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## Introduction to DMX

DMX stands for **D**igital **M**ultiplexing

DMX was a development of the United States Institute for Theatre Technology. (USITT) and has now become a worldwide standard for the control of lighting in theatres and for live entertainment. Increasingly it is moving into other areas of lighting control with the introduction of LED light fittings to the extent it is now found in commercial buildings for architectural lighting.

Before DMX theatre lighting control, when it moved into the electronic era the 0 -10V control standard was used. This was not such a great problem when there was only a small quantity of lighting channels. Typically, a system requiring 60 channels of control, for example, would require a cable with a diameter of 25mm (1"). This would then have to be split between each of the dimmer racks.

The advantages of this over earlier systems requiring large rheostats was huge and very quickly electronic desks began to be developed which brought about considerable advances in the type of shows that could be produced.

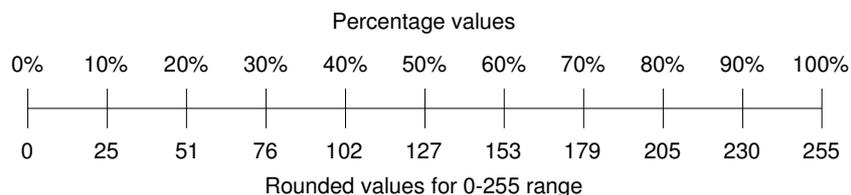
The number of channels required steadily increased and the method of linking the lighting control desk to the dimmers started to become an obstacle. At the same time some of the fittings to control became more complex.

Enter DMX.....

The bulky control cables, although only carrying low voltage signals could now be replaced with a cable of 5mm (0.25") diameter capable of carrying enough information to control 512 channels.

DMX sends information in a serial format. For simplicity of understanding assume that the level information for the 512 channels is sent in blocks of 512 and then repeated again. This occurs many times a second. For each of the channels a level between 0 and 255 is sent. 0 represents a level of 0% and 255 would represent a level of 100%. The resolution of DMX control is 255 steps.

When controlling a DMX device from an SCD24/SCD96 the resolution is reduced to 100 steps but over the range 0 to 255.



Are there problems with the reduced resolution? It is unlikely to cause a problem since most DMX devices do not need a precise DMX level for a function of the device to operate.

With regard to 3 or 4 colour fittings (RGB/RGBW), the number of colours is reduced from 16.7 million to 1 million.

### How does a DMX dimmer operate?

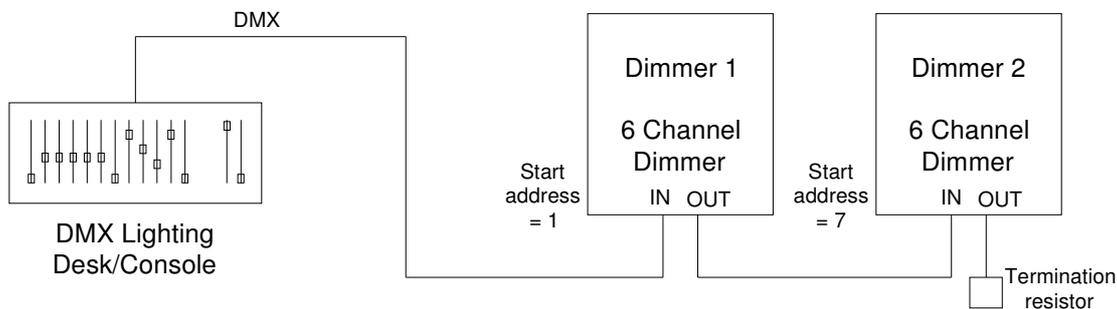
A DMX controlled dimmer responds only to the signals continuously sent to it by the DMX source e.g. a Lighting desk. If the DMX is removed depending on the design of the dimmer the dimmer will either remain at the last level received or turn off.

The SCD24 and SCD96 DMX Source Controllers allow DMX levels to be saved as Scenes and recalled from messages sent over the iLight Network. This makes it as easy to integrate and program DMX controls into an iLight system as it is with any other type of lighting.

To dim a channel from 0% to 100% in 3 seconds the DMX source send a channel value changing from 0 to 255 over a period of 3 seconds.

## What is a DMX network and how is it constructed?

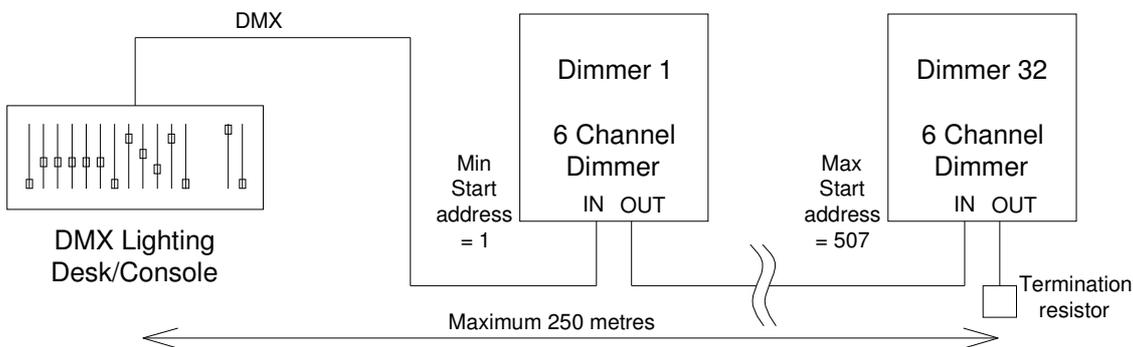
An example of a simple DMX network would be a lighting desk connected to two 6 channel DMX dimmers.



The type of networking used by DMX is known as 'multidrop'. With this type of network all of the receiving devices are connected in parallel on the network.

At the end of the network is a termination resistor, often switchable via a dip-switch on the DMX device. Typically, this has a value of 120ohm. The purpose of this resistor is to match the impedance of the source and prevent 'reflections' on the network which would corrupt data.

A maximum of 32 'receivers' can be placed on a DMX network. This means that, in the example shown above, the number of dimmers could be increased by another 30 to 32. The number of channels of each device does not matter provided that the number of channels to control does not exceed 512.

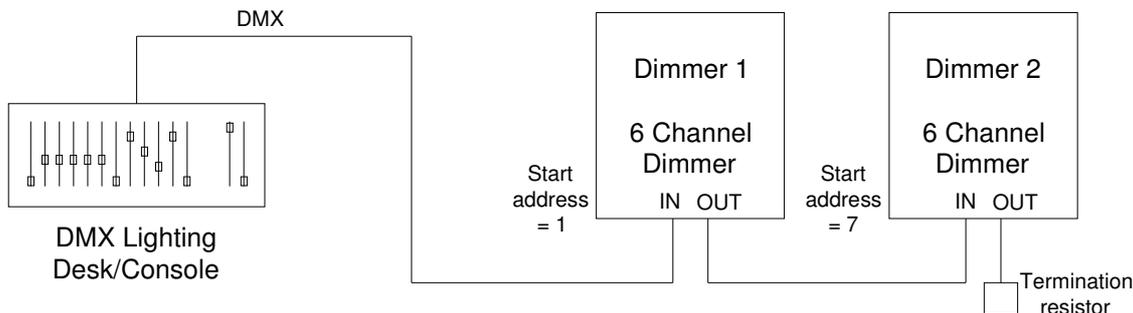


The maximum length of a DMX network is approximately 250 metres. If a network of greater than 250 metres is required then it may be necessary to include a splitter in the network to regenerate the DMX signal.

The limitation is due to the speed of the DMX transmission. The speed is 250K Baud. This means there are 250,000 pulses per second. This speed is required in order to send the values for the 512 channel levels enough times a second so that fades appear to smooth. The values of the 512 channels can be sent up to a maximum of 44 times a second.

## How are DMX devices addressed?

The Lighting desk is the source or transmitter of the DMX and the dimmers are each receivers of the DMX data. The data is received by both of the dimmers at the same time and they will respond to data according to the address they are set to. The address is also known as the 'Base Address'.



The dimmers set with a Base Address of 1 will respond to DMX channels 1 to 6 and the dimmers set with Base Address of 7 will respond to DMX channels 7 -12.

The base addresses do not have to be consecutive. Addresses can start anywhere in the range 1 to 512. So in the example above the Dimmer 1 could be set to have a base address of 10 and Dimmers 2 a base address of 300. This would mean they would respond to DMX channels 10 – 15 and 300 – 305. If two or more devices are to always respond together they all be given the same Base Address.

It is not normally possible to set the individual channels of a device to the same address however this is possible on iLight Source controllers which have been configured to receive DMX.

## What is a DMX Universe?

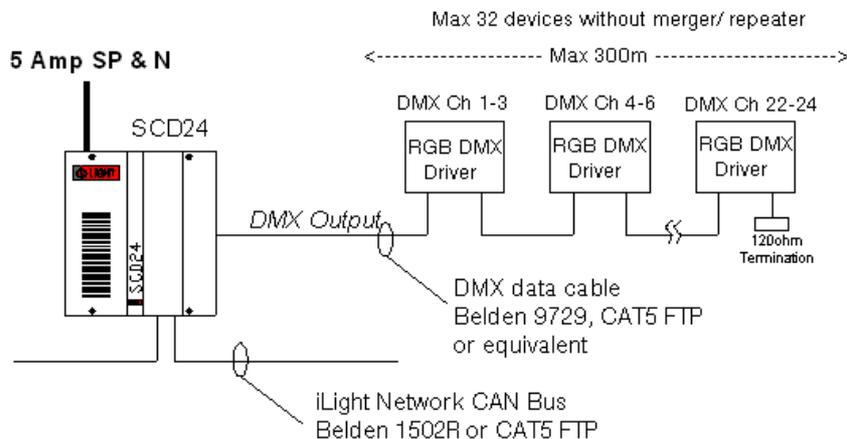
The term DMX Universe means 512 channels. A transmitter that sends only 512 channels is capable of controlling a single 'universe'. There are lighting consoles capable of sending multiple 'Universes'.

## What does 'Channels' refer to in terms of DMX?

A Channel in DMX terms is a channel on a DMX controlled device.

For example, a RGB LED driver would typically have three channels - Red, Green and Blue. The start address of the device would set the Channels in the DMX spectrum that the driver would respond to. If the start address was set to 11 then Red = channel 11, Green = channel 12 and Blue = channel 13.

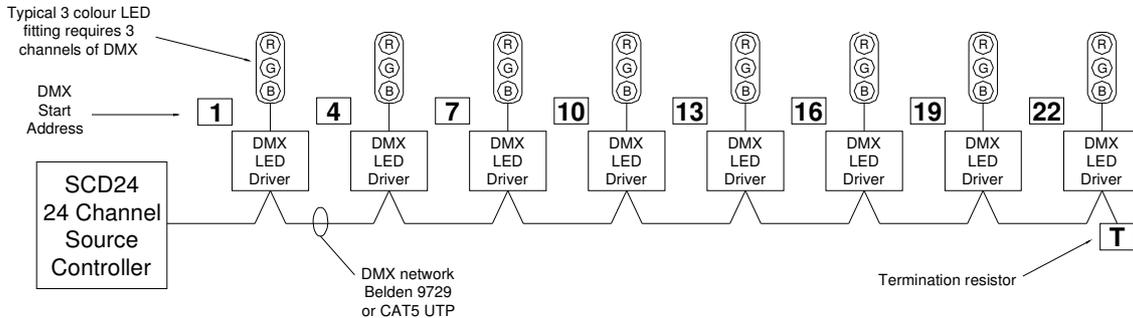
Setting up different base addresses allows devices on a single DMX line to be grouped or individually controlled. This is how a single DMX data cable can be used to control multiple, independently dimmed lights.



## How many devices can be controlled by an iLight SCD24?

A maximum of 32 devices can be attached to the DMX output of a SCD24. The maximum number of useable addresses is 24. The SCD24 transmits information for only the first 24 addresses of the universe with a fixed base address of 1 (1-24)

Example:

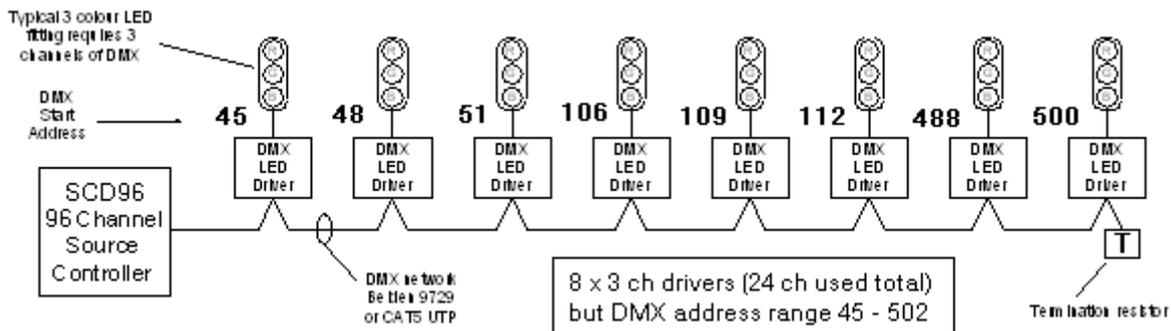


In this example 8 LED drivers are attached to an SCD24 using all 24 addresses available.

## How many devices can be controlled by an iLight SCD96?

A maximum of 32 devices can be attached to the DMX output of a SCD296. The maximum number of useable addresses is 96. Each of the 96 channels can be reconfigured to output any DMX address between 1 and 512, so there is no fixed base address.

Example:



In this example 8 LED drivers are attached to an SCD24 using all 24 addresses available.

## How are devices/fittings identified on a DMX network?

DMX devices are identified by the base address they are set to.

All base addresses can be unique if all fittings are to be controlled independently. Fittings with the same base address will be controlled as a group.

## How is the base address of a fitting chosen?

When setting the base address of a fitting you must also know the number of addresses of DMX the fitting uses.

Typically, 3 colour RGB LED driver will require 3 addresses but a complex moving head projectors can use 25 addresses for all the functions available.

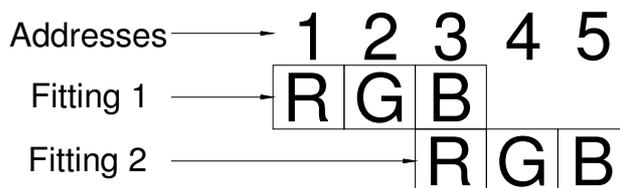
4 colour RGBW LED drivers are less common and will require 4 addresses due to the addition of a separate White channel. This is designed to improve the rendering of a white colour over that of blending Red, Green and Blue at 100%. It also increases overall colour palette available.

If all 512 channels are available then types of devices may be grouped by type or location but if there is limited availability of DMX addresses then typically the first fitting would be set with a start address of 1 and the next fitting would have the next available free address.

### What happens if the address is set incorrectly?

No damage will occur, but if the addresses of two fittings overlap then the results will not be as intended.

The effect of the address overlap above is that when DMX channel 3 is modified the Blue channel of fitting 1 will be changed but at the same time will the Red of fitting 2 also change.



### Does the power to a DMX controlled fitting need to be switched?

Fittings such as RGB LED drivers would normally be permanently powered from an uncontrolled supply.

Depending on the sophistication of a device one of the DMX address may be programmed to turn the device from standby to active state. This is a function of the device.

For example:

Martin QFX150 Fibre Projector.

This projector requires 5 addresses/channels of DMX to control it.

- Channel 1 – Lamp On, Lamp Off & Reset
- Channel 2 – Dimmer
- Channel 3 – Colour Wheel
- Channel 4 – Twinkle Wheel
- Channel 5 – Colour Speed

In this device the Lamp can be turned on and off using different values for the DMX channel set allocated to channel 1 of the projector.

If it was required to same energy then the power to a fitting could be turned off using a control system if this was integrated into the control methodology.

## What type of cable is used for DMX and how should this be installed?

The type of cable to be used is dependent on the type of installation and how the cable has to be terminated.

Belden 9729 is a good quality cable which is popular as it is designed to be terminated either to screw terminals or by solder connection to XLR connectors.

An increasing number of DMX controlled devices, especially LED drivers, are using RJ45 connectors for the connection of the DMX data. This requires the use of a suitable CAT5 cable.

Both Belden 9729 and CAT5 cable are suitable for indoor installation. Belden 9729 is a more robust cable.

DMX is regarded as a SELV cable and as such should be segregated from power cable in line with local regulations. Standard CAT UTP is not usually rated for inclusion with cables carrying mains voltages.

If cables are to run externally then suitably designed cables and connectors should be used and lightning surge protectors considered to prevent the induction of ground voltage through the data cable in the event of a ground strike.

## What are the typical DMX connection pin outs?

### XLR-5 pinout

1. Data Link Common
2. Data 1- (Primary Data Link)
3. Data 1+ (Primary Data Link)
4. Data 2- (Optional Secondary Data Link)\*
5. Data 2+ (Optional Secondary Data Link)\*

### XLR-3 pinout

1. Data Link Common
2. Data 1- (Primary Data Link)
3. Data 1+ (Primary Data Link)

### RJ-45 pinout

1. Data 1+
2. Data 1-
3. Data 2+\*
4. Not Assigned
5. Not Assigned
6. Data 2-\*
7. Data Link Common (0V) for Data 1
8. Data Link Common (0V) for Data 2\*

### Wire colour

- White/Orange\*\*  
Orange\*\*  
White/Green\*\*  
Blue\*\*  
White/Blue\*\*  
Green\*\*  
White/Brown\*\*  
Brown\*\*

\*Data 2 is not commonly used

\*\* T568B pin out. Not crossover.

## What happens if the network is incorrectly wired – will anything be damaged?

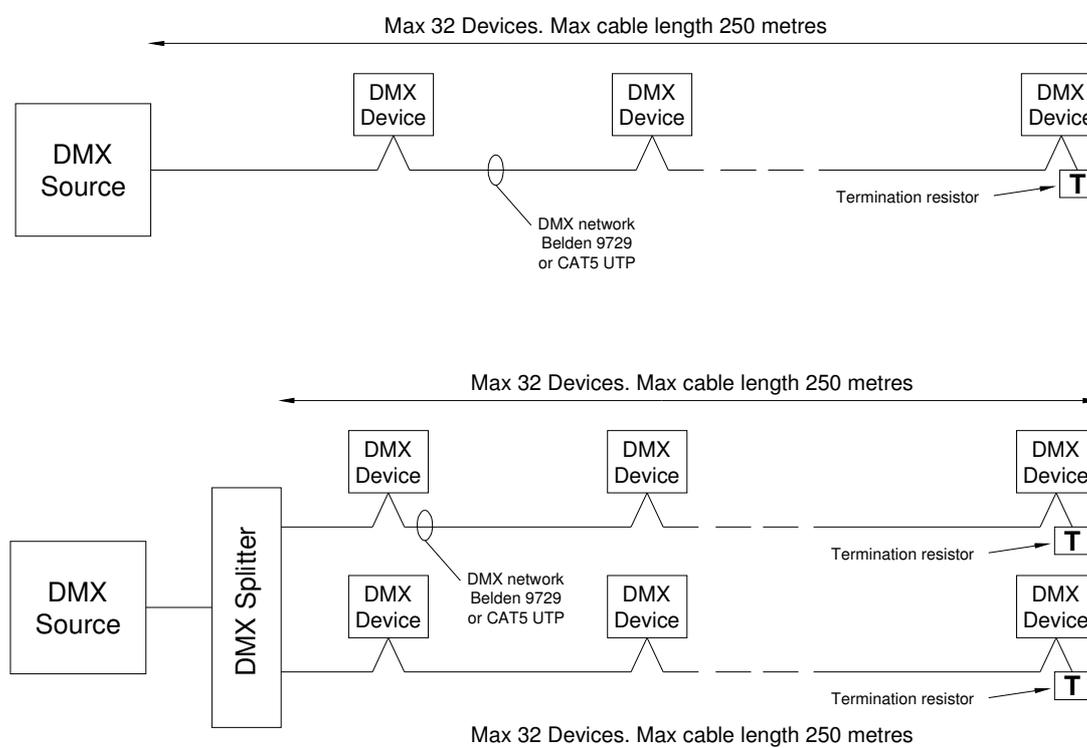
Misconnection of connectors will result in short circuits or open circuits

If there is termination error and wires are crossed, or there is a short circuit, it is very unlikely that damage will be caused but there will be no control, or unpredictable control.

Provided that the cables have not come into contact with any voltages higher than 5 volts the 'transceiver' chips inside the fittings will not be damaged.

## Network topology

A DMX network should be wired as a radial; much like the iLight CAN network. It should not have any branches, spurs or stars. If a branch is required then a splitter (by others) must be used. This is an active device and not a simple connection box and there are many types and sizes available in the market.



## Does it matter which phase the fittings are connected to?

The phase of the fittings does not matter.

## Can multiple DMX sources be connected to a DMX network?

No. For some installations a DMX merge unit can be used but this would be for specialist installation.

## What questions should be asked when discussing a DMX system with a designer?

What are the fittings?

Who is the proposed manufacturer of the fittings/drivers? Get a product number and ascertain the number of DMX channels each type of fitting requires.

What effect/control is required?

From this you should be able to ascertain whether the relative simple control obtained by using typically an SCD24 is adequate or if there are many channels and a complex control strategy then a Light Factory method of control maybe required.

When should the SCD24 and/or SCD96 be used? When should Light Factory be used?

This will be dependent on a number of factors:

If the requirement for primarily static control with a small number of colour changes running relatively slowly and there are a small number of channels then the SCD24, SCD96 or multiples of these might be appropriate.

If the requirement is for many channels of control and multiple effects (complex chasing colours and more theatrical effects) then a product such as Light Factory would be appropriate. Please visit [www.ilight.co.uk](http://www.ilight.co.uk) and look in the software section of the products list for further details.

Discuss with iLight Technical Support if unsure. Email your question to [ilightsupport@cooperindustries.com](mailto:ilightsupport@cooperindustries.com)

## How much time should be allowed for programming?

The question has to asked of the client/lighting designer about what it is they want the system to do. Ideally, a detailed specification will provided but this is not usually available as the 'artistic' aspect of the design is not developed until the system is available.

If the requirement is simple colour change in a domestic or commercial environment the once the DMX is operating then the setting of colour/levels should take no longer than normal programming.

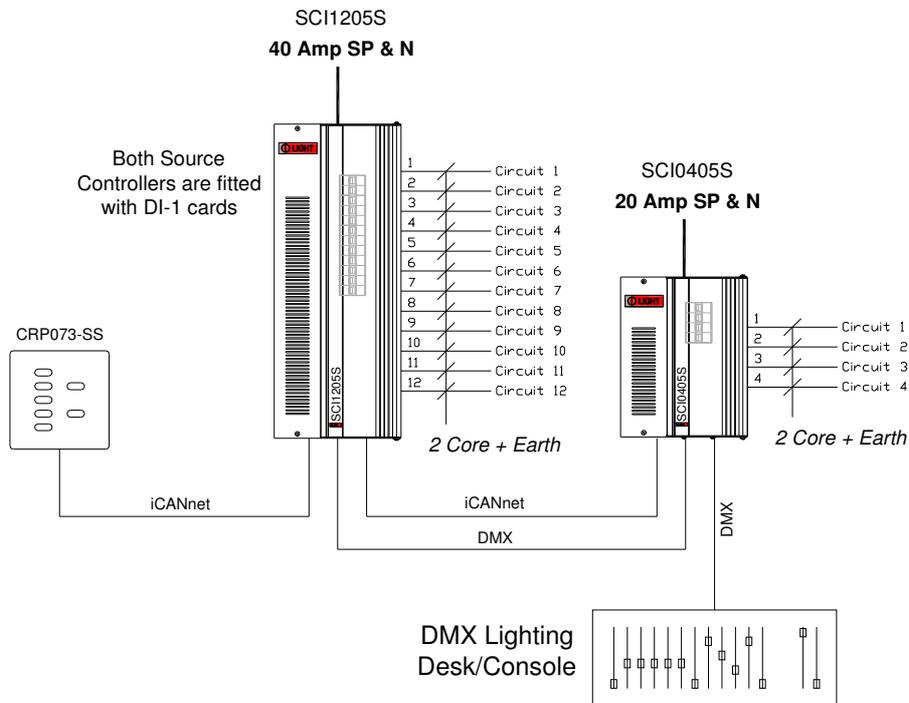
If the system is more extensive and there are many effects that are required then a fair approximation of the likely time required has to be made taking into account whether it can be done during the day or in the case of external lighting at night. Also take into account the time of year when programming external lighting.

If it is uncertain what is going to be needed then ensure that this is made clear that programming is in addition to the equipment; if in doubt discuss with iLight Engineering.

## How are iLight Source Controllers controlled with DMX?

All iLight Source Controllers can be controlled with DMX by the addition of the DI-1 card. The exceptions are:

- SCH1000T LCM
- All DINrail products, including SCMD6400 DALI Controller
- SCD24 DMX Source Controller
- SCD96 DMX Source Controller
- RI2 Relay Interface



The system shown can be controlled by both DMX and by messages received on the CAN network.

Both controls cannot operate simultaneously.

Each channel of source controller can be configured to any single DMX address in the range 1 – 512. Multiple channels can have the same address if required.

Each channel is further configured to operate in one of three modes:

**Mode 1 – CAN only**

In this mode the channel will respond only to messages received on the iCANnet

**Mode 2 – DMX only**

In this mode the channel will respond only to DMX data.

**Mode 3 – DMX if present**

In this mode the channel will respond to DMX data exclusively if the source controller is receiving DMX. If the DMX data is not present the channel will revert to iCANnet control.

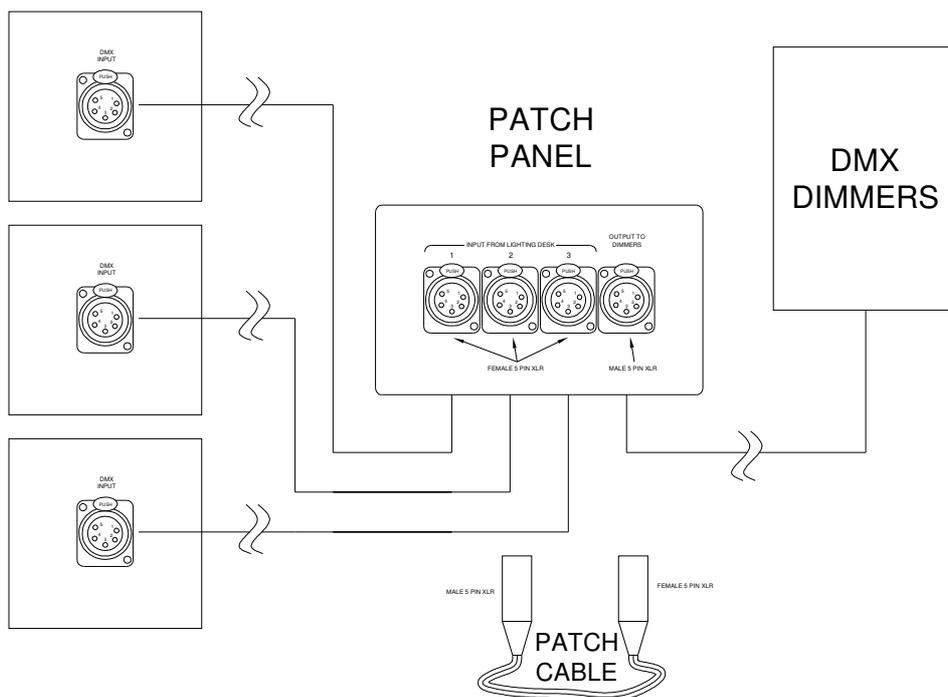
## How can a DMX network be tested?

You cannot test a DMX network properly without a source of DMX. DMX testers are available.

On the SCD24 and SCD96 it is possible to use the override facility of the unit to send each DMX (1-24) from 0% to 100%. By default from the factory the SCD24/SCD96 will output DMX channels at a value 100% (255) at switch on.

## What is a patch panel and how do they work?

An example of a Patch Panel is shown below. It is not acceptable to join the 3 input sockets in parallel. Each input socket is wired to a socket on the patch panel and then a Patch Cord is used to link the Input socket to the socket that connects to the dimmers.



## What is RDM?

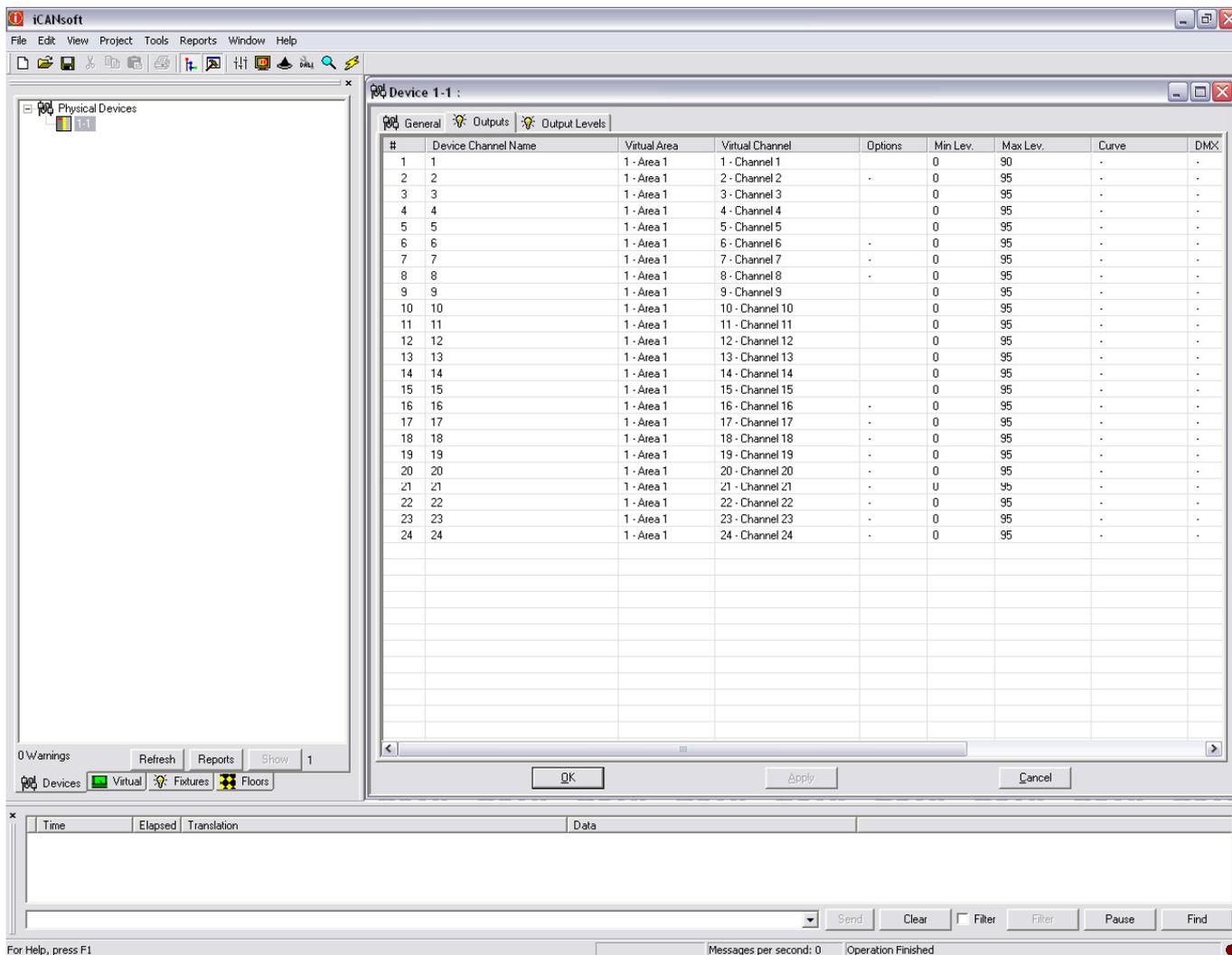
Remote Device Management or RDM is a protocol enhancement to DMX that will allow bi-directional communication between a lighting or system controller and attached RDM compliant devices over a standard DMX line. This protocol will allow configuration, status monitoring, and management of these devices in such a way that does not disturb the normal operation of standard DMX devices that do not recognize the RDM protocol.

Currently there are no iLight devices that use RDM.

## Configuration using iCANsoft

When the SCD24 is uploaded into iCANsoft it will appear as a 24 channel source controller. An SCD96 will appear as a 96 channel Source Controller.

Channels can be configured to any virtual channel in any area. A minimum and maximum level for each channel can be set but this would normally be set to be Min = 0 and Max = 100. There is not Curve or Option available.



## Example RGB Setup

3x RGB drivers are on the DMX network, connected to an SCD24.

If the first driver has a base address of 1, the second is 4 and the third is set to 7 it will be possible to control each of the drivers individually.

We will say that driver 1 is in Area 1, driver 2 in Area 2 and driver 3 in Area 3. In each of these Areas we will need to make 3 virtual channels; channel 1 'Red', channel 2 'Green' and channel 3 'Blue'.

In the outputs list of the SCD24 we will need to set device channels 1, 2 and 3 to Area 1, virtual channels 1-3 respectively.

For driver 2 we will need to set device channels 4, 5 and 6 to Area 2, virtual channels 1-3 respectively.

For driver 3 we will need to set device channels 7, 8 and 9 to Area 3, virtual channels 1-3 respectively.

### Example Scene Setting for Colour Selection

With RGB fittings a palette of colours are accessible by blending the 3 colours together at different levels. For full red you would set the Red channel to 100%, and the others to 0%. For purple you would have a combination of blue and red to get the desired tone.

### Example scene settings for colours:

Colour	Red Channel Level	Green Channel Level	Blue Channel Level
Red	100	0	0
Green	0	100	0
Blue	0	0	100
Purple	75-100	0	75-100
Orange	50-75	75-100	0
Cyan	0	50-75	75-100
Yellow	25-50	50-75	0
White	100	100	100

These settings can be saved as Scenes which allows colours to be selected through scene selection on push button panels, touchscreens or timeclock events.