

Theater in the attic

Day and Night lighting for Model Railroads.

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Trains, cars, streets, backgrounds, houses, lights, sounds ... We do our best to model our little slice of the Real World as realistically as possible, presenting a complete slice of miniature life. However, what happens when nighttime descends? CLICK! Someone hits the light switch, and it's night.... not exactly prototypical.

Visitors to Railz Miniworld in Rotterdam (the Netherlands) or any professional layout have seen a far better solution in action. As dusk descends on the layout, the sounds begin to change, the horizon turns red, and lanterns and house lights go on one by one. Even miniature fluorescent streetlights turn on one by one in sequence. It is a slow and smooth transition from day to night. The visitor experiences a more prototypical 24 hour day, in 24 minutes.



As designer of the Railz Miniworld installation, I received many requests for information for an installation for a “typical” small model railway room. The challenge in answering these requests is to scale the Railz Miniworld examples and solutions down to a level which is both technically and financially within the reach of the average modeler or club. In addition, the Rotterdam layout space has higher ceilings than most common structures, which opens up the use of dozens of fluorescent tube fixtures which may not fit in conventional rooms. The combination of the high ceiling with the numerous light sources give an even light distribution across the layout scenes (no “hot spots”). Due to the dimensions of the average attic or cellar it is very hard to achieve the required even light distribution.

So if we want to specify an integrated sound/light system suited for at home, what are our requirements?

- Can be assembled out of cheap and readily available components.
- Does not require complex installation or configuration
- Must not rely on a computer for “regular operation”
- Minimum 24 minutes duration per Day/Night/Day cycle
- Scalable solution to suit both large and small layouts
- A total price comparable to the price of one digital locomotive.

Existing solutions

Of course there are already solutions which could achieve the desired results. There is an OpenDCC DMX decoder, which allows control of 16 outputs from a DCC command system. This can be fun to map behaviour of the layout lighting system in response to changes and events in train control. Via a DCC-based macro, you can also run scenes. The OpenDCC website¹ has an enormous amount of information available for those who are interested in the system. However, unfortunately the electronics described are not readily available pre-assembled. You'll have to assemble and program them from scratch, and that is not suited for everyone.

¹ OpenDCC website http://www.opendcc.de/index_e.html

Another option is the “Light @ Night” system. This system makes use of, and therefore relies on, constant connection to a computer to provide entire room lighting control. The small scale version of this system even uses the original PC LPT1 parallel printer port.

After some detective work, a new plan was hatched which did meet the requirements, irrespective of the size of the layout or venue, which was both affordable and technically within reach of most modelers.

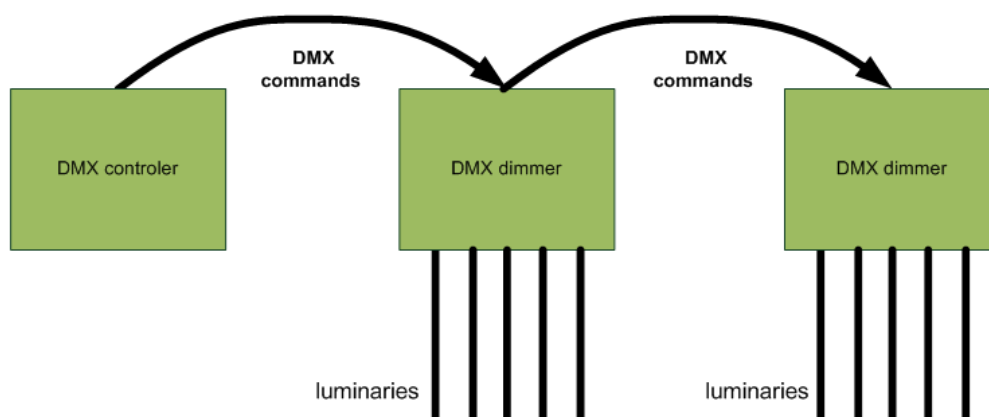
The techniques used are originally from the theater world. Hence the title "Theater in the attic"

Building Blocks

DMX-512 is a technique originally used to control lights in theater. The stage lighting of a theater was comprised of a control panel with dozens of faders, which sent commands to racks of electrical dimmers located backstage and in the wings. The dimmers then provided the appropriate level of power to the lamps.



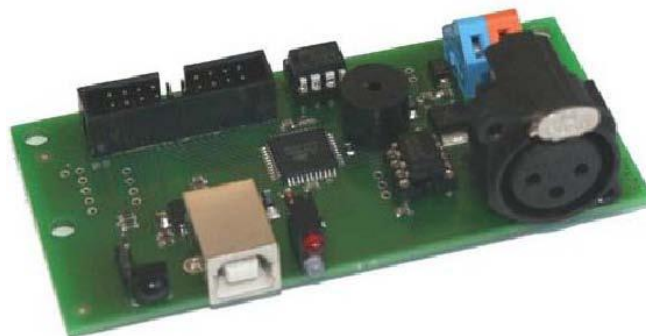
Soon, the first PCs were pressed into use as DMX controllers, either for manual control, or automatic assignment. On the other side of the line the lamps were complex, the assignments were also used for example control a moving automated spotlight, or control an automated color-changing unit. However, despite the complexity of the control and lighting fixtures, the basic hardware and DMX protocol remains the same. The cable between the devices can be daisy-chained. Each DMX device, often referred to as luminaires, must have a unique address to be set. In total there are 512 different address values available within the specification. Hence the official name DMX-512^{2 3}.



² <http://en.wikipedia.org/wiki/DMX512>

³ <http://www.wcsl.org/downloads/DMX512%20Wiring%20Standards.pdf>

For model railroading duties, the DMX controller does not have to be as complicated as that found in a theater. Manual operation to adjust the settings in realtime is not as critical as for Live Event missions. It may even be a simple PCB, if the right connections are available. A controller like the example device shown at right has a connection for a power supply, a USB connector for configuring and initial programming, and a DMX output socket. The overall footprint of the circuit board is only 5 to 10 cm.



The controller can be used directly from your computer to send DMX commands. However, more importantly for model railroading, the controller may be used as a standalone DMX command sequencer/playback device. Create the lighting sequences or 'scenes' on the PC, upload into the DMX Controller, and trigger the playback sequences as required. The controller remembers the scenes, even when the power is switched off.

Dimmers and Lighting

DMX dimmers are available in all sizes and price ranges. The following unit appears to meet the requirements typical of a Model Railroading application.

The Euro EDX4 Lite is a compact DMX controlled dimmer pack with four outputs.

- 4 channels, each capable of driving a 230V output
- 5A load per channel (1150 watts)
- Total load: 16A
- DMX address easy to set using hardware dipswitch
- capable of wall, ceiling, or upright orientation mounting
- Dimensions: 320x165x110mm

Not least, the price: the dimmer pack costs about € 90, - and is available from better-stocked consumer electronics stores.



For the US market there is a comparable unit. It's available from StageLightingUSA.com.

This one has comparable specs

- 4 DMX channels
- Dip Switch
- 4 channel double output
- up to 600W per channel, 2400W total load
- Fuse protection on each channel

The price is right too: \$69.95



The outputs of the dimmers can only be used with incandescent type lamps. These may include new 120/230VAC halogen lamps.



Unfortunately, the EDX4's 230VAC outputs are NOT designed to drive LEDs, or fluorescent tube-type lamps. Fluorescent tubes by design use a "ballast" which is not compatible with conventional voltage-based "dimming". Some "energy efficient" bulbs are simply a clever form of a folded fluorescent tube, so these are also not suitable for such a dimmer.

An LED light source also cannot simply be dimmed by varying the applied voltage. LED bulbs require a constant voltage to give any form of light. A LED can be dimmed however by providing a variable pulse width (PWM) waveform. This is very similar to the PWM technique used in the modeling world for fine low-speed control of DC motors in locomotives.

For both fluorescent lights and LED's, special DMX dimmers are available, but they are relatively expensive. To simplify the system shown, we have chosen a system using normal halogen or incandescent bulbs.

For the day-night simulation three colors are needed, white for daytime, red for evening and morning and blue in the night. Obviously the "prototype" moonlight is not blue in pure color. Blue, however, gives the desired effect: it is almost dark and the colors of the scenery seem to fade into a gray haze. Under "night light" conditions, the typical yellow streetlights and white lights in our model houses are clearly visible and can be quite striking (these colors do not need to be bright to stand out).

It is important for the day-night lighting to be evenly distributed over the model world. The solution here is to use "Rope lights". Versions of these in various lengths are often seen around the Christmas season and are available in various colors. Usually, these rope lights are made with cheap white LEDs. They are identified by the hard white or blue color. However, there are also versions available with incandescent bulbs, which are designed to be powered directly from a 120VAC or a 230VAC source. The beauty of these rope lights is they are cheap. The 13 mm thick tubes cost about € 2, - per meter (\$ 27 for 50 ft). With 36 light bulbs per meter they ensure an even distribution of light. The load per rope light is 16 Watt per meter (3 Watt per foot). Remembering that a single channel of the analog dimmer can handle up to 1150 Watt (230V) or 600 Watt (120V), that means a single output of the dimmer pack can be connected to up-to 70 meters or 200 foot of rope light.⁴

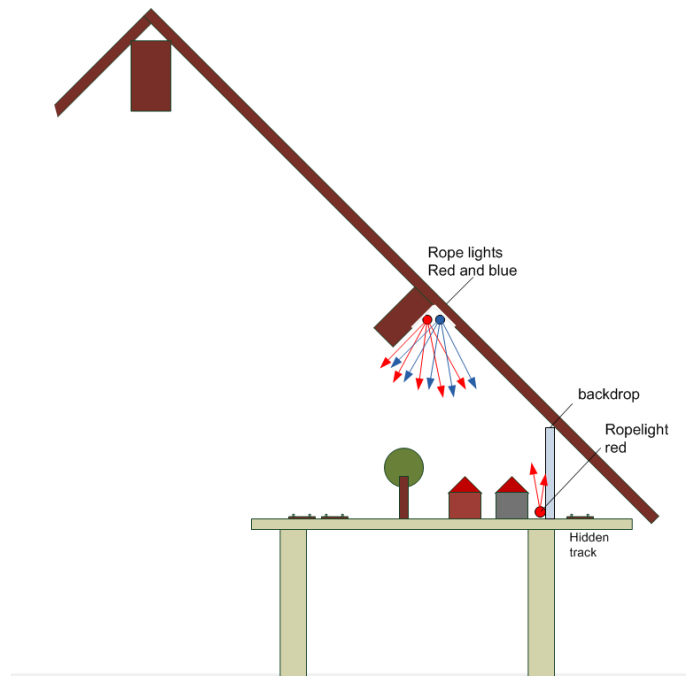


⁴ a random US rope light supplier: <http://www.1000bulbs.com/category/rope-light/>

The figure below is an example showing one way of locating and mounting rope lights so that the layout viewer cannot directly look at the light source, and that they evenly light the model world. If the roof beams are wood or dark brown it's better to paint them white. It improves the distribution and the amount of light.

You'll have to experiment with the location of the rope lights to get the result you want. If the light output for one color is insufficient you can add another stretch of rope light.

"White Light" rope light arrays are also available. However, unfortunately the white light from these is usually insufficient to act as overall attic lighting. For a controllable white light source we use ordinary incandescent or 120V/230V halogen light fixtures and bulbs. Assuming the use of the EDX4 dimmer unit mentioned above, and the first 2 channels to control the red and blue snake-light arrays, that leaves the remaining two dimmer outputs available for the "White lights". Those 2 channels can provide a total of 2300Watts at 230V or 1200 Watt at 120V, which should be enough to light most common-sized attics. If this is still not enough, you can add multiple dimmer packs. Remember however, that each dimmer uses up to 16 Amps (at 230VAC) or each. This represents the full capacity of a European domestic house mains power supply circuit. Therefore, for layouts which may require multiple dimmers, it is necessary to provide adequate Mains Power capacity. In the US, the average circuit is 25 Amp, this is not surprisingly also the maximum a single dimmer can supply (2400 Watts x 120V)



An easy way to connect a row of typical mains-powered "white" light bulbs is by means of a festoon cable, similar to those used to string lights through Christmas trees. Cheap domestic versions of such cables have a fixed number of fittings in which E27 size bulbs can be mounted. However, there are also more professional (and expensive) versions which allow the user to simply "clip in" the bulb fittings wherever they may be required, along the length of the specially-designed cable.

The Dutch name for this festoon cable is "prikkabel" ⁵.



⁵ A random example webshop: <http://www.elektronica-shop.nl/contents/nl/d1225.html>

Setting the DMX Addresses

Every DMX device must have a unique or "starting address", and this is the case with the EDX4 dimmer units. On the DMX dimmer module there is a small group of 10 DIP switches, which can be used to set the start address. The first nine switches in the group are used to assign an address ranging from 1 thru 512 to be assigned to the dimmer. The address is the sum of the chosen switches using the values from the next table. You may recognize the powers of 2 from the binary system.



| Switch | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|--------|---|---|---|---|----|----|----|-----|-----|
| Value | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 256 |

Examples:

Switches 1 + 3 (values 1 and 4) indicates start address 5

Switches 1 + 2 + 5 (values 1, 2 and 16) indicates start address 19.

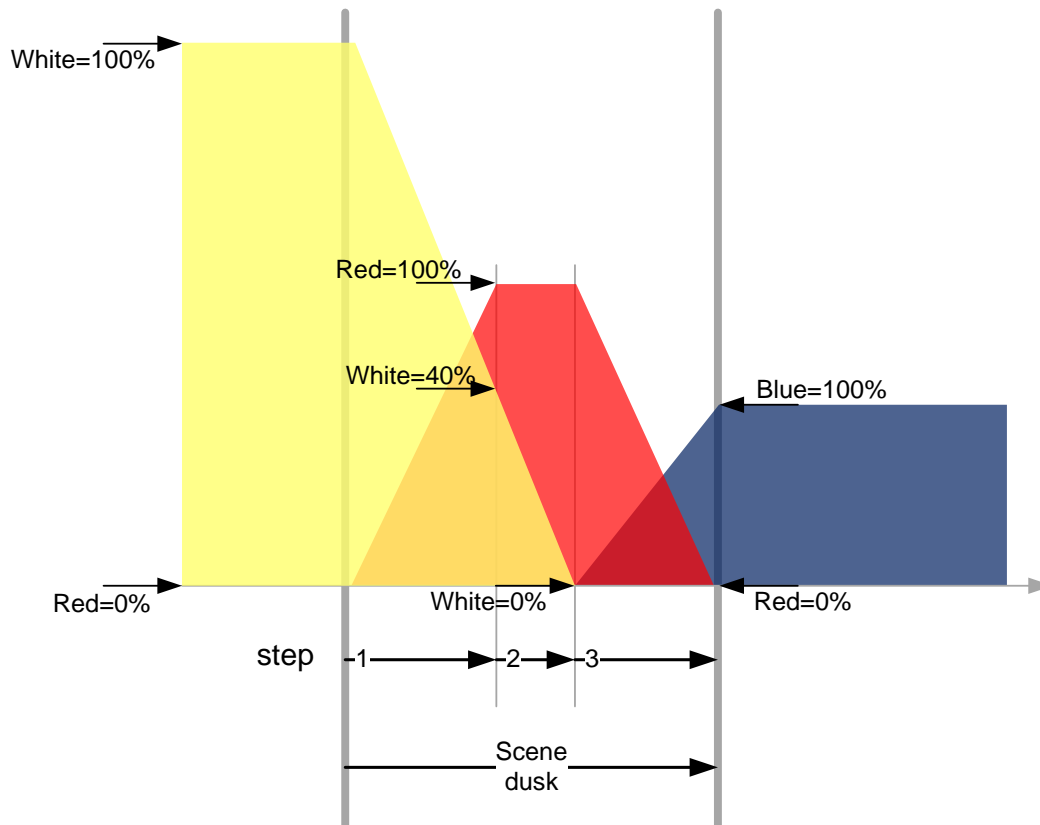
On most DMX devices, the tenth switch has a special function. This may vary between DMX units, check the manual for your particular DMX device. In the case of the EDX4 dimmer, setting the DMX address to "no address" (address 0), and set Switch 10 to the "ON" position, the dimmer plays a quick demonstration program. This can be useful for testing lamps and the dimmer itself.

For every DMX device in the chain you'll first have to find out how many addresses it will listen to. The EDX4 dimmer in this example has four channels, and thus listens to the first four addresses starting with the start address. The next module will be at start address + four.

You are allowed to have more than one DMX device on the same starting address. They all will listen to DMX commands for this starting address.

Scene details

We need to program the gradual transition from day to night and vice versa. For this we need to look at the transition in detail. First the light dims slightly, then the horizon turns red, and finally it slowly becomes dark. The following graph uses yellow to indicate the “White light” channel behaviour.



The table lists each step two times. The fade time is used for the gradual transition for beginning the sequence to the final value. The overall change from day to night in this example is 90 seconds. You might insert an additional 'wait time' (delay) for the sunset after step 2 so as to stretch the transition time.

| | Initial situation (= final situation dawn) | step 1 | step 2 | step 3, (=final situation dusk) |
|--------------------|---|--------|--------|------------------------------------|
| Fade time | | 30 s | 30s | 30s |
| Wait time | | | - | 3 min |
| white ⁶ | 255 | 100 | 0 | 0 |
| red | 0 | 255 | 255 | 0 |
| blue | 0 | 0 | 0 | 255 |

The three minutes after step 3 is the time between the final outcome of the dusk and early morning dawn scene. In this scene similar steps are programmed to simulate a sunrise. For a total loop of 24 minutes, we must program the last step of the sunrise scene with 18 minutes wait time.

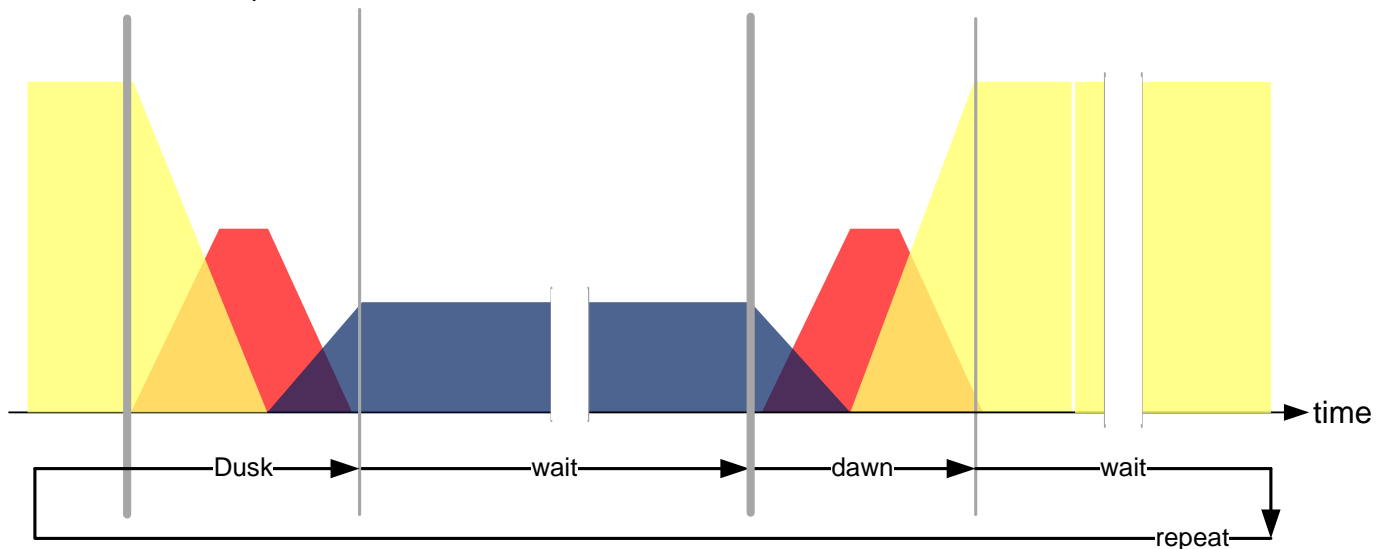
⁶ In DMX terms 100% is a value of 255.

When we first implemented Railz Miniworld, I looked up the real world day light times, and we programmed the simulation as realistically as possible. In 24 minutes we exactly reenacted 24 hours. Already in the first week after the opening our visitors gave us feedback: "the dark time is too long!"

In winter, the "real day" is more dark than light. Because we sleep through the night, the feeling we recall is of a shorter nighttime. So, soon we had the times changed again. The total night with twilights lasted, as in the example, about 6 minutes.

If you study the scenes concepts and necessary steps, you will soon figure out that it is possible to simulate with only one scene and more steps. However by splitting up the cycle of a 24 hour day into discrete steps, it gives the possibility to use the DMX Controller to drive the changes manually. If our attic public asks for it, we can start the night with a single press of a button... not instantly with one click, but with a subtle transition through a sunset.

The overall scene sequence looks like this.



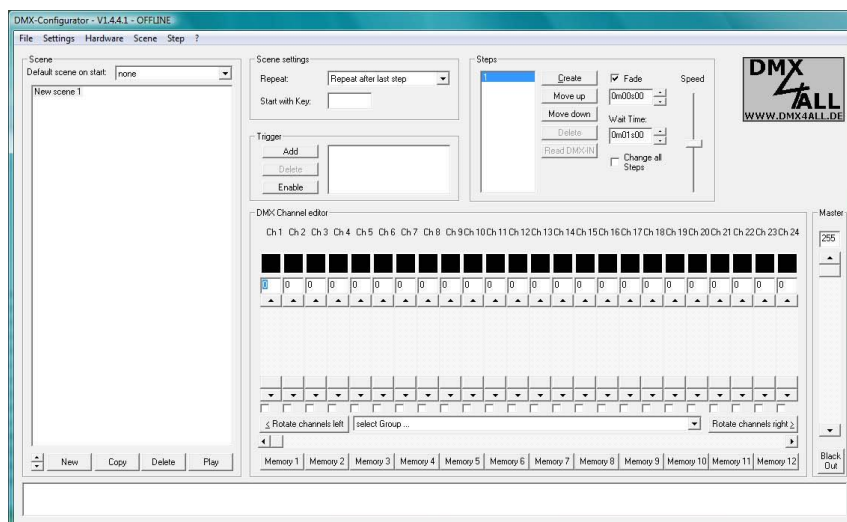
Software, scenes and steps

The necessary software for programming of the DMX controller/playback unit is available for free via the publisher's website. The software is quite simple to use, and should be readily understandable by anyone with basic computer literacy.

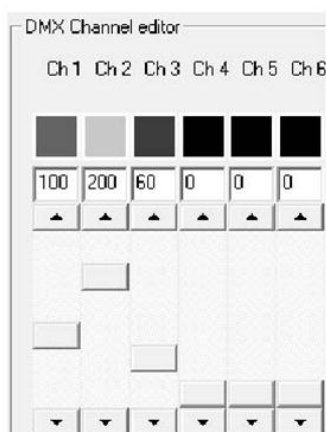
On the application screen are some faders. These allow the user to set a voltage/brightness value for each dimmer channel, from 0 (light is OFF) to 255 (light is at maximum brightness).

To the left of the screen is a tab which allows the creation of scenes. Each scene may consist of one or more steps or sequences.

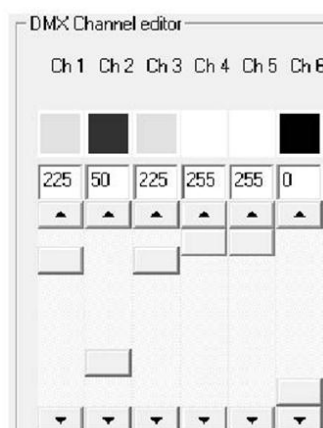
Next to the logo you can create steps.



Now set the first few faders:



Create one extra step and move the faders again. The position of the faders are kept for each step.



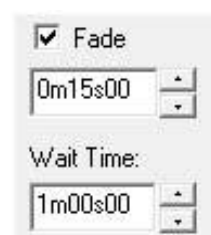
In the box "scene settings" choose "repeat after last step".



The software can now play the scene; it repeats the steps without any delay. This is nice for a disco, but is not suitable for a model world.

For step 1 and 2 select the following settings:

- Fade Time = 15 seconds
- Wait Time = 1 minute



The scene will now wait one minute between steps 1 and 2, then gradually change in 15 seconds to the values of the next steps. If you hit the play button, you see the faders slowly move to the new values. Remember to set these timings for the second step too, otherwise the fades shoot back to the values of the first step.

According to this basic principle, you will have to program two scenes, one for the morning and one for the evening. The needed values can be read in the table of the previous section.

For every scene you can choose what happens next:

“Stop after last step”

“Repeat after last step”

“Execute scene XYZ”

If you have programmed multiple scenes the last task is to chain the scenes together:

evening → morning → evening, etc

Besides these two scenes, I recommend making a scene with only one step: all white lights at 100%. Choose this scene as the “default scene” so that when you switch the system on you will be able to work on your layout.

If you're happy with the scenes you need them to send the DMX Player. Look in the menu for Hardware -> write memory. You can do this as many times as you like.

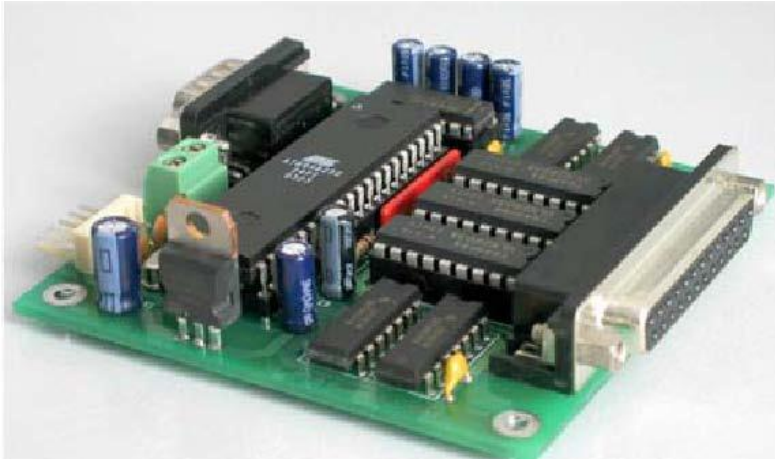
Once the system is turned on, the default scene is shown and all the white lights are on. But how do we get scenes to start and run automatically? There are two solutions.

The first is a series of switches which can be connected to the DMX Player. Every switch controls a scene. The included manual provides a clear example of the connectors. This controller has a maximum of 10 scenes directly controlled by the switches, it's enough for our attic.

The second solution is more expensive but also makes a much greater impression on our attic the audience. At dmx4all.nl is a small remote for sale. With the press of a button the remote starts the selected scene. If your DMX-Player is hidden under the table you can buy a cable to extend the infrared receiver. Of course, the two solutions can be combined.

DreamPlayers and other modules

So far, only combinations of day-night illumination have been described. But there's more: The lights in the layout structures and lanterns have to be switched on when it gets dark in our attic.



There is a simple and effective controller available. Van Perlo Electronics⁷ sells a product called "lichtorgel" (light organ).

This module is also widely used in Railz Miniworld. The module is just like the DMX-Player. It can, independently from a PC, play pre-programmed scenes. The module has 24 outputs for lights and LEDs⁸. Per output you can program multiple scenes and steps. With these steps you can simulate simple house lights, street lanterns or flashing campfires, a welding effect or a flashing neon tube simulation. The module has four inputs that can be used to start four scenes. These inputs can be controlled with simple switches but also with outputs from other electronic modules.

Similarly, the Dream Player⁹. This module is relatively unknown in the Netherlands.

The origins lie with an international group of enthusiasts who specialize in layout sound. They have an Internet discussion group and prepared specifications which led to the Dream Player. This module plays user loaded sound which is stored on an SD memory card (as often used in digital cameras). Unlike mp3 this module player plays the sound with high quality, 44.1/16 resolution, like a CD player.

This module has also four inputs to trigger four audio scenes. The module costs about € 65,- (\$ 80,-). The module has a small headphone jack. Combine this with a set of PC speakers with a subwoofer for an excellent audio result.



Ready to run scale sounds are available from Fantasonics Engineering⁹, but it is much more fun to put together your own scene. The sound of a Dutch city is quite different than an American city. An SD format memory card of 512 MB is required for almost one hour of stereo sound. However nowadays 512Mb cards can be hard to find due to their small capacity. 2 Gigabyte SD cards cost almost nothing, are much more commonly available, and work fine too.

⁷ <http://dinamo.vanperlo.net/>

⁸ A 32 output module which controls lights and servo's is in development.

⁹ <http://www.fantasonics.com>

Several software packages are available which enable the user to create and compose their own sounds, and even entire soundtracks.

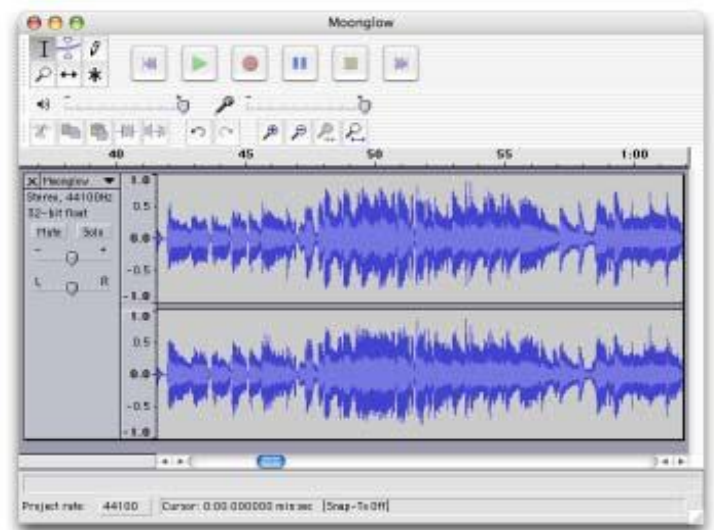
Audacity is an excellent package that is freely available and works on PC and Mac. It is beyond the scope of this article to describe the full capabilities of the average audio editing application. In short, they allow placing of individual sounds in sequence, to form a complete sound scene or soundtrack. Individual sounds can also be edited with effects such as EQ, volume changes, echo, or reverb. Each individual sound can also be panned between left and right speakers or channels. For example, one can create a sound with a little more reverb and less volume.

A firm direct echo is a hint that the source of the sound is between hard surface walls (i.e., a tunnel, factory, or city).

In the twilight periods, the birds are more active, at night there is barking dog and an owl might be heard. In the morning there will be more traffic activity, the site is active and a bell might be heard. During the day there might be a broadcasting station (i.e., a car radio, or a radio in a structure).

Just close your eyes, and look around!

The FreeSound.org website has an impressively large library of free sounds available for download. There are many random sounds from many sources and locations, but also some impressive Live Location street recordings such as "SundayMorningBellsAmsterdam.mp3" or "Dam and Krasnapolsky.wav".



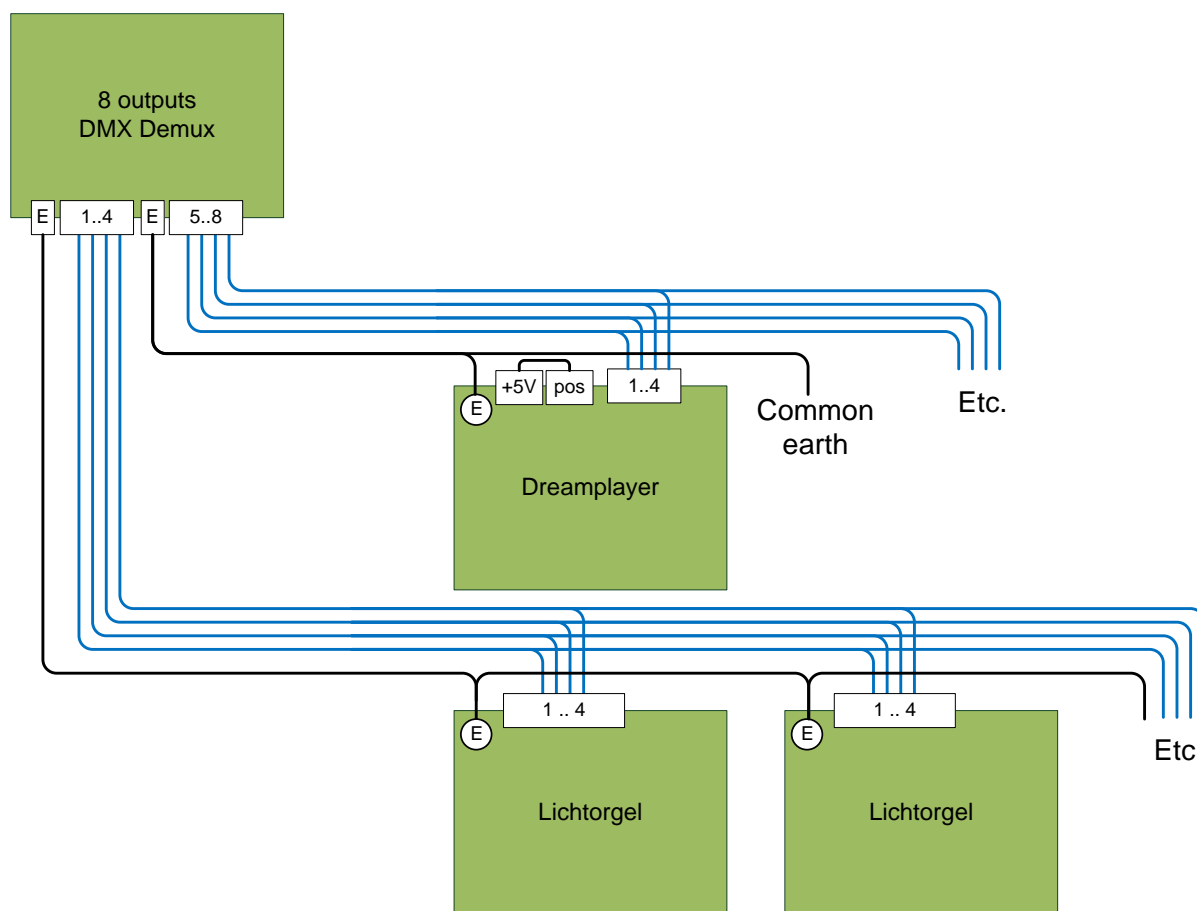
To connect the four inputs of both the light organ and the Dream Player to the DMX system, an additional DMX interface card is required. Again a DMX4ALL provides the necessary interface.

The Universal DMX Demux costs € 40, - and like the dimmer can be connected to the DMX cable.

The module has eight outputs that can be configured in different ways.

- Threshold, DMX eight channels, all values to the threshold 128 sets the output out, with anything above 128 the output is switched on.
- Binary, one DMX channel. Sets the eight outputs according to the 8-bit binary pattern.
- PWM; eight DMX channels. For each output a pulse width modulation is created which, for example can control LEDs or DC motors.
- Strobe; eight DMX channels, a special variant in which various strobes can be controlled. Nice for a lightning effect!
- Servo; eight DMX channels with which the positions of eight servos can be set.

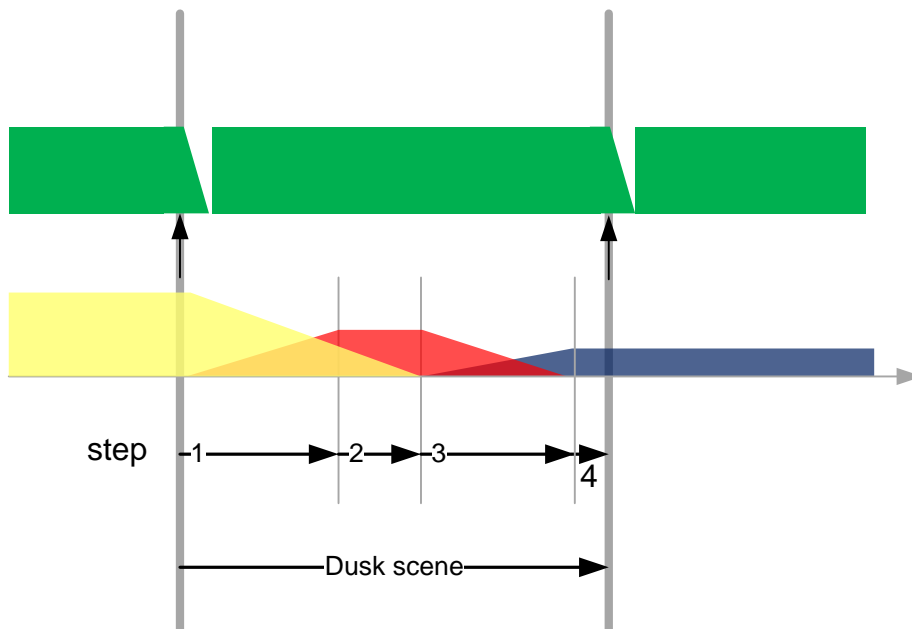
The threshold method is used for the light organs and dreamplayers. As long as the modules work with one common ground, the outputs can be connected directly to the inputs. Multiple dreamplayers, light organs can be connected in parallel.



In this theater in the attic, the channel DMX dimmer is at address 1..4. The start address of the DMUX module should therefore be set at five, so it will listen to channel 5-12. If the software switches on your DMX channel five, then the light organ starts to play the LEDs. Switch on channel nine starts the first sound from the dreamplayer. Because the module operates with a threshold, less than half dimmed outputs do a trigger the DMUX. Just remember this when you fade the “trigger” channels.

Starting sounds

The sounds are started when the scenes begin. If the previous sound is not yet Dream finished, the player then fades out over five seconds, and then new audio file starts. The figure is somewhat exaggerated indicated in green. Keep this in mind when designing the sound scenes.



Translated into the DMX values:

Start dusk scene, step 1:

- channel 8 off and channel 5 on (Light Organs start scene 1),
- channel 12 off and channel 9 on (Dream Player starting sound 1)

finish dusk scene, step 4:

- channel 5 off and channel 6 on (Light Organs start program 2)
- channel 9 off and channel 10 on (Dream Player starting sound 2).

Cables, connectors and power supplies

We have to tie the whole lot together with a couple of different cables.

Computer<-->DMX-Player

A standard USB A-B cable. This is not included with the controller. Such cables are very common, and if you do not already have one by hand, they are readily available from most computer-type stores.

DMX-Player<-->DMX-dimmer

A DMX cable with three pin XLR connector and plug. This cable is at sale with dmx4all.nl or any sound equipment store. It resembles a microphone cable, but it is certainly not the same. Note that some DMX devices are equipped with XLR 5-pin connections, and will require appropriate adaptor cabling.

DMX-dimmer<-->DMX Universal demux

The output of the DMX dimmer is a three pin XLR plug. On the side of the Universal DMX demux is a small three-pole plug is required. This cable you will have to make yourself.

Hint: Buy a long DMX cable with an additional XLR connector (male). Cut the cable in two pieces and solder one side of the plug. The other cable end gets the new three-pin plug. Be sure to use the correct names and pins of the wires. The colors are not standardized!

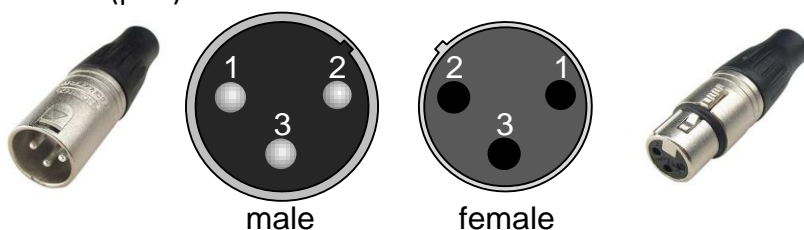


The XLR plugs and sockets are numbered holes and three pins. According to the DMX512 specification, they have the following functions:

1 = GND

2 = DMX - (minus)

3 = DMX + (plus)



If pins 2 and 3 of the cable are swapped, the cable will not work anymore. As an example, light-grade DMX cable generally uses the black wire as earth, red as the data Positive polarity and Yellow for data Minus polarity. For thick professional-grade DMX cable such as Eurocable, the copper shield is the earth, the red is data Positive polarity, and blue data Negative polarity. The solder joints are insulated using a small piece of heat shrink tubing on each pin. As with any data cable, it is advisable to avoid putting undue strain or tension on the cable and connectors, and ensure they are installed with adequate cable retention.

dmx4all.nl offers a handy connector for sale to suit the Universal DMX demux unit. This allows easier connection than dealing with individual wires and solder joints.

DMXUniversaldemux<->Light Organ

The light organs are typically near the street lanterns or the little houses. A medium-sized layout needs a few of these modules. For connecting the inputs you can use a simple computer network cable (CAT5). Use orange, green, blue and brown for the control channels 1..4. The other colors (orange / white, green / white blue / white brown / white) can serve as common earth.

Any cable with five or more wires will work fine.



DMXUniversaldemux<->DreamPlayer

Like the light organs can use a network cable. If the Dream Player is close to the DMUX module you could screw the yellow wires direct into the Dream Player. Remember to connect the common ground too!. The Dream Player has six connections and can used in different ways. Combined as described here you will have to make a small jumper between the "pos" and "+5 V" terminals.

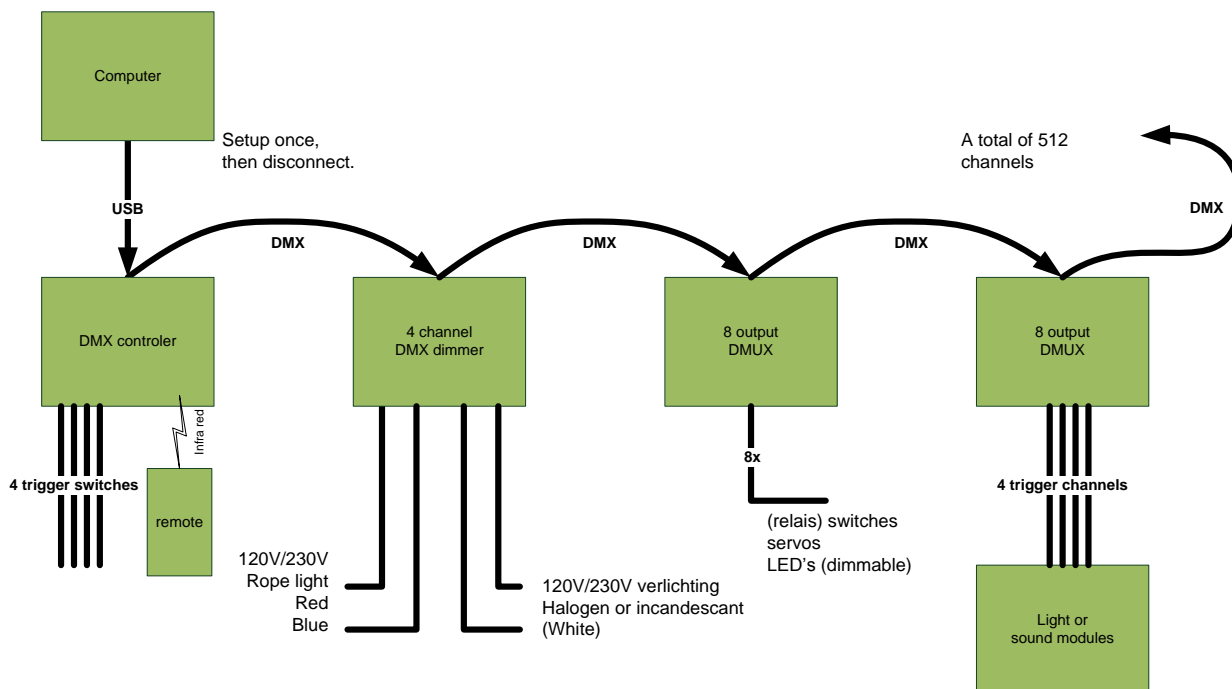
Power Supplies

The modules all need a simple power supply. A adjustable power supply for a few dollars is enough. On my test setup I stripped the plug of the power supply and used a terminal block to distribute the power to the modules. If the modules are further away feel free to use multiple power supplies. Keep in mind that you have a solid common ground and use the same voltage on all the modules. The picture shows a simple 600 mA power supply. With the yellow wheel you can set the output voltage. In the factory they set to the wheel to 0V. Note that it saves you a lot of time to look at this first, the author of this document had a full night finding out this nice feature 😊



System Overview

The following describes the overview of the modules and connections.



Cost

| | |
|-------------------------------|--|
| DMX-controller | € 70 |
| DMX-dimmerpack | € 90 |
| Rope lights | Approx. € 2 per meter |
| Halogen lighting | Depending on desired system deployment |
| Various cables and connectors | Approx. € 30. |

Optional

| | |
|--------------------|--------------|
| Remote control | € 30 |
| DMXUniversal demux | € 40 |
| Light Organ | € 48 |
| Dreamplayer | Approx. € 60 |

With this shopping list a basic system can be obtained for around € 250 or \$ 320.

A fully-optional system can be assembled for around € 400 or \$ 525

Conclusion

The system as it is presented meets the stated requirements. It is a relatively simple and affordable system that complements the modeling world with a new experience.

It's a combination of available and cheap components. It's expandable for any new modules or new imagination!

About

The author Hans Nouwens (Netherlands, 1970) is modeling enthusiast with past experiences in sound engineering and theatre techniques. He is co-initiator of Railz Miniworld and during the daytime works as IT enterprise architect for TU Delft.

Some of his efforts can be seen at <http://www.1op87.nl>

Translation

This document is originally written in Dutch and translated into English with the generous help of Jim Wells, owner of Fantasonics and moderator of the Layout Sound group from the United States and co-moderator "Professor Klyzlr", Pro-Audio/Lighting professional from Australia.

More Information

<http://www.railzminiworld.nl>

A unique experience!

Railz Miniworld is the largest indoor model railroad layout of The Netherlands. When you visit The Netherlands and the Rotterdam region you'll have to visit our attraction. You will see 500 sqm of model railway layout, including 200 sqm Rotterdam in Miniature. A model railroad layout is a big and detailed world in miniature that tells a story, it's full of motion, it's full of lights and it generates sounds. It's much more than "just" model trains. Day and night on the layout are simulated by dimming the lights in the exhibition hall and activation of thousands of lights on the layout.



DMX4U.NL <http://www.dmx4all.nl/> or <http://www.dmx4u.nl/>

Supplier of the DMX modules.

If you decide to order this please put "theater op zolder" in the Comments box. This will let the owner know how you heard about their products, and in the spirit of openness and honesty, I receive a small commission to finance further model train-related research.

<http://dinamo.vanperlo.net>

Supplier of Light Organ and other smart components for your model layout.



<http://www.fantasonics.com>

Supplier of DreamPlayer unit and soundtracks

<http://audacity.sourceforge.net>

FREEware Audio Editing application for MacOSX, Microsoft Windows, and GNU/Linux.



<http://www.freesound.org>

Online search engine and FREE sound library