

# Condenser fan speed controllers

## Fitters Notes (Part 14)



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**In the last edition, we dealt with controlling water cooled condensers. This time, we will be dealing with the possibilities within air cooled condenser control. Air cooled condensers can be elegantly controlled via speed controlled fans. Pressure controlled speed controllers are so precise that the high pressure side of a refrigeration system is subject to virtually no pressure fluctuations.**



Single-phase speed controller for wall mounting (type "RGE")

extent that further control measures are not necessary).

In principle, control of the condensing pressure would be conceivable by directly influencing the heat exchange surface. Similar effects could be achieved using classic louvres which are driven by multileaf damper motors (as used in ventilation practice) for example. However, such systems today are rare, at least in commercial refrigeration or standard air conditioning practice, and are characterised by the use of forced air cooled condensers.

The controller then adjusts the speed of the motor when voltage is applied in the course of the sine curve. The electronic components required for this are called triacs. They initially ensure that no voltage flows after the sine wave of the supply voltage has crossed zero.

Then when the triac is triggered the voltage is let through again. It is important to note that fan motors are subject to a considerably higher thermal load than a fan with direct drive. A reduced cooling of the smaller air volume flow at reduced speed is added to the increased temperature of the motor due to phase-angle control.

The manufacturer should be consulted regarding the suitability of a fan motor for this type of speed control (or the information taken from the respective data sheets). Nothing could be worse than a fan motor being switched off in summer by a bimetallic relay just because this problem was not taken into account.

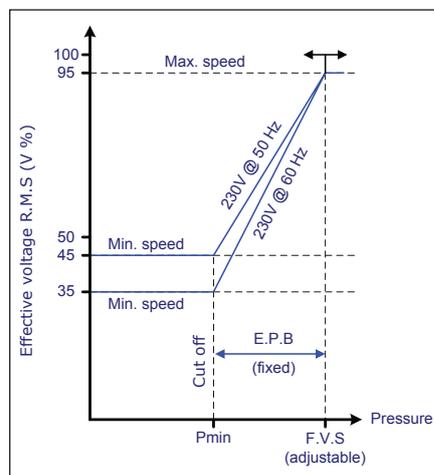
### Purpose

The purpose of a condenser fan speed controller is to keep the condensing pressure in a compression refrigerating plant always at a constant level. This is achieved by adjusting the fan speed. When the condensing pressure in the system increases, the speed of the fan is increased; when the pressure decreases, the speed of the fan speed is reduced. In simple words, the heat exchange surface and air flow rate determine the capacity of a condenser apart from the temperature difference.

A higher air flow rate under the same conditions will reduce the condensing pressure. This shows that controlling the fan speed at the condenser only influences one of the two parameters, namely the air flow. There are practical reasons for this. It allows easy installation of a speed controller according to the phase-angle principle and retrofitting at low costs. The control result is exceptional (i.e. pressure fluctuations on the high pressure side are reduced to the

### Principle

The phase-angle principle is most widely used in condenser fan speed control. The following is important for refrigeration engineers: A phase-angle controller is not a variable frequency drive, which means that it does not change the frequency of the fan motor supply voltage. It removes the first section of the sine wave at zero passage.



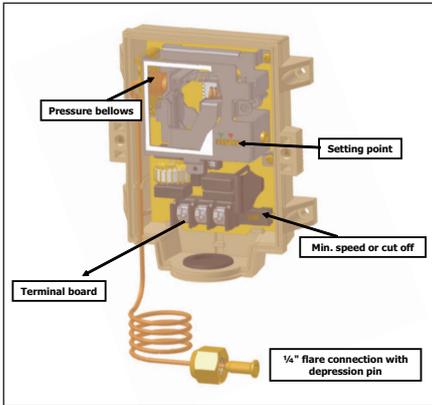
Pressure/speed graph

### Power ratings

As the subject we are dealing with here concerns power electronics, it is clear that there must be different power ratings for fan motors with different outputs. For its most popular single-phase models (230 V, 1~ 50 Hz, our standard "mains voltage"), Danfoss has 3, 4, 6 and 8 A versions in the "RGE" series.

Some practitioners could argue that the majority of axial flow fans used in commercial refrigeration and run-of-the-mill air conditioning systems do not even consume a nominal current of 1 A. This is correct. Only, controlling several condenser fans - particularly on

separate horizontal condensers - with a speed controller is usual practice and meaningful. Controlling only one fan on a condenser with about eight fans would not have any particular effect and at most would prove to be a nuisance to residents due to the permanent starting and stopping.



*“RGE” single-phase speed controller - internal components*

As long as the sum of the individual current consumptions does not exceed the maximum Ampere of the speed controller, several motors can be used with one phase regulator. The motors must be connected in parallel, to “RGE”, for example. There are also speed controllers for three-phase operation. 5 A “RGE” are available for this purpose. Given the fact that the current consumption of three-phase types is divided between three phases (L1, L2 and L3), this maximum value is very high. For a three-phase 5 A type, complete groups of fans with comparatively large motors can be used.

**Types**

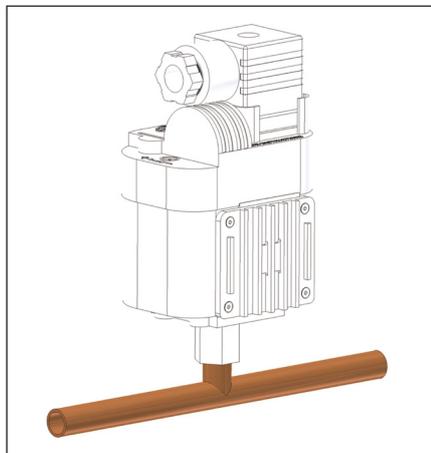
Condenser fan speed controllers are available for wall mounting (type “RGE” of Danfoss) and for direct mounting on pipes (“XGE”). Wall or panel mounting is particularly suitable for new installations. For easier servicing, “RGE” can be mounted next to pressure switches, for example, and - if provided - permanently installed pressure gauges. This facilitates changes to adjustments during servicing routines. Installations designed this way also look very professional and clearly arranged.

For retrofitting a refrigeration system with speed control, “XGE” for direct mounting is suitable. “XGE” can be screwed to existing 7/16” UNF service

nipples without having to remove the refrigerant from the system. When mounted, the integrated depressor pin automatically opens the refrigerant circuit in the direction of “XGE”. So the actual pressure is passed on to the speed controller. A kind of combination of both types is the “XGE” with male flare connection. This variant is similar to the type for direct mounting, but can be mounted on the wall using a bracket. At the customer, the pressure can be made to flow from the main pipe to “XGE” with a prepared capillary tube with union nuts or a 6 mm copper pipe.



*Speed controller for direct mounting (type “XGE”)*



*Mounting on pipe*

**Electrical connection**

The electrical connection of phase controllers is generally simple. The phases to be controlled should generally be routed towards the speed controller and away from it towards the fan motor. With three-phase motors, these are the phases L1, L2 and L3, which are routed from the power supply (switchboard) to the speed controller. The respectively processed voltage signal is then passed on to the motor. It normally suffices to

use a four-core sheathed cable (three phases and one protective conductor) between the speed controller and condenser fan.

For standard three-phase motors, the use of a neutral conductor is not necessary. If a floating protection contact (e.g. for motor over temperature) is to be routed from the motor to the switchboard, this will increase the required minimum number of cores to six. For single-phase types, it usually suffices to route phase L1 via the speed controller.

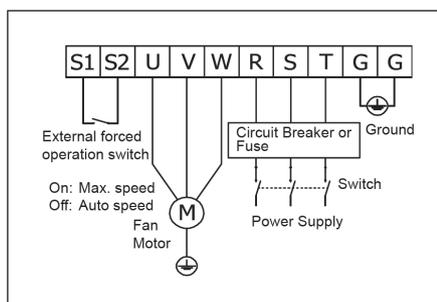
However, for practical (wiring) reasons, the neutral conductor (N) is often looped via the speed controller, despite the fact that no effect is produced here by the phase controller. This is because one sheathed cable is routed to the switchbox and the other to the fan. If one would want to route the neutral conductor directly from the motor to the switch cabinet - which is possible - an additional cable would have to be routed from the condenser motor to the switch cabinet. This is additional work which could be avoided.

**Forced operation at full speed**

In some cases, it may be necessary to temporarily bypass the speed controller and operate the condenser permanently at full speed. This type of arrangement always results in a minimum condensing pressure, which is possible with the currently used fan and prevailing operating conditions. For this purpose, with single-phase types, L1 of the supply cable can be connected to the output of L1 of the speed controller via a floating contact.



*“RGE” three-phase speed controller - interior view*



Wiring diagram three-phase "RGE"

For three-phase "RGE" speed controllers, contacts "S1" and "S2" are provided. If these two contacts are shorted, 3~"RGE" will also operate at maximum speed. This floating contact can be closed or opened either with a manual switch or a pressure switch.

The use of a manual switch will facilitate routine servicing. For cleaning the condensing coils with nitrogen, the manual switch can be set to the position "on" (speed controller bridged). Operation at full fan speed helps to permanently remove the dust from the condenser which is blown out of the condensing coils into the space between the condensing coils and fan.

The second arrangement using a suitable pressure switch would not be very practical for normal operation (at an excessive condensing pressure, the phase controller would automatically switch to full speed), but could play an important role with regard to additional operating reliability. The pressure switch must be set to a comparatively high switching value - slightly below the cut out point of the high pressure switch - allowing it to intervene only when an error occurs in the speed controller. This is normally not necessary, but conceivable for particularly important and sensitive refrigerated products.

### Minimum speed

In addition to this manual override, which requires a wiring arrangement, a large number of phase controllers also allow the preselection of a minimum speed. Selection can usually be made between the option "minimum speed" and "complete cut out at a specific minimum speed". If preference is given to the minimum speed option, the fan motor continues to operate at

the minimum speed selected by the speed controller even if the condensing pressure decreases further.

This variant (there are "RGE" controllers that combine both operating variants in one unit which can be preselected with a switch or there are also "XGE" controllers where the mode must be defined when being ordered) is particularly suitable for condensing units on which no 100% suction gas cooled compressors are installed.

This applies to Danfoss condensing units with black reciprocating compressors. The "minimum speed" mode thus ensures constant minimum air movement via the compressor. This light air flow is totally adequate for compressor cooling.

The second option is to cut out the motor below a specific speed. This has the advantage that the set pressure (condensing pressure) is not decreased. A disadvantage is slightly irregular operation, particularly in transition times. Times of lower ambient temperatures. Here, frequent starting and stopping occurs, which can be more of a nuisance to residents than continuous operation of the fan at a moderate speed.

### High IP degree of protection

As condenser fan speed controllers are preferably installed outdoors, a high IP degree of protection must be ensured. A high IP degree of protection means that the power electronics in the phase controller are well protected against moisture and fine dust.

A degree of protection of minimum IP54 for outdoor use must be ensured. "RGE" speed controllers have the degree of protection IP54. The "5" in the "54" means that they are "dust-protected".

The "4" as the second digit indicates that the unit is protected against splashed water. For use under particularly harsh conditions, "XGE" can be used with the degree of protection IP65. This is a very high degree of protection as the "6" stands for total "dust-proofness". The unit ("5") is even protected against water projected from a nozzle.



IP54 - three-phase "RGE"

### Preview

In this edition we have concentrated on controlling the fan speed to keep the condensing pressure at a constant level. The next edition will deal with how suction pressure can be controlled by stopping and starting compressors. Read more in the next "Fitters Notes" - Part 15 "Pack controllers".



Pack controllers