White Paper

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Powering Safety Systems - Significant Power "Headroom" is Good Practice

Introduction

One of the most common sources of Fire and Gas detection system failure is power supply interruption and disturbance. Power supply specifications of an instrument refer to the voltage that must appear at the instrument power terminals, not the power supply rated output. There are many factors that impact voltage reaching the fire or gas detector, any one of which may cause an unwanted shutdown or damage to the instrument.

The most fundamental factor to consider is wire resistance between the power supply and the device but there many other factors.

The total power or voltage required to be supplied per instrument is the "Power required by the Instrument" plus the "Power loss in the wiring". Perhaps surprisingly, on installations with long wiring runs the "Power loss in the wiring" could exceed the "Power required by the Instrument".

Wire Selection

There are voltage losses across the length of the cable due to its resistance. The total wire length to the instrument and the return run must be included in calculations. If the instrument is 1000 ft away then the wire length for loss calculations is 2,000 ft.

Consider 18 AWG wire at 7 ohms per 1,000 ft. If the nominal voltage of the UPS supply is 24V dc one should consider that the batteries could at times fall to as low as 22V dc and the voltage to the instrument may follow battery voltage. If the instrument requires a minimum of 18V dc to operate then there is room for a wiring loss of only 4V dc and even so, the instrument is on the edge of failure.

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Suppose that the instrument is rated at 6.0 Watts. Is that a nominal wattage or a maximum? It is very important to consider power needs in the worst case scenario, ie. Full alarm with 21 mA output, all relays energized, any required internal heaters are active, visual indicators illuminated and any other loads on the line active, such as a local alarm devices.

In this case, the current requirement is 6.0W/24.0V dc = 250 mA and there is a voltage drop of 0.250 A x 7 Ohms = 1.75V dc per 1,000 ft. If the instrument is 1,200 ft from the power supply then the wire length is 2400 ft and the voltage lost is 4.2V dc. So, 22V dc supplied less 4.2V dc loss is 17.8V dc so the instrument will not run. It would be a high risk to have these power cables more than 800 or 900 ft long.

Integrity of Wiring Connections

While consideration of wire resistance is of primary importance one must also consider voltage losses at each wire connection point. Industrial installations often include junction boxes and marshalling cabinets where wires are terminated coming in and going out. When these termination points degrade over time due to vibration, temperature, poor installation or corrosion, the resistance increases and more precious voltage is lost, possibly leading to failure.

Future Additions

Many safety instruments today have the ability to install options at a future date. If a system is operating on the edge of power required then any future additions of option boards or local indication devices will cause the system to fail unexpectedly.

Voltage Boosters - DC to DC Converters

If the operating parameters of the 24V dc UPS system are not variable, as is often the case, and more voltage is needed for the instruments to operate reliably then voltage boosters may need to be considered. These can patch a problem but introduce another layer of complexity and another point of failure and thus a reduction of reliability. The cost of such a patch may include loss of reliability and thus exceed the benefit derived.

Power Supply/Chargers

Most supplies are combined charger and power supply with battery backup. The dc power supply is normally supplied by 120V ac. If ac main supply fails, the system reverts to a 24V dc battery bank as the source. The battery voltage will eventually drop from 24V dc to perhaps 22V dc and eventually cut off. Does the supply output voltage to the instrument drop when battery voltage drops? If so, and there insufficient voltage head room then failure may be sudden.

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Voltage Head Room

How much “spare” voltage is needed? There is no absolute answer to this but all of the above concerns should be carefully considered and with understanding that the more spare voltage you have…the better and safer you are.

A Better Solution

Net Safety Monitoring designs all its fire and gas detection instruments to give the designer the greatest possible power supply “head room”. The initial aspect of this design is keeping power consumption to a minimum; generally 40 to 50 % lower than competitors. This saves on total power and reduces the cost of higher capacity UPS systems. It also saves installation costs by providing the opportunity to use smaller wire gauge such as 18 AWG where others may require 16 or 14 AWG.

With any particular wire gauge chosen it means distances from the power supply to the instrument can be many times greater. In the above example, with a Net Safety instrument rated at 3.0 Watts and with its low operating voltage limit less than 10V dc it is possible to use 18 AWG wire for distances up to 6,000 ft instead of 1,200 ft as imposed by many competitive manufacturers.

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