areas made it impossible. Thanks to the compactness of the tandem Scroll / Scroll Digital compression unit, it was possible to keep equipment inside with no impact on surroundings. Thanks to the continuous capacity modulation from 10% to 100%, provided by Scroll Digital technology, a suitable cold supply was achieved under any operating conditions.



c. Various Scroll Racks:

OEM: Space Engineering Services

"Space Engineering Services" - an OEM in UK has been using scroll digitals since many years and have already installed more than 1000 pieces in UK market so far. Tony Mills, plant manufacturing director of Space Engineering, says: "We like the digital scrolls as it gives great capacity control at low load that we typically see on convenience packs. We have used digitals scroll compressors since 2007 and they have proved successful ensuring we can maintain capacity at low loads"



2. Condensing Unit Application

Due to its compact dimensions and simple control, digital modulation technology is well suited for condensing units. The modulation range of 10 to 100 % allows for precise control of systems in multiple evaporator applications. Pre-configured parameter settings save time during commissioning and support the plug and play philosophy of compact condensing units like EazyCool ZX. The reduced number of compressor starts helps to limit the stress on the system and improve the overall reliability thus reducing lifecycle costs for the operators. For larger capacities, units with stepless capacity modulation typically feature a tandem configuration where a fixed capacity scroll compressor is combined with a Digital Scroll compressor. In this case the modulation range is even extended to 5% to 100% of the nominal capacity.

a. Cold rooms for Hotel Facility

End User: Van der Valk Hotel

Location: Emmen, Netherland

Installer: Rosval Production & Development BV

Details: Two Copeland ZXD units equipped, with digital scroll compressors, and one ZXLE unit was chosen to serve seven cold rooms along with one freezer room. The existing system with R404A had dedicated units attached to each of the cold rooms. Mr. T. Duivenvoorden, General Manager of the Van der Valk Hotel Emmen was concerned with the noise that was being produced with the old system and hence decided to move to low noise Emerson ZX units with digital scrolls which modulates between 20-100%. The new system charged with low GWP refrigerant R448A is now running trouble free since last few months leaving Mr Duivenvoorden a satisfied customer.



b. Stokrotka Grocery stores

Location: Lublin, Poland

Installer: Arcold

Details: At Stokrotka, Emerson EazyCool ZX/ZXD Condensing units are being installed since three years. These units proved to be ideally suited for high density urban areas due its compact design & quiet operation as in some cases they need to install them in very unusual places. Energy efficient operation and reliability is an added value addition for these units.



"Models from ZXDE range are serving, among others refrigeration cabinets, fresh meat display cases, obtaining a proper temperature storage, which has direct effect on the quality of served products and customer satisfaction, which for us as a supermarket chain is most important." – Refrigeration Specialist Mr. Jakub Maćik said.



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For more details, see www.emersonclimate.eu

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