XP Power

TECHNICAL ARTICLE

AN INNOVATIVE TOPOLOGY FOR 24 HOUR TURN-ROUND OF CUSTOM CONFIGURED PSUS

Power supplies are traditionally the last sub system to be specified and the first to be needed for system prototype testing. They are also frequently impacted by late changes elsewhere in the system, whether by the need for more current, or even for additional voltages, and designers have traditionally struggled to balance project budgets and the need for fast time to market, where custom designs become inappropriate.

As companies focus on core competences designing PSUs in-house has become less attractive, even when using building-block modules or combining multiple self-contained units. What is needed is a flexible topology that can be configured to customer requirements, using off-the-shelf tested and proven modules, and shipped as a complete sub-system.

This article explores an alternative approach to this problem that simplifies configuration while assuring full agency approvals, even for medical equipment. The result is not a kit of parts but a complete, configured and tested sub-system using versatile packaging to accommodate up to ten outputs and with a wide mix of output voltages and currents. This production-ready topology also enables maximum benefit to be gained from combining innovative Western design with low cost module manufacturing in the Far East and local final assembly.

A Different Approach

Using DC-DC modules as building blocks can produce configurable power supplies but in many applications it is issues of heat, mechanics, control and monitoring that need customisation. It's just these aspects that designers have to sort out for themselves. Although standard brick DC/DC modules handle raw power conversion design work is still required to create the power sub-system.

True configurability revolves around dividing the system into two parts: input and output. Within its total power rating, the input section is capable of supplying any number of customer-specified output combinations. Each output is specific for a given voltage and maximum current. Many technical and commercial issues influence the division between input and output, perhaps nowhere more crucially than at the transformer. Unfortunately, building the transformer primary as part of the input and making the secondary part of the output module means that every configuration requires assembly of a custom transformer. XP's uses a different topology that allows for easy local configuration at recognised centres around the world, with units despatched within 24 hours from receipt of order. XP resolved the problem by separating input and output at the off-line 380 VDC rail, making each module fully testable electrically, and making configuration a simple plug-in exercise. The input includes protection, EMC filtering and power factor correction, together with a boost converter, to deliver stabilised bulk power at 380 V DC from mains input between 90 – 264 V AC, 47 – 63 Hz. Although different models can support different combinations of output sections, depending on their power rating and physical size, modules will fit in any chassis within a family, using a mechanical and electrical interface. This has the additional benefit that as new output modules are added to the current list of 147 single, dual and triple voltage models, they become immediately useable with any input stage in their family.

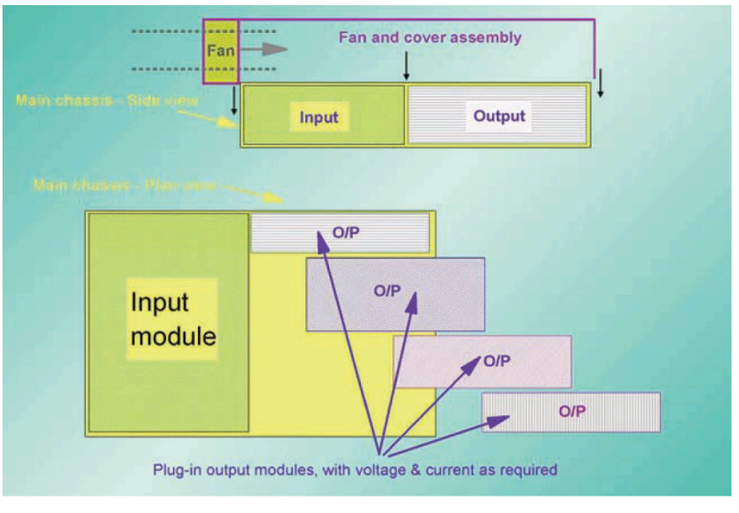

Figure 1

Taking the Heat

As equipment gets smaller, waste heat remains a key consideration for any PSU sub-system so thermal and mechanical design is critical to flexibility. To emphasise the importance of packaging, lower power models using this topology are designed to fit within a 1U system chassis and are just 39.7mm high, despite offering configurable power up to 350 watts in total. The same thermal design has been applied to higher power models, enabling the enclosure of a 2,000 W multi-output, configurable PSU with less than 124 mm overall height.

Each complete PSU consists of three elements (Fig 1):
1) Main power chassis
2) Cover and fan assembly
3) Plug-in output modules

Input power conversion, protection and filtering is included in the main chassis which also provides the plug-in location for the output modules. It is designed to deliver maximum airflow through the plug-in modules, irrespective of configuration. Chassis and module construction both provide a rigid, flat interface for mechanical location and efficient thermal management. Although the higher power models combine the cover and fans into the chassis, lower power chassis may be supplied without the fan and cover, further reducing cost where forced air is available within the end equipment or system. Each module design optimises the balance of conduction and air-flow cooling. For example, the "A" sized 5V / 20A module uses a simple L-shaped sub-chassis, whereas the "C" sized 5V / 100A module incorporates a substantial extruded heatsink, but all within the same height and length.

Single output modules

VOLTS	CURRENT	VOLTS	CURRENT	VOLTS	CURRENT	VOLTS	CURRENT	VOLTS	CURRENT
2.0 V	20.0 A	2.2 V	20.0 A	3.0 V	20.0 A	3.3 V	20.0 A	5.0 V	8.0 A
	35.0 A		35.0 A		35.0 A		35.0 A		20.0 A
	60.0 A		60.0 A		60.0 A		60.0 A		35.0 A
	100.0 A		100.0 A		100.0 A		100.0 A		60.0 A
									100.0 A
5.2 V	8.0 A	5.5 V	8.0 A	6.0 V	17.0 A	8.0 V	12.5 A	10.0 V	
	20.0 A		20.0 A		23.0 A		20.0 A		10.0 A
	35.0 A		35.0 A		50.0 A		37.5 A		18.0 A
	60.0 A		60.0 A		80.0 A		60.0 A		25.0 A
	100.0 A		90.0 A						
11.0 V	4.0 A	12.0 V	4.0 A	14.0 V	3.0 A	15.0 V	3.0 A	18.0 V	11.0 A
	10.0 A		10.0 A		8.0 A		8.0 A		17.0 A
	18.0 A		17.0 A		14.0 A		13.0 A		27.0 A
	25.0 A		25.0 A		20.0 A		20.0 A		
20.0 V	7.0 A	21.0 V	2.0 A	28.0 V	6.0 A	30.0 V	5.0 A	33.0 V	4.0 A
	10.0 A		6.0 A		7.0 A		7.0 A		6.0 A
	7.0 A		8.0 A		14.5 A		11.0 A		11.1 A
	21.0 A		17.0 A		18.0 A		16.0 A		14.0 A
			21.0 A						
36.0 V	4.0 A	42.0 V	3.0 A	48.0 V	3.0 A	54.0 V		60.0 V	
	6.0 A		5.0 A		4.0 A		2.5 A		2.0 A
	11.1 A		8.5 A		8.5 A		4.0 A		3.5 A
	14.0 A		10.5 A		10.5 A				

Table 1.

Dual & triple output modules

OUTPUT V1	OUTPUT V2	OUTPUT V1	OUTPUT V2	OUTPUT V3
12V @ 4A	12V @ 4A	5V @ 20A	12V @ 2A	12V @ 2A
15V @ 3A	15V @ 3A	5V @ 20A	15V @ 2A	15V @ 2A
12V @ 4A	5V @ 8A	12V @ 10A	15V @ 2A	15V @ 2A
15V @ 3A	24V @ 2A			
24V @ 2A	5V @ 8A	300 – 350 W; 1 to 3 modules		
5V @ 8A	5V @ 8A			
24V @ 2A	24V @ 2A	400 – 600 W; 2 to 4 modules		
5V @ 10A	12V @ 10A			
12V @ 10A	12V @ 10A	800 – 1000 W; 3 to 6 modules		
5V @ 10A	24V @ 5A			
15V @ 8A	15V @ 8A			

Table 2.

The flexibility of this modular topology is apparent when considering the MP series of power supplies. There are currently 112 single, double and triple output modules that use only three mechanical formats across the whole range. Every MP chassis from 300 to 2,000 W can handle every module format. Thousands of configurations are possible based on the options shown in Tables 1 and 2.

Design Flexibility

A 15 V supply adjusted to 12 V is still capable of its maximum current rating at 15 V. This means that 20% of its space and capability could be redundant if not used. In order to avoid this while maximising power and space efficiency, each module features optimum output adjustment and is available at 25 different voltage levels between 2.0 V and 60 V. To further increase space efficiency dual and triple output models are available, offering either multiple voltages (e.g. 12 V, 12 V & 5 V) or a single voltage (e.g. dual 5 V). The LP series, for example, offers 23 different multiple output modules. Since all outputs are fully floating, it is also possible to series connect outputs to further enhance the flexibility and capability of the power system.

A recent application example of this is where a customer required +10V, +12V and +36V outputs. These were supplied from an off-the-shelf module with standard rails of 24V, 15V & 5V as shown in Fig.2.

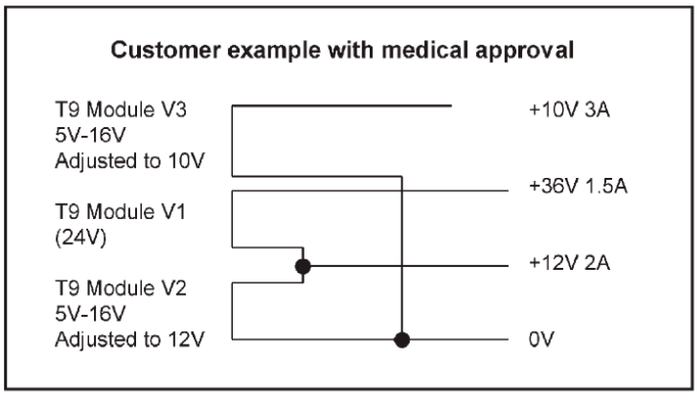

Figure 2.

Over-voltage, over-current, remote sensing, current sharing, remote inhibit AC and DC OK signals, together with 1% ripple, 1% load regulation and 0.1% line regulation performance are included as standard to meet most requirements. Customised modules can also be developed for higher volume applications, while still using standard modules wherever possible to minimise overall PSU costs.

What can you do with it?
As well as avoiding the engineering costs of custom PSU design, the flexibility of a locally configured power supply can clearly reduce the time, cost and risks normally associated with changes to power requirements. However, it is useful to remember that these changes can come from three sources:

1) Last-minute changes in system design
2) Updates or upgrades later in the system life-cycle
3) System functionality configured to individual customer requirements

With configuration and burn-in test requiring only 24 hours for sample quantities, designers can ensure that the PSU configuration matches the latest system needs, yet when specifying today's requirement, they can be confident that future system upgrades will not make the whole power supply obsolete. As system builders look more closely at lifetime costs such built-in future proofing can be an important benefit for end-users.

There can be benefits to OEMs' end customers too

Using the configurable power topology described, a supplier of laser surgery equipment, for example, is able to benefit their customers who can select only those functions that they need from their laser system to minimise cost, confident that this can be reflected in the power supply fitted to their equipment. Cost is controlled, since unnecessary PSU capability is avoided, but if the customer wants to upgrade or amend the system the PSU configuration can be simply reworked accordingly. In another instance, a medical company cut costs by replacing a custom power supply with a configurable solution, working with XP to develop a custom cable harness that would fit into the existing application.

Summary

Whether it is to meet low volume needs, where engineering costs for conventional custom designs are hard to justify, or where volume requirements contain variation or uncertainty and where time-to-market is key, the architecture described provides the flexibility to configure multiple output PSU sub-systems and to deliver complete, tested and fully safety approved (UL, CSA & TUV) units in 24 hours. In-house design, and a dedicated local configuration facility, ensures that designers have access to the level of technical support they demand, while the topology enables maximum benefit to be gained from low-cost Far East manufacture of all sub-assemblies. The result is a flexible configuration service delivered at competitive cost and with built-in future proofing.