Selecting a Powering Scheme for DMX-Net RDM

GODDARD DESIGN

The DMX Net RDM modules will operate over a wide range of supply voltages. Each module can operate with a power supply ranging from 9 to 30 volts. The module consumes about the same power regardless of power supply voltage. Hence, as the power supply voltage goes up, the current requirement drops. (See table 1) In systems where a module or two are used as a buffer, choosing a low voltage of, say 9 volts, may be appropriate.

Table 1

Volts	mA
9	95
12	73
14	64
16	56
18	50
20	45
22	41
24	39
26	36
28	34
30	30

In larger systems where multiple modules are daisy chained over considerable distance, the voltage drop on the supply conductors becomes important. For such systems we recommend using a 24 volt supply. We also recommend that the voltage drop in the common return be kept to about 3.5 volts or less. While common conductor voltage drops of 5 volts are electrically acceptable, they decrease your powering options.

The good news is that with our Mark 2 module powered by a supply of around 24 volts, many common systems can be built using either standard data cable, such as EIA 485 rated two pair cable (AWG 22 gauge), or with Cat5 or better data cable. If your needs are similar to the examples below you are likely to have no problem, but you must check. We can help with these calculations.

A DMX- Net system may have as many as three voltage drops that are important. Let's talk about them.

1- If you are using 485 wire, the drop in the power supply and common conductor when both wires are the same gauge

2 - When the distance between the power supply and the closest module is greater than the distance between modules (when the power supply is at the location of the first module, this drop is 0 volts)

3 - The drop found when the power supply and common wires are of different gauges

1 - In a system using a moderate quantity of modules spread over moderate distances, using 485 data cable may work well. Here is an example using 485 cable.

Say that on one branch of the system, you intend to put 15 modules, 12 feet apart and you want to use 485 cable (which is 22 gauge wire) for both data and power. The power supply is at the first module.

Use this equation, which is based on Ohm's Law and information from the copper wire resistence table

Vd = D*R/ft*Mi*X (* means multiply)

X = the sum (N-1)+(N-2)+(N-3).. . (N-N) (where N = the number of modules)

Copper Wire Table at 25 C Table 2	
AWG	ohms/ k ft
26	40.8
24	25.7
22	16.1
20	10.15
18	6.4
16	4.2
14	2.53
12	1.59
10	1.00

D = distance module-to-module in feet

R = resistance per foot (this will be the number in the copper wire table divided by 1000)

Mi = Normal maximum module current. (Assume the raw PS voltage is 24 volts. Assume that there is drop in the supply and common lines, and that a drop of 3 volts per line is close to ideal. For supply and common, this means 2 lines, each with a drop of 3 volts for a total of 6 volts. The effective supply voltage to the furthest module is 24 volts minus 6 volts = to 18 volts. Thus the maximum current is likely to be 50mA or less - see Table 1)

Vd = Voltage drop in one wire of the supply pair.

So for 15 modules

X = 14+13+12+11+10+9 +8+7+6+5+4+3+2+1+0 =105

D = 12 ft

R = 16.1mΩ (the resistance per foot of 22 gauge wire) See copper wire table

Mi =50mA

So-

12ft*16.1mΩ*50mA*105 = Vd = 1.0V for either wire

(Remember that is 12*0.0161*0.050*105 when you do the conversions for milliohms and milliamps)

This translates into approximately a 1 volt drop in each wire.
At a 1 volt drop the modules will be consuming less current than the 50 mA per module that we used for our calculation.
This is a very conservative calculation, which is good.

If you want to locate the power supply remotely from the first module, you need to add the drop in the wire that is carrying the power from the PS to the first module. Let's assume your power supply is located 100 ft from the first module. Can you stay with 485 wire?

The drop in the feeder cables (Vf) will equal the distance between the power supply and the first module (Df) times the resistance per foot of the feed cables(R) times the assumed module current (Mi) times the number of modules:

Vf= Df*R*Mi*N

Since we have assumed a module current of 50 mA in the first example, we will assume it here as well.

Vf = 15* 50mA*16.1mΩ*100ft = 1.2 volts.

Adding the 1.2 volts drop to the 1 volt drop calculated above gets you a drop of 2.2 volts per conductor for the power supply to the furthest module. Since the total voltage drop to the furthest module is approximately 4 volts, this system is conservatively powered.

So we could run this branch of a system using the data cable for both power and ground for a run of 15 modules, 12 feet apart, 100 feet from the data room.

Another possible layout is a branch of a system using Cat 5 cable, using one pair for data, one pair plus 1 additional wire for power supply and 3 wires for common. One wire of Cat5 has a resistance of 25.7mΩ/ft.
Two conductors of Cat5 in parallel have a resistance of about 12.8mΩ/per foot while 3wires have a resistance of about 8.6mΩ per foot.
The system has 25 modules, located 10 ft. apart. Assume an operating current of 50mA. Rp is the voltage drop of the power line and Rcm is the voltage drop of the common line.

X=24+23+22+21+20+19+18+17+16+15+14+13+12+11+10+9+8+7+6+5+4+3+2+1
N = 25 # of modules
X = 300
D = 10ft distance between modules
Mi = 50mA (0.05) module current
Rp = 12.8mΩ (0.128) (power feed)
Rcm = 8.6mΩ (0.0086) (common)

Vd = D*R/ft*Mi*X
Vd (power) = 10ft*0.0128Ω*0.05A*300 = 1.9V on the 2 CAT5 conductors used for power
Vd(common) = 10ft* 0.0086Ω*0.05A*300 = 1.29V on the 3 CAT5 conductors used for common. This will work.

Now can I move the power supply away from the modules, say 125feet?
To keep the voltage drop low, we may use a larger wire size, for example #18 AWG.

25 modules drawing 50mA equals 1.25Amps (25 * 50mA = 1.25Amps)
Df = 125 ft.
Rf = 6.4mΩ
Mi =50mA
N = 25
(125ft*6.4mΩ * 50Ma * 25) = 0.953 volts = 1 volt

So the drop on the commons to the furthest module is 1.29volts + 1volt = 2.29volts, well within the limit of 5 volts.
The drop on the power line is 1.9volts +1volt = 2.9V
Effective power supply voltage is 24volts - 5.19volts (the sum of 2.29V and 2.9V)= 18.8 so we are right to use 50mA as the module current with 18 gauge wire.

Another example is 32 modules 8ft apart, on Cat 5 wire using 2 wires for power and 3 wires for common.

N = 32
X =496
D = 8ft
Mi = 55mA We may need to allow for a greater drop in supply voltage.
Rp = 12.8mΩ (power feed)
Rcom = 8.6mΩ (common)
Vdc = 8ft*8.6mΩ*55mA*496 = 1.88V -- well within allowed limits.
Vdp = 8ft*12.8mΩ*55mA*496 = 2.79V – not a bad drop in the power supply.

If we were to remote the power supply 130ft away, and used #16 wire for the feed line, the voltage drop would be:

55mA*32 *130ft*4.2mΩ= 0.961V
The effective power supply with the 130 ft feed line is 24 -((.961*2) + 2.79 +1.88) =17.41

These examples illustrate real-world applications. While every application will be different, most systems can use ordinary cabling. A little thought is necessary in the design/layout process. Goddard Design Co. is happy to provide assistance.

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