Installation of Electronic Equipments in the Cabinet

All electronic equipment operate using electrical power and dissipate part of it into heat which is generally removed by the surrounding ambient air and determines an increase in the operating temperature. High operating temperatures reduce their life and increase the probability of failures according to the Arrhenius criteria, for example an operating temperature increase from 25 to 50 °C can cause a failure rate ten times higher.

In a cabinet air circulates and removes heat by convection (natural convection cooling) or, more effectively, by forced ventilation (fans) or even more effectively by refrigerated forced ventilation (air conditioning). Installation of electronics in cabinets restricts free air movement and rises their internal temperature. These effects can be reduced in two concurring lines of action:

- by limiting the power dissipation and the heat produced inside the cabinet
- by encouraging air circulation (and exchange of heat) inside the cabinet

A simple way to improve air circulation is to provide space between the isolators, also installing isolators in horizontally oriented DIN rail rows with the enclosure main surfaces oriented vertically allows better air circulation inside the enclosure and significantly improves heat exchange.

What ultimately determines the operating temperature rise inside a cabinet is the total power dissipation and the provisions available for removing the heat with cool air (natural convection or forced cooling). The maximum power consumption of each type of isolator is specified in the corresponding data sheet so by summing the power of each unit in the cabinet the total power **Pmax** can be easily found. In normal operating conditions however the power dissipated by the installed equipments is not likely to be the maximum value specified for all of them and at the same time, the value of the effective power **Peff** can therefore be considered smaller (typical 70 %) than the value **Pmax:**

Peff ≤ Σ Pmax * 70 %

1) Closed Cabinets with Natural Convection

Closed cabinets are preferred in dusty or harsh environments where they offer a better equipment protection but their heat / power dissipation capability is modest. Heat is removed by air flowing internally and exchanged with the walls of the cabinet, the calculation of the maximum allowed power dissipation in this type of cabinet is:

Pmax = Δt * S * K

where:
Pmax [W] maximum allowed power dissipation
Δt [°C] maximum allowed temperature rise
S [m²] free heat emitting surface of the cabinet
K [W/m² * °C] thermal conductivity coefficient (K=5.5 for painted steel sheets)

As an example a cabinet sized 600x600 mm and 2000 mm high has a temperature rise of 10 °C for an installed power of 250 W.

2) Open Cabinets with Natural Convection

Open cabinets must operate in clean environments, their heat / power dissipation capability is medium.

Heat is removed by air flowing through the equipment, circulating from bottom to top of cabinet (convection). Depending on the type of engineering (freedom of cool air to enter at the bottom of the cabinet, to circulate vertically around the equipment extracting heat and to exit at the top of the cabinet), the power dissipation improvement can be two times better than case 1.

The cabinet must be equipped with inlet and outlet louvers in the lower and upper ends of the cabinets, vertical air flow inside and outside the cabinet must be kept free from obstacles to enhance the “chimney effect” air circulation.

As an example a cabinet sized 600x600 mm and 2000 mm high has a temperature rise of 10 °C for an installed power of 350 W.

3) Open Cabinets with Forced Ventilation

Open cabinets must operate in clean environments, their heat / power dissipation capability is high with forced ventilation

Air is forced into the louvers on the bottom of cabinet, flows through the equipments, and finally exits at the top of the cabinet, where generally is forced by one or more fans. The calculation of the required airflow is:

Q = 3.1 * Peff / Δt

where:
Q [m³/h] is the required airflow
Peff [W] is the dissipated power (typical 70 % of the maximum power dissipation)
Δt [°C] is the maximum allowed temperature rise in the cabinet

As an example a cabinet sized 600x600 mm and 2000 mm high has a temperature rise of 10 °C for an installed power of 500 W.

4) Closed Cabinets with Forced Ventilation and Heat Exchanger

Closed cabinets with forced ventilation are preferred in high dissipated power and harsh environment where natural convection cabinets cannot be used. Hot air is extracted from the cabinet by a fan, cooled by a heat exchanger (using a cooling fan with ambient air) and forced back into the cabinet; depending on the type of engineering the improvement can reach a 5 times higher power dissipation than in case 1.

As an example a cabinet sized 600x600 mm and 2000 mm high has a temperature rise of 10 °C for an installed power of 1000 W.

5) Air Conditioned Cabinets

Air conditioned cabinets are preferred in hot climates and / or harsh environments.

Cabinet temperature can become equal or even lower than the ambient temperature. A specific refrigerating system or the existing air conditioning system can be used for cabinet conditioning.

As an example a cabinet sized 600x600 mm and 2000 mm high has a temperature rise of 10 °C for an installed power of 1000 W.

Power Dissipation of D1000 Series Isolators

Data sheets of each D1000 isolator specifies the current consumption (maximum current from the nominal power supply, typical 24 Vdc, in normal operation); this data serves to dimension the current rating of the power supply unit. Data sheet indicates also the maximum power consumption (maximum power required from the power supply in the worst (abnormal) operating conditions like for example supply voltage at 30 Vdc, short circuit on the outputs and on the inputs terminals.

The power dissipated **Pd** inside the enclosure for analog signal isolators is:

Pd = Current Consumption (A) * Supply Voltage (V) - Power Dissipated into the input/output loads

Analog signal isolators have higher dissipation than digital signal isolators, in addition multi-channel barriers (2-4 channels) have higher dissipation than single channel units. As an example in analog signal isolators each transmitter requires and dissipates 15 V * 0.02 A = 0.3 W. Usually the loads outside the isolator dissipate 1/3 of the total power used.

Isolators are not running at the maximum current all at the same time, the average power consumption of a multitude of isolators can be considered to be only 70 % of the value obtained from the data sheet. Considering the 1/3 load power and the 70 % above discussed, the power effectively dissipated internally by the isolators can therefore become ½ of the actual power delivered by the power supply.

Digital barriers dissipate all the supply power inside the enclosure consequently the total power dissipation into a cabinet, with mixed analog and digital barriers, is determined by the number of channels more than by the number of isolator enclosures.

The following tables give advises for the DIN rail orientation (vertical or horizontal) of the barriers mounting and for single or multi-channel isolators, installed on DIN rail, bus or custom board assembly.

A) Cabinet with Natural Ventilation

Maximum recommended ambient temperature in °C as a function of barrier type and installation method:

Type of Isolator and Number of Channels	Installation as a Single unit	Installation in Multi units DIN Rail Bus		Installation on Custom Boards	
	any orientation	Vertical	Horizontal	Vertical	Horizontal
1	60 °C	30 °C	35 °C	35 °C	40 °C
2 - 4	60 °C	Not recom.	30 °C	30 °C	35 °C
D1012Q PSD1001C	60 °C	Not recommended *		Not recommended *	

B) Cabinet with Forced Ventilation

Maximum recommended ambient temperature in °C as a function of barrier type and installation method:

Type of Isolator and Number of Channels	Installation as a Single unit	Installation in Multi units DIN Rail Bus		Installation on Custom Boards	
	any orientation	Vertical	Horizontal	Vertical	Horizontal
1	60 °C	40 °C	45 °C	45 °C	50 °C
2 - 4	60 °C	Not recom.	35 °C	40 °C	45 °C
D1012Q PSD1001C	60 °C	Not recommended *		30 °C	40 °C

* operating isolators in not recommended conditions significantly shortens its life and increases the probability of failures.

A more exhaustive discussion of cabinet engineering styles and optimum installation of isolators can be found in Application Note APN0029.