Technical data sheet

Perspex® Spectrum LED

Perspex® Spectrum LED Technical Information
Perspex® Spectrum colours have been specially formulated to give optimised colour performance with both transmitted and reflected light using both white and coloured LEDs. The excellent brightness and evenness of illumination of the Perspex® Spectrum sheet allows sign makers and specifiers to develop backlit solutions that are slimmer, brighter and more cost-effective in operation than more traditional designs. Of course, other light sources can also be used e.g. fluorescent tubes.

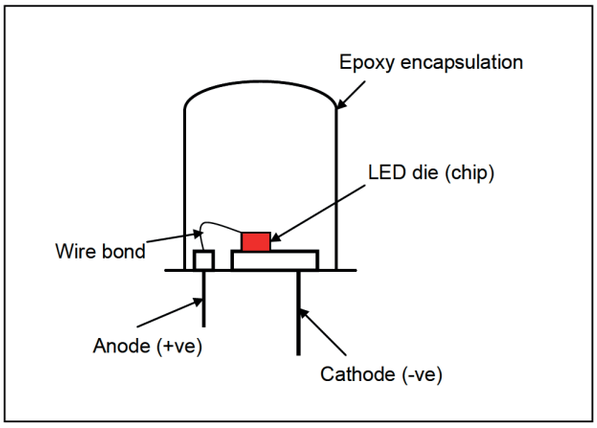
In service, Perspex® Spectrum sheets allow the development of backlit solutions that offer many potential benefits to customers:

- Optimum brightness and strength of colour
- The hiding power of Perspex® Spectrum colours has been maximised to conceal the LED light sources and avoid “banding” or “hot spots” associated with some backlit systems
- The development of elegant slim backlit signage solutions
- Cost savings as fewer and lower energy LED light sources can be used
- Environmental benefits due to lower energy use and lower heat output

All Perspex® Spectrum colours are manufactured using Perspex® cell cast acrylic sheet. They therefore retain the superior physical attributes and characteristics of Perspex® cast acrylic sheet products (e.g. outstanding gloss surface and weatherability).

What are LEDs?
Light Emitting Diodes (LEDs) are becoming ever more popular as light sources for use in illuminated signage and display applications. Their small size, low energy requirement and long lifetime mean that they are gradually replacing more traditional light sources.

Figure 1 – basic LED construction



An LED is a “solid state” electronic component with the features of a diode, i.e. it only allows electrical current to flow in one direction. When an electrical current is passed through an LED in the right direction, the LED emits light. The LED die is similar to a filament in a lamp as it emits the light.

Coloured LEDs
The colour of the light emitted from an LED is primarily dependent on the chemical composition of the material from which the die is made. Coloured encapsulations are also sometimes used.

Multi Coloured LEDs
Light from individual LEDs can be mixed together to produce a wide range of colours. Normally red, green and blue LEDs are combined in LED modules where the overall emitted colour can be controlled by blending the colours from the individual LEDs.
They are sometimes referred to as RGB LEDs. These modules require an electronic control unit to blend the colours together.

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LED modules and strips
Individual LEDs are called discrete LEDs. To be of practical use discrete LEDs are populated on to printed circuit boards, usually with additional electronic components to control the electrical current. An assembly of one or more discrete LEDs can be combined in a module to be used for back-lit signs or lighting. Alternatively discrete LEDs can be combined together in strips of varying lengths that can be rigid or flexible. Therefore they can give the designer or sign-maker greater design flexibility. The LED modules or strips can either be mounted behind the sign or display or along the edge for edge-lit applications. It is also possible to mount LEDs into channels machined into the display material e.g. channel lettering.

LED Brightness
The normal unit used to express light output is lumens and this allows some comparison to be made between different light sources e.g. LED and incandescent bulb. However many traditional light sources are rated by power (Watts) and therefore as LEDs use less power a direct comparison is more difficult to achieve.
Some LEDs can have a light output of about 100 lumens/watt (lm/w) with developments continuing all the time to increase light output still further. The colour of the LED will also have an influence on the light output; white LEDs typically have highest light outputs across the visible spectrum. A typical example shows that a 4-5 watt LED will have about the same light output as a 40 watt incandescent bulb i.e. 400 lumens.
Of particular relevance to signage, luminance is often measured in lux and can be considered as the amount of light per area. Luminance: lux = lumens/m^2.

Construction
With the wide range of available colours of Perspex® Spectrum sheet and the many different types of lamps, it is not possible to present a simple set of rules which assures the most effective results for every application. However some general guidelines can be given. The luminance of any internally illuminated sign or display is determined by five factors:

1. Lamps - their number, type, light output, colour and position in the sign case.

2. Materials - the light transmission, reflection, absorption and diffusion factors of the Perspex® grade and thickness used.

3. The Sign Case - its dimension, particularly its depth and the reflection factor of the paint or other finish used on the inside of the case.

4. Light Absorption - the effect of absorption of light by the lamps and electrical equipment within the case.

5. Maintenance - the reduction in the light output of the lamps with increasing age and the influence of dust inside the case.

The lamp spacing ratio for LEDs is similar to that for other light sources i.e. ratio = 1, the same distance between the LEDs as that between the LED and the front panel.

Benefits of LEDs in signage applications
- The development of elegant backlit signage solutions and improved aesthetics:
  - Slim signs
  - More even illumination
    - LEDs installed correctly in combination with Perspex® Spectrum can provide a much more even illumination than tube lighting.
    - Small size: LEDs can be very small (smaller than 2mm2), enabling the corners of challenging light boxes to be better illuminated e.g. the letter “K”
    - On/Off time: LEDs light up very quickly.
    - Dimming: LEDs can be easily dimmed.
- Environmental & cost benefits
  - LEDs have a much longer lifetime than alternative light sources e.g. 50,000 hours in comparison to fluorescent tubes rated at 10,000 to 15,000 hours, resulting in:
    - Lower costs over the lifetime of the sign
    - Reduced maintenance costs
    - Fewer outages
  - Energy savings as fewer and lower energy LED light sources can be used to achieve the same level of brightness.
  - Efficiency: LEDs produce more light per watt than incandescent bulbs. Energy savings of up to 80% is typical for LEDs in comparison to equivalent fluorescent tubes.
  - Low heat output (Cool light): In contrast to most light sources, LEDs radiate very little heat. Wasted energy is dispersed as heat through the base of the LED.
  - Quick on and off as well as easy dimming saves energy
- Slow failure: LEDs mostly fail by dimming over time, rather than the abrupt burn-out of incandescent bulbs.
- Safer to maintain with a lower working voltage of 12v
- Durability: LEDs, being solid state components, are difficult to damage with external shock, unlike fluorescent and incandescent bulbs which have fragile glass tubes or bulbs and delicate filaments.

Typical light output (lumens/Watt) for LED and Fluorescent light sources
Providing definitive light output data for LEDs and fluorescent light sources is difficult as LED light sources tend to be directional whereas fluorescent light sources emit light in all directions. Depending on the application and design of the light fixture or sign this can have a significant effect on the perceived light output.

For light sources giving similar light outputs the following values are typical:
Fluorescent tubes: 80 – 100 lumens/Watt
LED lamps: 40 – 60 lumens/Watt
However, as LED lamps are directional they can supply a similar amount of light to a chosen area as the fluorescent lamp if correctly designed. Therefore LED lamps are often described as equivalent to a fluorescent lamp.

Basic cost comparison using LED and Fluorescent light sources in a 1.05m x 1.05m sign box with a Perspex® Spectrum 1TL2 panel

	LED T8 lamp	Fluorescent T8 lamp
Life span, hours	50,000	15,000
No. lamps needed for a 1.05 m x 1.05 m sign box using Perspex® 1TL2	4	4
Cost per lamp, £	35	3
No. lamps needed for 50,000 hours usage (equivalent to circa. 10 years at 12 hours/day)	4	16
Total lamp cost, £	140	48
Watts per bulb	15	30
Total kWh over 10 years	3000	6000
kWh cost (assume £0.10/kWh)	300	600
Total lamp + kWh cost over 10 years, £	44	648

Information based on typical 2011 data.
Assumes both LED (15W) and fluorescent (30W) lamps are clear and have a minimum light output of 1,600 lumens per metre.

Other cost considerations:
Fluorescent lamps and ballasts require replacement maintenance costs e.g. labour.
Fluorescent lamps have a disposal cost – contain mercury.

Estimating Sign Brightness
Estimating sign brightness can be difficult as it depends on a number of factors such as the light source, diffusing panel and fixture design. However, a basic estimate can be made if the necessary information is available. It should be noted that the actual sign brightness will probably be lower than the figure calculated as factors such as sign cleanliness and the age of the lamp can reduce brightness over time.

- calculate the light being generated from the light source, L lumens; Fluorescent, L lumens = No. of lamps x lumens/lampLED, L lumens = No. of modules x lumens/module or No. of lamps x lumens/lamp
- calculate the illuminated surface area of the sign A m^2; Area, A m^2 = length x height (for a simple single faced sign)
- Light diffusion factor, U %; Light diffusion, U % = Light transmission of the diffusing panel e.g. Perspex® Spectrum 1TL2 has a light transmission of 48% using an illuminant D65 lamp.

Sign Brightness, B lumens/m^2 = (L x U) / (A x 100)
Or, using alternative candela units,
Sign Brightness, C candela/ m^2 (cd/m^2) = B x 0.318

Therefore, for the example above where a 1.05 m x 1.05 m sign is illuminated using Perspex® 1TL2 and 4 T8 lamps the sign brightness would be estimated as:
L = 4 x 1600 = 6400 lumens
A = 1.05 x 1.05 = 1.1 m2
U = 48%
B = (6400 x 48) /(1.1 x 100) = 2792 lumens/m^2 or 888 cd/m^2

Benefits of using Perspex® Spectrum LED sheet

Colour strength
The sign or display will have a strong colour whether lit or unlit as Perspex® Spectrum range has been specially formulated to give optimised colour performance with both transmitted and reflected light.

Diffusion
A critical factor when illuminating signs with LEDs is the diffusing power of the acrylic sheet. LEDs are small, intense sources of light and incorrect sign box construction will result in uneven illumination – so called “hotspots”. Perspex® Spectrum has been formulated to optimise diffusion whilst retaining vibrant, attractive colours both transmitted and reflected, enabling the construction of thinner, more elegant signs.

Type of LED
Although specially designed to excel with white LEDs, Perspex® Spectrum will perform equally well with coloured LEDs. As with any other light source, the colour of the LED will have an impact on the transmitted shade. Our market research suggests that the signage market is moving in favour of white LEDs.

Light boxes built with Perspex® Spectrum sheets will show no “hotspots” above 50mm depth when used with typical LEDs at correct spacing, and still maintain a high light transmission level.

Perspex® Spectrum sheet also excels with High Brightness LEDs, however the depth of the light box may need to be adjusted to give optimised even illumination.

Design flexibility
The excellent brightness and evenness of illumination allows sign makers and specifiers to develop back-lit solutions that are slimmer, brighter and more cost-effective in operation.

Other Light sources
Perspex® Spectrum sheet can successfully be used with other light sources where a high degree of diffusion and light transmission is required.

Points to consider when using LEDs
Fundamentally LEDs are light sources just as incandescent and fluorescent bulbs and tubes. Therefore the same considerations should be used when using LEDs in signage or display applications. Refer to sections 6 and 7 of the PX261 Corporate Imaging brochure.

Sheet brightness: Perspex® Spectrum colours have been specially developed for use with LED light sources to give strong and bright colours. The level of brightness can be reduced by using either fewer or less bright LEDs.

The quality of the overall construction is of direct relevance to the lifespan of an LED illuminated sign box. Units should be designed to provide sufficient weatherproofing as well as ensuring the removal of the small amount of waste heat generated by the LEDs. Most LED units fail not with the LED but rather the total product e.g. moisture ingress or heat build-up affecting electronic components.

10 year guarantee
The normal Perspex® 10 year outdoor weathering guarantee applies to this product.

Light Transmission
Perspex® Spectrum sheets are available in a wide variety of colours covering the full visible spectrum.

Colour Code	Colour	Transmission Peak (at specific colour wavelength)	Y Value (illuminant D65)
1TL1		39	36
1TL2		49	48
2TL1		46	22
2TL2		44	30
3TL1		47	12
4TL1		46	7
4TL2		44	5
4TL3		45	6
6TL1		31	15
6TL2		22	12
7TL1		38	5

All Perspex® Spectrum colours have constant light transmission. The light transmission stays the same whichever thickness sheet is ordered.

Additionally our in-house colour laboratory can produce customised solutions to suit particular applications.

“Channelled” LED letters

Channelled LED letters are thicker Perspex® letters into which a hole, channel or groove is cut and LEDs sealed inside the channel. Perspex® offers a range of make-to-order products suitable for this application. For more information, please contact your local representative or the Lucite International Sales Office.

Masking

Perspex® Spectrum coloured sheet is supplied with double-sided, non-thermoformable PE masking. The showface masking is printed with the Perspex® logo.

Table of Properties

Values quoted for the properties of Perspex® Spectrum sheet are the results of tests on representative samples and do not constitute specifications

Property	Test Method	Unit	Value
General properties			
Density	ISO 1183	g cm^{-3}	1.19
Water Absorption	ISO 62	%	0.2
Thermal Properties			
Vicat Softening Point	ISO 306 A	°C	> 110
Flammability	UL94	Class	3
	DIN 4102	Class	B2
	NFP 92-507	Class	M4
	BS 476 Part 7	Class	HB
	ISO 11925-2	Class	E
Coefficient of Thermal Expansion (Linear)	ASTM D696	x 10^{-5}. K^{-1}	7.7
Mechanical Properties			
Tensile Strength	ISO 527 (5 mm/min)	MPa	75
Elongation at Break	ISO 527 (5 mm/min)	%	4
Flexural Strength	ISO 178 (2 mm/min)	MPa	116
Flexural Modulus	ISO 178 (2 mm/min)	MPa	3210
Impact Strength – Charpy (unnotched)	ISO 179	kJ M^{-2}	12
Rockwell Hardness	ISO 2039-2	M scale	102
Electrical Properties			
Surface Resistivity	IEC 93	Ω.m^{-2}	> 10^{14}
Electrical Strength	IEC 243	kV.mm^{-1}	15