

Components & Planning

DMX 512: DMX stands for Digital Multiplexing. It is a digital protocol used to control and automate lighting systems. The system has 512 addresses in a “Universe”, or group, on a single cable run. Each address is a digital data channel for control signals.

Lighting System Type: The light source is the basis for selecting all other components. The lighting system will be made with selected LED tape or fixtures. Multiple output channels may be available for 1 to 5 channel operation. Lighting loads will be powered directly by the Decoder power output channels. Consider the purpose of the lighting and how many fixtures or length of LED tape will be required. For low voltage Class 2 systems, the loads will need to be put into 96W sections or less. Basic lighting systems with multiple channels discussed here can be thought of as a single unit where color chosen is uniform through the entire light source at the same time. Lighting with individual, addressable pixels (different colors in different parts of the light at the same time) is not discussed here and is a different type of system.

Decoders: These devices take in the DMX signal from the Master (wall) Controller and convert the data signal to the proper power output for each LED channel (Red, Blue, Bright, Dim, etc.). GM Lighting Decoders have a 3-digit display showing the address assigned to the Decoder. Check Decoder instructions for wiring more than 32 Decoders continuously in a run.

Master Controls: Typical wall controls offered by GM Lighting are pre-programmed with simple functions, dimming, modes and zones. Zones on the wall controls cover multiple data addresses and output channels on the Decoder. A 4 channel Decoder with an address setting of 001 will align addresses (001, 002, 003, 004) with Zone 1 on the Master Control wall plate. This is the default setting. Other Zones can be set up to correspond to other addresses. The Wall controls discussed here are basic controls. More advanced controls requiring programming of modes for color sequences is possible but beyond the scope of this document. More advanced Master Controls would replace the Wall Control but the same Decoders can be used.

Decoder Settings: The Decoders have basic settings to select addresses, and other advanced features. You may set different addresses depending on your application.

Decoder DIP Switch Settings

- **Switch 1 – Bit Setting:** This setting must match up to the controller bit setting to properly dim. Unless different controllers are to be used, use the default setting.
- **Switch 2 – Output Frequency:** The decoder uses a PWM output to drive the LEDs. The frequency of the output can be left in default mode for general applications. It is recommended to set the switch to ON for reduced flicker.
- **Switch 3 – Dimming Speed:** For smoother transitions between dimming levels, the smooth setting can do this by slowing down the response time. For general use and with preprogrammed scenes, the default setting with faster transitions is best.
- **Switch 4 – Display:** This numeric display aids in setting up the addresses. Unless there is a reason to turn it off, use the default setting.

DIP Switch Settings	Switch 1 Bit/Dimming	Switch 2 Output Frequency	Switch 3 Dimming Speed	Switch 4 Display
ON (high)	16 bit (65536 levels)	4000 Hz PWM	Smooth (slow)	Off after 30sec
OFF (low) *DEFAULT*	8 bit (256 levels)	500 Hz PWM	Standard (fast)	Always On

Connections

- See the Master Wall Control manual for guidance on which output terminal is wired to which wire on the LED tape or light fixture. These Decoder connections will allow LED colors to match the color on the control for typical room lighting.

Typical Connections On Decoder Terminals For Various Control Functions

Typical use	# of Channels on Master Control	Decoder Terminal V+ Connects to	Decoder Terminal 1 Connects to this Color	Decoder Terminal 2 Connects to this Color	Decoder Terminal 3 Connects to this Color	Decoder Terminal 4 Connects to this Color	Decoder Terminal 5 Connects to this Color
Single Color	1	+24V	One color/white	-	-	-	-
Tunable White	2	+24V	Cool White	Warm White	-	-	-
RGB	3	+24V	Red	Green	Blue	-	-
RGBW	4	+24V	Red	Green	Blue	White	-
RGB +Tunable White	5	+24V	Red	Green	Blue	Cool White	Warm White

Zones: For connecting Decoders to different Master Control Zones follow these steps.

- A zone set up would control a group of lights in an area at the same time. Multiple zones can be used.
- Usually, address 001 is all that needs to be selected for simple systems with 1 Zone at the Master Control (wall control). In this case, zone 2, zone 3 and beyond will not function since the addresses would not exist.
- For more than 1 zone, determine how many channels you are controlling with your Master control. (ex RGBW = 4) Then select addresses that are multiples of the number of channels you are controlling for each zone. This allows a different set of addresses to be used for each fixture group without overlapping addresses. Wiring connections for multiple zones are not affected within the same Universe. The display on the decoder will indicate the address setting as it is adjusted and set.

Decoder Channel settings for multiple Zone settings (8 bit mode)

Typical use	# of Channels on Master Control	1 st Decoder Group Address	2 nd Decoder Group Address	3 rd Decoder Group Address	4 th Decoder Group Address
Single Color	1 (mult of 1)	001	002	003	004
Tunable White	2 (mult of 2)	001	003	005	007
RGB	3 (mult of 3)	001	004	007	010
RGBW	4 (mult of 4)	001	005	009	013
RGB +Tunable White	5 (mult of 5)	001	006	011	016
	Group of Channels (above) Controlled by Zone (below)	Zone (below) will control Channel Group starting at Channel (above)	Zone (below) will control Channel Group starting at Channel (above)	Zone (below) will control Channel Group starting at Channel (above)	Zone (below) will control Channel Group starting at Channel (above)
	Wall control Zone	1	2	3	4

Notes: Assuming 1 Universe. Decoders set to 8 bit. Each decoder group can have 1 or more Decoder. More than 1 Decoder can have the same address. Addresses shown prevent overlap of data signals. Consult factory for 16 bit mode details.

Layout: This step involves knowing where the LED light sources, Decoders, Wall controls and power supplies will be located and mounted. All controls and power supplies should be in a location that can be easily accessed for installation and maintenance. Routing of all data and power cables will need to be planned for length and connections. Knowing how sections will be separated for Class 2 groupings will assist in this step. Plan to avoid mounting or routing any of the DMX system parts or cables near electrical devices or appliances that may emit electromagnetic noise. (HVAC, motors, microwaves ovens, washing machines, and power lines for these devices.)

Data Cables & Terminator Resistors

DMX rated cable: Always use DMX rated cables for data connections to prevent malfunctions. The system could be unresponsive or flicker if the data signal is not getting to the Decoders from the Master Control. There are 3 basic cable types that can be used. See sections below regarding Ethernet cables, DMX rated data cables and XLR cables. There are also ratings for proper use inside walls or plenums.

Ethernet Cable: Ethernet cables are a cost-effective way to make connections. Ethernet cables with a CAT5 or CAT6 rating are suitable for DMX use. These cables provide shielding to noise and have the data bandwidth and impedance to handle DMX signals over long runs. These cables use RJ45 connectors, at both ends, which are accepted by GM Decoders for all inputs and outputs. For GM Master Wall Controls, you will have to cut off the one connector and strip back outer insulation 2". Identify the wires needed. (**Brown = Ground, See table below for +Data, and -Data wiring scheme. It is important to use the single twisted pair noted for the data lines to reduce noise and allow proper function when using a RJ45 connector on one or both ends of the cable**) CATx cables will be marked with the type of CAT cable and EIA/TIA number. Then strip insulation and connect these 3 wires to the matching terminals. Make sure that unused wires do not contacting anything.

CAT5/CAT5e, CAT6/CAT6a Cable Wiring for DMX Usage

When Using RJ45 Connectors	RJ45 Connector On CATx Cable	EIA/TIA-568A Wiring Scheme	EIA/TIA-568B Wiring Scheme	Pairs
+Data	Pin 1 / Wire 1 Color	Green / White	Orange / White	Paired 1-2
-Data	Pin 2 / Wire 2 Color	Green	Orange	
(not used)	Pin 3 / Wire 3 Color	Orange / White	Green / White	Paired 3-6
(not used)	Pin 4 / Wire 4 Color	Blue	Blue	Paired 4-5
(not used)	Pin 5 / Wire 5 Color	Blue / White	Blue / White	
(not used)	Pin 6 / Wire 6 Color	Orange	Green	Paired 3-6
(not used)	Pin 7 / Wire 7 Color	Brown / White	Brown / White	Paired 7-8
Ground*	Pin 8 / Wire 8 Color	Brown	Brown	

*Use only 1 wire for ground, pair is not needed.

DMX rated cable (No Connectors): An alternative is to use shielded data cable rated for DMX use. The cable can have 2 wires with an impedance of 120 Ohm and have a shielded foil wrap with data ground wire (3rd wire). **Note that this is a "signal ground" wire which is NEVER TO BE CONNECTED TO building "earth ground". This would be a shock hazard and could damage the controls.** Strip wire ends and connect to screw terminals on DMX equipment. There are no connectors. Cables with different numbers of wires can be used, but make sure to use the wires with the same twisted "pair" which will keep electrical noise down. Use the same wire at each end of the cable for "+ to +" or "- to -" DMX data connections. There should be a ground wire consisting of bare wire wrapped around the outside of the cable. Fold back wires and use electrical tape to hold the remaining wires out of the way so they do not contact anything.

XLR cables: GM Lighting Decoders can accept 3 pin XLR connectors. 5-pin XLR connectors are available, but are not compatible with GM Lighting Decoders unless you use a 5 to 3 pin adapter. Cables should be shielded and have a male connector at one end and female connector at other end. Be sure that the cables are DMX rated with an impedance of 120 Ohms. Audio or microphone cables also use XLR connectors but have a lower impedance closer to 45 Ohms. The low impedance audio cable can degrade the digital signal making the DMX system malfunction. XLR cables are used when a more durable cable is required. At Master Wall Controls, you may have to cut off the one connector and strip back outer insulation 2". Strip insulation from the 3 wires and **determine which wire is Ground, +Data, -Data using continuity test**. Connect the 3 wires to the proper terminals (Ground, +Data, -Data) on the Decoder. Fold back wires and use electrical tape to hold the remaining wires out of the way so they do not contact anything.

Installation Rating for Cable: Data cables may also need to be rated for In-Wall (general), Riser or Plenum use. This need arises when cables are installed behind walls or above ceilings. A riser refers to a open space where electrical conduit, water pipes or mechanical equipment are installed or routed in a building. A special ceiling space exists to handle HVAC air circulation. This is defined as a Plenum. In-Wall, Riser or Plenum rated cables have a low-smoke and low-flame ratings. Such cables will not produce a lot of smoke or sustain burning easily in the event of a fire. XLR, Ethernet and shielded cables are all available with In-Wall, Riser or Plenum ratings. Check the local building codes for requirements of your installation to ensure use of proper materials. Then verify the cables have the proper markings to match the ratings required.

Look for these recommended ratings/markings: [NEC NFPA70 (2023) Tables 800.113, 850.154]

- CMP = Communication cable, Plenum rating
- CMR = Communication cable, Riser rating (can substitute CMP)
- CMG or CM = Communication cable, General rating (can substitute CMP or CMR)

Terminator Resistor:

Use a Terminator resistor at the end of a single DMX run. From the Master Wall Control, data cables go in and out of each Decoder. On the last Decoder, farthest away from the Master Wall Control, connect a Terminator resistor to the last output. At the screw terminals, use a 120 Ohm, ¼ watt resistor. It must be connected between the +Data and -Data terminals. This prevents the data signal from reflecting back into the line which can distort the signal and create various malfunctions.

- Use 1 Terminator resistor on the Decoder output with farthest connections from the Master Control.
- Do not use a resistor on any other upstream Decoders.
- GM Lighting Decoder data output terminals are all connected. A resistor, XLR plug or RJ45 jack with Terminator resistor are also acceptable to use even if different cables are used. (pick one)
- Do not install more than one Terminator resistor on the last Decoder.

DMX Planning – Summary

***It is highly recommended that a qualified DMX installer be used to ensure proper installation and operation of the system. Consult with qualified personnel during the planning stage to ensure the correct components are chosen for a smooth installation.

1. Select a Luminaire/Light Source for each application. Determine the number of channels.
(ex RGBW = 4) Determine total Luminaire wattage and operating voltage.
2. Select a Decoder with same number or greater number of channels as the Luminaire.
3. Select a Master Control with the same number of channels as the Luminaire.
4. Verify that the controller and decoders will operate at the same bit setting for dimming (8 or 16 bit).
5. Determine settings to enable the Decoder to work properly with the Master (wall) Control. List Decoder addresses to align with Wall Control Zones.
6. Select power supplies of proper input voltage, output voltage and power for Decoders and Master (wall) Controls.
7. Determine which type of data cable, installation rating and connectors will be used (ex Ethernet, XLR 3-pin Cables, Plenum rated, etc.)
8. Determine preliminary layout of the run from Master (wall) Control to the Decoders to the Luminaires.
9. Determine where power supplies will be mounted.
10. Determine final layout of Lighting System in the space. List Zones and Class 2 power sections. Specify locations for mounting components and routing cables. Avoid putting DMX devices or cables near electrical noise producing appliances.

Trouble Shooting Tips

Possible causes and solutions to malfunctions including no output or flickering or wrong output.

Fixture & Power Supply: Check LED tape or fixture individually for problems.

- Check that building power is working.
- Check power supply output for proper voltage and power rating.
- Check polarity of power supply input and output connections.
- Check LED load by connecting power to each channel directly with a known good power supply of the same voltage and power rating required.

Cables: Check each cable individually for problems.

- Check to see that DMX rated cables, with 120 Ohm impedance, are used. Replace any cable without proper data ground shield or impedance. Check results.
- Check for damaged cables or connectors.
- Swap out each cable one at a time with known, good cable.
- Check for proper connection of wires at each end of cables when stripped terminal connections are used.
- Test cable with a cable tester for continuity.
- Replace any bad cables/connectors.

Decoder & Master Control Set Up: Check each unit individually for problems. Modify and check result.

- Break run into smaller sections to troubleshoot.
- Check individual Decoders for function. Add one Decoder, at a time, back into run with good cables to determine location of failure.
- Check to bit setting of decoder matches bit output of controller.
- Check polarity of DMX data connections.
- Check to make sure the last decoder has a 120 Ohm terminator resistor across +Data and -Data output terminals.
- Check Decoder output channel connections for proper LED color lead input.
- If Master Control appears to not respond properly, replace with unit known to be good.
- If there are more than 32 Decoders in a single run, consult instructions for modified wiring connections to boost signal.

EMI (Electrical Noise) & Proper Function: Check DMX data cables, Decoders Master Control or Power supplies

- Are cables running new line voltage power lines, electrical devices or appliances? If so try moving cables and check results.
- Check to make sure DMX rated cables, with 120 Ohm impedance, are used. Replace any cable without proper data ground shield or impedance. Check results.
- Check to make sure the last decoder has a 120 Ohm terminator resistor across +Data and -Data output terminals.
- Are power supplies properly grounded to Earth, electrical ground? Repair any disconnected ground and check results.
- For bigger problems, a line filter may be required on the appliances. This would require consulting with an expert knowledgeable in EMI issues and resolution.