Redundancy, DC UPS, Buffer Modules & DC/DC Converters
How to Increase the Reliability of the 24V Bus Voltage

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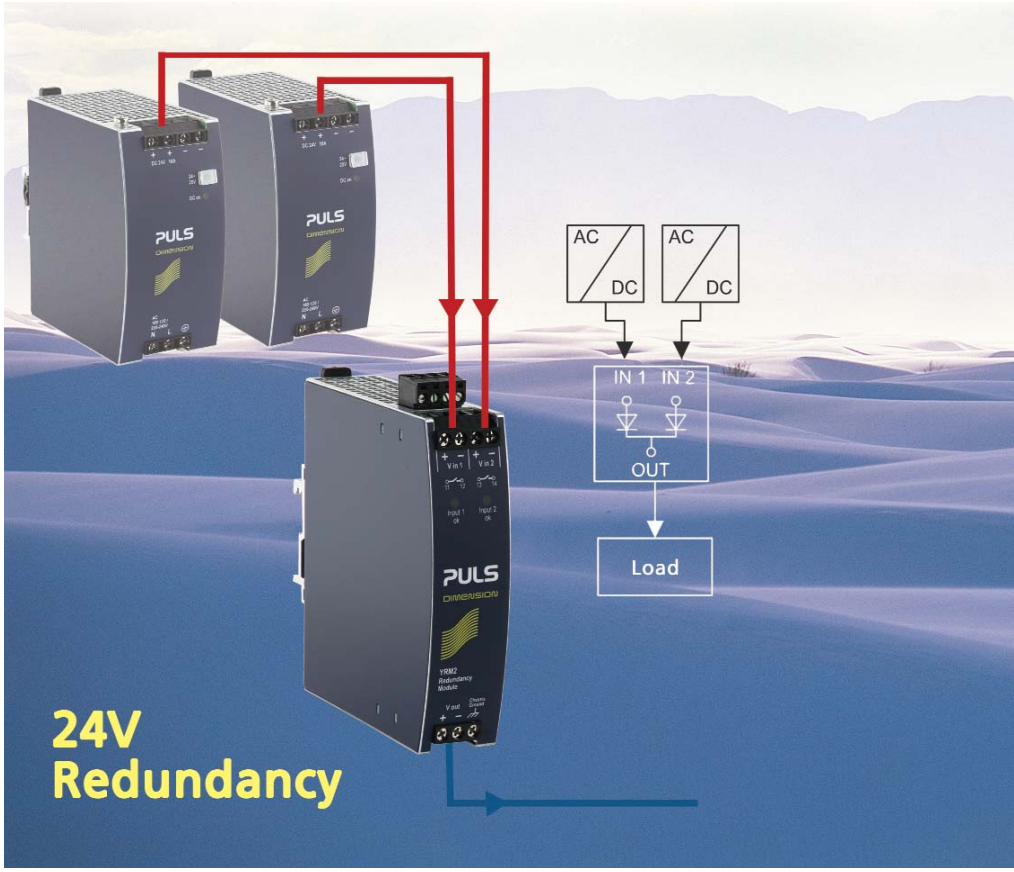
Power supply units are like the human heart. Your heart keeps your body working just as a power supply keeps the control system operational. Each does its core function with little need for attention. However, when a problem occurs immediate action is required in order to keep the system alive. Control systems are becoming more and more complex and sensitive and if the 24V power supply fails, the whole system shuts down resulting in loss of data, system down time or a long restart process.
All of these conditions lead to lost production and higher costs.



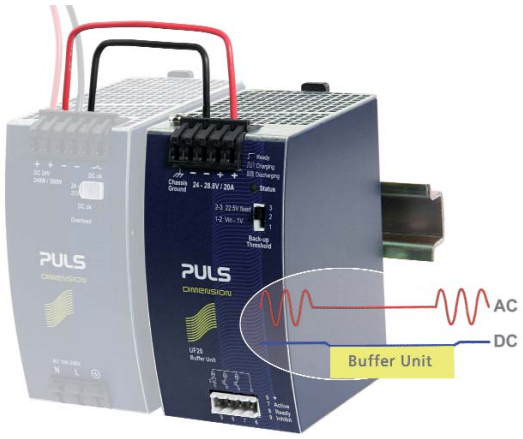
Basic requirements for a reliable 24V control system start by using robust and sufficiently sized power supply units with a properly configured wiring scheme. Other devices can also be added in addition to the power supply to help improve the reliability of the whole control system. This application note describes the way these additional devices function. The following three reasons are the most frequent cause for why the power supply can no longer provide voltage to the load:

1) Temporary failure of the input voltage such as a power outage or upstream protective device being triggered.
2) Failure of the power supply itself.
3) Temporary output voltage dip or loss due to short-term high power consumption loads such as motors.

Uninterruptible power supplies (DC UPS):
DC UPS's bridge temporary mains failures, voltage fluctuations or unexpected system shutdowns. If the mains voltage fails, the DC UPS along with a battery, takes over the load current and can buffer it for an adjustable length of time. The duration (buffer time) depends on the size of the battery. The most popular type of battery

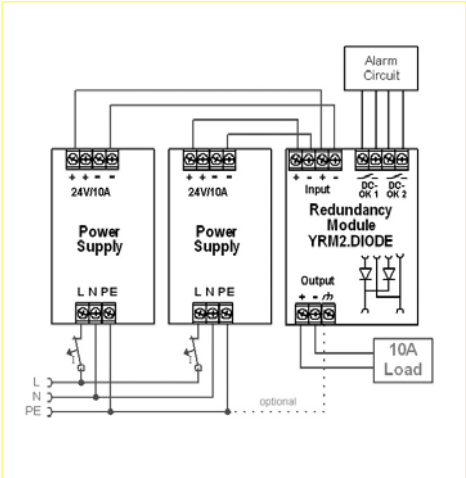
for this purpose is still the maintenance-free AGM battery because of its low cost and worldwide availability. But watch out – maintenance-free doesn't mean you can ignore them. These batteries can age very quickly and must be replaced periodically. If regular inspections do not occur, then the battery may not work when needed. It is important when choosing a DC UPS to look for an unit with the following features; supplies the batteries with an exact end-of-charge voltage, has a deep-discharge-protection included and is equipped with a buffer time limit which prevents the battery from being discharged too much. These functions help the batteries reach their maximum possible service life. Because two batteries connected in series have inherent problems, PULS offers the UB10 series for this purpose, which only needs a single 12V battery to buffer 24V. The „single battery concept" allows even more precise battery management, which provides the longest battery service life possible.

Capacitor-supported buffer modules
Statistically, 80% of mains power failures are interruptions in the voltage lasting up to 200ms. These are caused by switching operations in the power networks, by overloads in adjacent circuits or as a consequence of lightning strikes. These short failures do not matter for non-sensitive loads such as light bulbs, but they can cause electronic equipment to drop out completely. These short failures can be bridged by means of capacitors and handled without the maintenance of batteries. For this purpose, PULS offers the UF20 series buffer modules for 24V and 48V supply voltages. While the power supply unit is providing voltage, the internal electrolytic capacitors are charged to approximately 200Vdc and stores the energy. If there is a mains voltage failure, this stored energy is then released in a regulated process to the load. Both models can provide load currents up to 20A but at 24V, 20A or 48V, 10A you have a guaranteed buffer time of 200ms (typically 310ms). This time is even longer for lower load currents. Thanks to the electrolytic capacitors, the PULS buffer modules are maintenance- and service-free, simple to operate and do not need control wires. The units are simply connected in parallel to the load. To gain longer buffer time or to increase the buffer current, multiple units can be connected in parallel. Buffer modules supply energy in addition to the power supply unit. If for

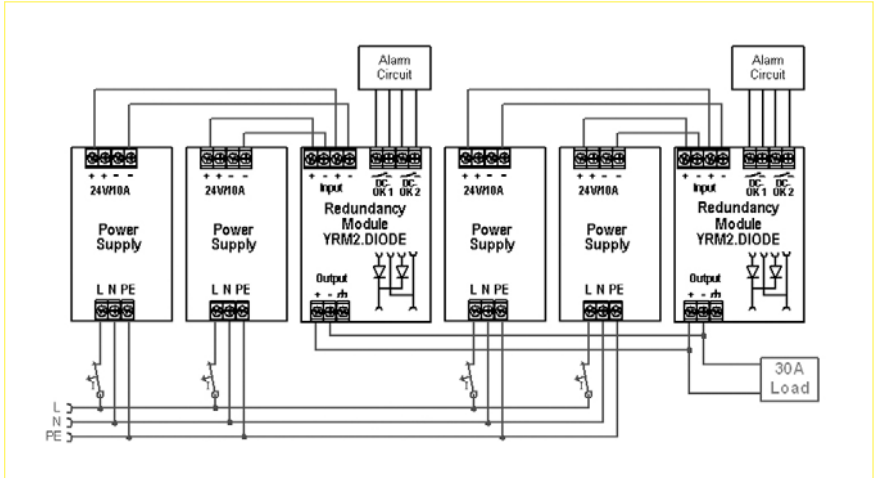


example, a device is connected and draws a high starting current, the additional stored energy from the buffer module helps prevent the voltage from dipping.

Redundant systems:
Redundancy means „duplication for reasons of safety": In a nuclear power station there is a back-up system for each of the most important control systems. An airplane has two redundant systems, even if one would suffice. Faults in such systems can result in severe consequences. In these cases redundancy create safety. Even if the consequences in industrial control systems are not as serious as in airplanes or nuclear power stations, redundant systems improve the reliability of the system and prevent economic losses. Redundancy does not stop at the control devices but the power supply must also be configured for redundancy. For a power supply, redundancy in simplest terms is two units connected in parallel, each capable of handling the load by itself. This scheme is known as 1+1 redundancy. For higher power requirements there are also n+1 redundant systems. In this case for example, 30A is required and four 10A units are used to operate the load. If a unit fails, the other 3 units can continue to safely supply the system with power. In basic terms redundant power supply systems are



1+1 redundant system for 10A



n+1 redundant system for 30A

individual power supply units connected in parallel. However, it is important that the power supply units are isolated (decoupled) from each other by means of diodes and each unit has its own independent monitoring circuitry (e.g. DC OK signal). For redundancy, it is not important for the current to be delivered symmetrically between the individual units. This would be an unnecessary expense, unless an individual unit was being operated in a continuous overload condition. In addition to redundant power supplies with built-in decoupling diodes (SLR series), PULS offers various redundancy and diode modules for currents between 10A and 40A. These can be used to build redundant systems with standard 24V power supply units. The PULS latest addition is the YRM2.DIODE redundancy module which has two inputs and one output. Decoupling diodes isolate the two inputs to ensure that a power supply unit whose output encounters a short circuit does not become a burden to the other unit. Both input voltages are monitored and if the voltage falls below a certain threshold value, a signal is activated to report this failure. This enables early fault detection and the initiation of maintenance routines. The YRM2.DIODE redundancy module was designed to be used with power supplies which do not generate a DC OK signal themselves. The YR2.DIODE diode module is a simpler version that is only equipped with decoupling diodes and can be used with power supplies that have an integrated DC OK signal. Both modules can be loaded with a maximum of 25A at the output. This limit must also be observed when there is a short circuit on the load side and both power supplies deliver the short circuit current.

Tips for safe redundancy operation:

1) When possible, the input to the power supplies should be fed from a separate sources and individual input fuses should be used.
2) 3-Phase units provide additional functionality when one phase fails.
3) Use redundancy or decoupling diodes so that a faulty unit will not become a burden to the remaining units.
4) All power supplies must be monitored individually and faults automatically reported (DC-OK-signal).
5) Set all output voltages to be as equal as possible and set unit to parallel operation if this option is included.

DC/DC converters

DC/DC converters are appropriate when too little voltage is delivered at the end of long wires. In this case, neither a buffer module or a DC UPS would help. If a PULS CD series 24V to 24V DC/DC converter is used, a deprived 24V can be refreshed to a stable 24V voltage.

If you compare the costs of procuring these units with the costs and consequences of down time, you can see that in many cases the units pay for themselves just after a single fault event. Increasing the reliability of the 24V system saves money and the inconveniences of down time

Measures for increasing the reliability of 24V power supplies		
Mains interruptions < 20ms	Buffer time of power supply units	
Mains interruptions < 200 to 500ms	Buffer Module	UF20-series
Mains interruptions > 200ms	DC-UPS	UB10-series
Mains undervoltage	DC-UPS	UB10-series
Power supply failure	Redundant units	Y-series
Temporary overloads by 24V devices	Buffer Module	UF20-series
Refreshing of a low 24V (e.g. voltage loss on lines)	DC/DC converters	CD-series
Failure of a single phase	3-Phase units also run on 2 phases	3-phase units