Implementation possibilities for efficient cooling of 19" cabinets

By Nicole Jeroschewski, Heitec

This article clearly shows the demand for good planning of cooling solutions in the cabinet area. This is no longer just about planning to be as cost-efficient as possible. Electronics and with it the dissipation of heat from the cabinet becomes more and more complex. It is no longer sufficient to take a look at the investment costs only.

The miniaturization of electronic components always results in the generation of heat in devices and thus in 19 "cabinets. More and more components are being installed in narrower spaces, but the heat loss performance of the individual modules is usually not reduced accordingly. On the contrary, miniaturization is creating more and more power dissipation in ever smaller spaces. This leads to a continuous heat development in the cabinet. The result is shortened lifetime of the components due to excessive heat stress. Electronic components installed in a 19 "cabinet are generally designed for a maximum operating temperature of 50 °C. The lifetime already doubles when the prevailing temperature is reduced by 10 °C. Therefore, cooling – whether passive or active – is essential for most applications today. There is a myriad of cooling solutions, which is why one has to choose from case to case which of these solutions brings decisive advantages for the respective application. The use of air/water heat exchangers is an option to cool cabinets. But also, the use of various cabinet coolers, such as side climate modules, roof-mounted cooling units or fan trays is a common approach to get cool air to the electronics and the heat out of the cabinet.

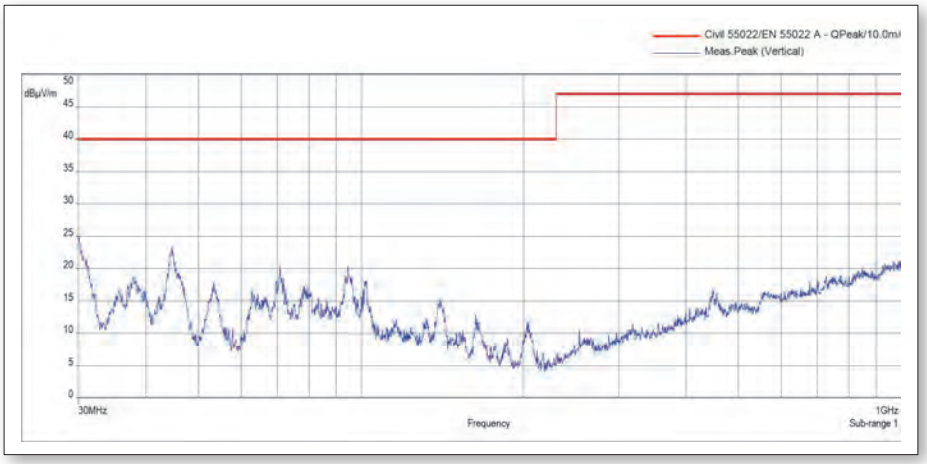
With air/water heat exchangers, the highest cooling performance can be achieved in the smallest possible space. The cooling of the air inside the server cabinet is executed in such a way that the power dissipation from the cabinet is released via the heat exchanger to the water and led to the outside. This way, a cooling performance of up to 10kW can be achieved. The maintenance effort of this cooling solution is relatively low, but with the use of air/water heat exchangers, high infrastructure requirements are associated, which of course have an impact on the costs. IP protection of these devices is usually at an IP value of 55, which provides a fairly high level of protection.

Side climate modules are used in cabinets specially prepared for this purpose – therefore, the installation is not possible at any time in any control cabinet and the installation costs are also not negligible. However, these air conditioning units produce a cooling performance of up to 3.5kW and are thus accompanied by a cooling potential that is not to be underestimated and which is required in many applications.

Roof-mounted fans are often used in cabinets when the warm exhaust air is to be sucked up and blown out of the server rack. These are very efficient in their cooling performance, but their installation is partly cost-intensive and furthermore, hotspots (air areas with conspicuously high temperatures), which predominate directly in the cabinet, are not prevented very reliably. However, the advantages of roof fans are obvious when it comes to saving space in the cabinet itself. With 43, the IP protection of roof fans is in the middle range.

Fan trays have the advantage that they can be used specifically where the heat must be dissipated – so, hotspots can be directly cooled or prevented. However, it has to be accepted that one or the other height unit in the cabinet is used up for it. If the heat generation in the cabinet is manageable, it is not necessary to deploy an expensive cooling solution. Often complex cooling solutions are needed, which are accompanied by an expensive infrastructure. Nevertheless, for certain application areas, using a simple fan module is still the best solution. In most cases it can be retrofitted easily in the cabinet and is often also the much cheaper alternative. Therefore, before installing expensive cooling solutions, one should always think about how much cooling power is actually needed. With an IP protection value of 20, the protection performance is rather low. But since fan trays are installed directly in the cabinet, the protection that the cabinet itself offers is more important at this point.

With a review of the various cooling options that can be found, one quickly realizes that there is rarely a blanket statement to ensure that there is a cooling solution for cabinets



The electromagnetic compatibility of the cooling is also verified in the course of product release.

which is always cost and energy efficient. Therefore, an accurate analysis of the application is generally unavoidable. Factors such as the required IP protection and the required cooling performance are the values that should be looked at in more detail firstly.

The type of cooling solution that should be used also depends on other factors, such as the ambient temperature and the maximum permissible internal temperature of the cabinet. The ambient temperature has a decisive influence on the heat or the effective cooling in the cabinet. Temperature changes in the environment are detectable inside the cabinet one to one. Therefore, if possible, the cabinet should be set up in a place with lower ambient temperature, to keep the energy expenditure for the air conditioning as low as possible and in consequence, to keep the operating costs low as well. This logically results in the installation location. As expected, the most favorable thermal conditions arise for a free-standing single cabinet, so that heat can be emitted to the environment through all free surfaces via radiation and convection.

The component compactness – the distance of the components in the cabinet to each other – also plays a significant role in the heat development in the cabinet and in the emergence of so-called hotspots. Thus, in any case precise planning of positioning not only makes sense from a purely functional perspective. Furthermore, care must be taken to ensure that no bulky and large-scale components impede the suction of hot air from the interior of the cabinet to the outside, thus preventing undisturbed influx of cold air into it. In principle, cold air flow of all cooling solutions should always be directed near the most powerful components because the greatest power dissipation – and thus the most heat – is produced there. This arrangement ensures that the cold air supply from the deployed cooling solution directly reaches the components without any loss and cools them optimally.

So, not only the choice of the cooling solution needs to be considered. Many factors play an important role. But if you have opted for a cooling solution, it is important to ensure that the air flows are guided accurately and that air circulation is optimized. Not only is this arrangement proven to save energy, which makes a significant contribution to environmental protection in about 3.5 million active control cabinets in Germany – investment and operating costs can also be reduced to a minimum by precisely planning the cooling solution. The selection of individual components can play a decisive role. This is the reason why cooling solutions with low energy consumption are becoming more and more attentive. Even if the investment costs of these components in an energy-saving variant are usually slightly higher than the conventional components, they amortize themselves after a short period of time and are often even the more cost-saving alternative.

The optimal internal temperature of the cabinet is normally at +35°C. It makes no sense to adjust the temperature lower, because at a lower temperature there can be a significant condensation development in the cabinet. In addition, the devices and components forming condensate after cooling has been switched off or the door of the cabinet has been opened are getting undercooled. With its HeiCool Eco for installation in a 19 "cabinet or carrier, Heitec has dedicated itself to the development of a particularly energy- and thus cost-saving fan tray. With just about one quarter of the energy consumption of a conventional fan tray on the market, it is truly beneficial for the user despite its marginally higher purchase price. With a standard price of approximately €0.2 per kWh and an energy saving ratio of 79%, the additional cost for the Eco fan tray is already amortized after about 16 weeks and the use of this cooling solution continues to pay off with every operating hour the HeiCool Eco is in use. This can be decisive from an economic point of view – and in addition to considerable cost savings, companies are making a significant contribution to a positive carbon footprint. Because it is paradoxical – the components in use are becoming more and more efficient, but the cooling solutions required for this have to become more and more powerful, which at the same time makes them very energy hungry. The housing of the HeiCool Eco is made of a high-strength aluminium alloy – which is why the fan tray is also suited for use in the railway sector - and impresses with its high-quality optics and the special design of the air vents. The three energy-saving fans, with an energy consumption of just 4.4W per fan, are particularly low in energy consumption and with a flow rate of 175m³/h in the 230VAC version they are also still at the level of comparable conventional fans. If, for example, the cabinet needs to be cooled by 25K, the fans will be able to cope with a power loss of about 1400W. HeiCool Eco is available for various installation situations. In addition to a 19" variant for the conventional assembly in a 19" cabinet, there is also a version as a slide-in variant, in which the fan tray can be easily inserted and pushed out of the cabinet on a high-quality aluminium frame anytime.

As a specific accessory, a thermostat (adjustable switch-on temperature for the fans) has also been included in the HeiCool program. Air deflectors for intelligently guiding the air flows in the cabinet complete the accessories program. With them, partial streams of cold air can be routed from front to back into thermally critical component space to avoid hotspots. In practice, the function of the air deflectors is such that cold air is sucked in upfront and passed through the subrack. The heated air is then expelled at the rear. These accessories, like the HeiCool Eco itself, are entirely dedicated to the topic of energy efficiency. With them and the thermostat, cooling is aimed to be possible wherever specifically necessary. This not only makes a decisive contribution to the protection of the environment – the purse is significantly disburdened as well.

Adding to the accessories program of Heitec Electronics, there is fan monitoring that reports when one or more fans are no longer working, and a fan control, which is suitable for use in fan trays, among other things. The fan control offers a variety of functions. For example, temperature thresholds can be defined, from which the fans are given a certain rotational speed. Other functions include, for example, an alarm when the maximum temperature is exceeded, as well as a status request via an integrated I²C bus. The modules for monitoring and control can be used for project-specific purposes in systems of completely different dimensions and requirements, too. ■