Technical Article

Putting the data into power supply data sheets

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Why is it that seemingly similar power supplies have significantly different performance and reliability characteristics? The answer may lie in the specification detail that can be missing from some data sheets, available only in the long-form data/application notes or may even be due to “specmanship”.

For this exercise we’ll look at typical data for an ac/dc power supply though many of the issues may equally apply to dc/dc converters.

Input Characteristics

Input voltage range

AC/DC power supplies are typically universal in nature, meaning that they operate over a wide range of input voltages, normally from 85 or 90 VAC up to 264VAC. This feature allows a single product to operate world-wide without changes in configuration of the input stage. Some products utilise automatic input voltage range selection giving two operating ranges; typically 90 to 132VAC & 180 to 264VAC. Universal input power supplies provide better immunity to supply disturbances in some circumstances and this may be a benefit.

If the power supply is to be used close to its full power capability within the application it is important to check the specification details on the available output power in the low input voltage area, where some products de-rate by as much as 20 or 30%, meaning that they may be operating outside of specification when operating from nominal 100VAC or 115/120VAC supplies or at the very least may infringe the design margins of the end equipment. Ignoring this de-rating in the available output power will seriously affect the reliability and life time of the power supply and therefore the end equipment.

De-rating the power supply output power at low input voltages is common in lower cost universal input power supplies and is normally due to the limitations of the active power correction boost converters employed.

Earth leakage current

Earth leakage current is a parameter which varies widely from product to product. The earth leakage current is largely a consequence of EMC filtering within the power supply and is normally only a key consideration in medical applications, equipment using multiple AC/DC products or where external EMC filters are utilised to reduce overall system noise.

Inrush Current

A key consideration affecting the selection of fuses, filters and switchgear is the inrush current at the point of application of the AC power. The maximum inrush current is usually specified in the data sheet however there is more to this than a simple maximum value.

In lower power, lower cost products the inrush limiting is typically via a simple NTC thermistor which will provide protection from a “cold start” but may take a minute or more to return to its initial value following the initial switch on. This results in an inrush current many times the specified maximum during an off/on cycle even with a relatively long delay. The inrush current is also likely be specified at 25 degC and may be significantly higher even for a cold start in higher ambient temperatures.

In products above a few hundred watts, this thermistor is likely to be taken out of circuit once the output voltage is established, to remove unnecessary power dissipation, removing this as an issue.

Inrush current is an important factor to be considered to avoid nuisance tripping of fuses and circuit breakers as well as reliability of switches and filtering. The fuse rating given in some data sheets is usually the rating of the internal fuse which is designed to operate only in the event of catastrophic failure and is not user replaceable. Determining the value of the equipment fuse needs to take into account the normal maximum running current, the inrush current and the effects of aging. The equipment fuse should also only be required to operate under catastrophic failure conditions as the electronic power supply overload protection will cater for any problems on the DC side.

Output characteristics

Overload protection

All power supplies offer overload protection to protect both the power supply and the load tracking and wiring from overheating. This may come in a number of different guises or characteristics.

In low power products a trip and restart or “hiccup” mode is common as this helps to keep costs down by utilising primary control schemes. Trip & restart overload schemes are generally unsuitable for loads involving high start up currents such as electromechanical equipment, lighting equipment or applications which have a high capacitive element, as start up may be unreliable and variable even from unit to unit. This overload characteristic is also unsuitable for direct battery charging applications. With these types of load a constant current overload characteristic is desirable.

Remote Sense

Low voltage high current applications will benefit from products which offer remote sense where the output voltage can be measured at the point of load. This feature is particularly desirable where the load is variable. If the load is relatively constant then a simple user adjustment of the output voltage will be adequate and more readily available though may result in other voltage rails also being adjusted by the same percentage in multiple out supplies where the additional rails are often semi-regulated.

Output accuracy and minimum loads

Output accuracy or regulation is specified in many different ways by various manufacturers. It should encompass line regulation, load regulation, cross regulation (for multiple output supplies), transient response, initial set accuracy and temperature coefficient. These parameters can be specified over differing input ranges, load ranges, load step changes and temperature ranges etc. While these items can be presented in many ways the majority of single output supplies will have comparable performance. Perhaps the most important consideration is for multiple output units where the performance can be very different.

Single output power supplies rarely require a minimum load but multiple output units often require minimum loads on one or more outputs and this should be made clear on the product data. Minimum loads are normally specified to reduce the effects of cross regulation between outputs and to maintain the output accuracy within the specified limits. These minimum loads will need to be considered in the system design and where necessary components added to ensure that they are met.

As standby/no load power consumption requirements reduce, the addition of minimum loads is becoming a real system performance issue and other solutions are required, particularly in low power applications where features such as inhibit are rare due to market cost requirements and the primary control systems in general use.

Output ripple & noise

Ripple & noise is one of the product performance specifications which is most open to interpretation, making comparison from the data sheet difficult if not impossible. The main variables are the measurement bandwidth and the use of various external components and measurement techniques. The only real way to compare performance is to measure the products under the same measurement regime.

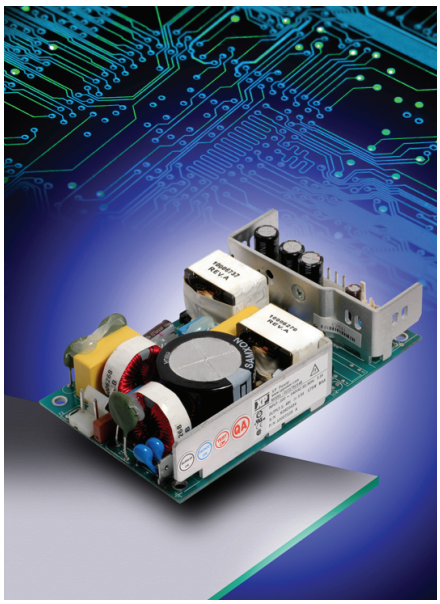
Efficiency

Most data sheets will offer a figure for efficiency allowing the user to quantify the waste heat generated within the end equipment. The efficiency of a power supply will vary dependant on the load and input voltage applied, so it is important to understand the units efficiency under the operating conditions of the application. Efficiency during operation at low line is typically lower than at high line and may vary by as much as 6-7%. The most important parameter is the worst case efficiency in order to understand the maximum waste heat generation by the supply.

The drive in power supply development is to increase efficiency in order to reduce the physical size of the product and reduce power consumption. This is also being driven by the standby/no load power and average active efficiency requirements set out in legislation such as Energy Star, CEC, EISA and EUP.

Power density specifications are being increasingly used by power supply and dc/dc converter manufacturers to convey advancement in power technology & efficiency. If these watts per cubic inch specifications are compared it is essential to ensure that the products have similar specifications and do not require external components to meet various specification requirements.

Reliability, Temperature & Cooling



The 3" x 5" CLC175 AC/DC power supply from XP Power is capable of delivering its 175 W full load output with only 10 CFM airflow

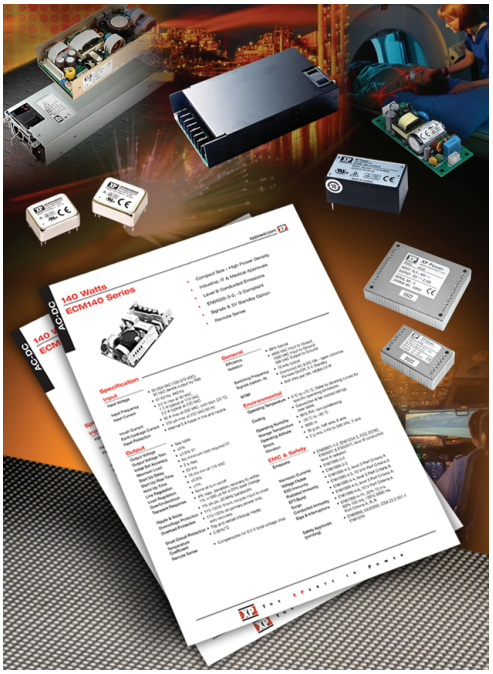
The normal measure of reliability of power converters is given as Mean Time between Failure (MTBF). The MTBF is normally calculated based on the predicted failure rate of the components utilised within the product, a so called parts count method. When comparing the MTBF of various supplies there are a number of key parameters to check to ensure that the specifications are indeed comparable. Firstly the methodology needs to be identical; typical methods are MIL217 at its various issue levels and Bellcore RPP (now managed by Telcordia Technologies). These two methodologies will give very different results and cannot be compared to one another. Where the MTBF is given to the same specification then in order to be compared it must also be stated under the same environmental conditions to prove a useful tool to the system designer.

The most influential factor in terms of reliability and lifetime is the ambient temperature and effective cooling of the power supply. Convection cooled products need adequate space to cool effectively and forced cooling requirements need to be carefully considered to ensure that the product is adequately cooled in the specific application. Manufacturers are increasingly providing key measurement points within the sub assembly to ensure that the product will be both safe and reliable and to ensure adequate lifetime. Thermal de-rating data is normally provided up to ambient temperatures around 60 to 70 degrees C. Careful consideration of this data is required since some products de-rate from as low as 40 degrees C. For example, most power supplies from XP Power de-rate from a minimum of 50 degrees C, some from 60 degrees C. Also, be aware that while a unit might be specified to operate at an ambient temperate of, say, 40 degrees C, when the unit is enclosed within end-user equipment the internal temperature can be much higher than that.

Airflow is another important consideration. Be aware that some products may specify an airflow rate that might be difficult to achieve in practice e.g. 20 – 30 CFM. As a guide, look for a required airflow less than 15 CFM. Typically, XP's products require 10 – 13 CFM.

EMC

Datasheets include EMC specifications. Open frame products include conducted emissions and conducted immunity specifications with some providing information on radiated emissions and radiated immunity, some may require additional components to meet the stated performance so these should be considered when selecting the product for the application. External power supplies must provide specifications for both conducted and radiated EMC performance as these are considered stand alone products. Typically the products are evaluated using passive loads in an ideal test set-up which is unlikely to be replicated in the end application so choosing a supply with local engineering support and test facilities will be an advantage during the end product development.



In summary, power supply and dc/dc converter data sheets contain a lot of information which needs careful consideration when applied to the end application. The data is generated with the power supply or converter in isolation and in some instances additional components are required to meet the various parameters. Cooling and de-rating information may differ significantly between products though this is not always apparent in short form data and efficiency data is normally given under best case rather than worst case conditions. How well the power supply performs in the end application is the key consideration and a study of the long form data and application notes will often provide the detail required to select the best power solution for your system.

XP's Power Supply Technical Guide is a free 148-page guide to power system technology. It is available to download free-of-charge at www.xppower.com

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