

Basics of Lighting

ISC Learning Centre



July
2009

Schneider
Electric

Basics of lighting - Contents



- > Introduction
- > Selection parameters
- > Overview of building lighting
- > Overview of home lighting
- > Overview of other types of lighting
- > Introduction to lighting bus

Why this module?



- With the world focusing on how to reduce the energy bill
- With professionals wanting more efficiency and safety at work
- With consumers seeking to improve comfort and security
 - The types of lighting have become more and more varied
 - The choice of lighting is becoming more and more important
- The objective of this module is to give you basic information on the different lights found on the market and help you understand their connection with our lighting control offer.



This module is the first of a set of basic modules on Lighting Control (see list at the end of the module)

Lighting & energy consumption



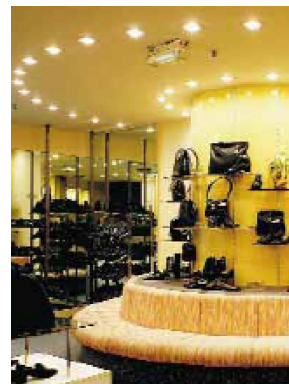
- Lighting alone is responsible for 19% of the world's electricity demand
- Lighting accounts for 10 to 33% (USA) of each country's electricity consumption
- A huge concern especially for public lighting (30% more than 20 years old)



City lighting, park, car park, road lighting, stations, game fields, docks, etc.

Buildings

- Lighting = 25 to 50% (average 40%) of electricity bill



> Offices, hotels, shops & supermarkets



> Schools, gymnasiums, medical care

Industry & Housing

- Lighting = 10 to 15% of the electricity bill



> Power plant, heavy industry, laboratory, warehouse, factories, workshop...



> Apartment buildings, homes

On the market today

- Two main technologies

- Incandescent lamps
- Gas discharge lamps

- Several types of applications

□ different needs □ several types of lights

- Professional use
- Private use



- Types of control

- Conventional (wiring)
- Field-bus
- Central systems

Technologies on the market

- Incandescent bulbs "GLS"*:

- Most common bulbs ➤
- LV & ELV* halogen ➤



- Gas discharge lamps:

- Fluorescent lights:
 - Low pressure mercury fluorescent tubes
 - Compact Fluorescent Lamps "CFL" ➤
- High Intensity Discharge lights "HID"
- High Pressure Mercury "MBF"
- Low Pressure Sodium "LPS, SLP, SOX"
- High Pressure Sodium "HPS, SHP, SON" ➤
- Metal Halide "MH, HQI, MIB" ➤



- Others: Light Emitting Diodes "LED", induction ➤



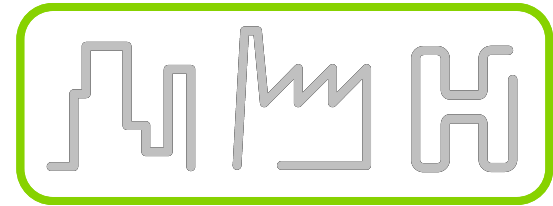
*GLS= Global Light Source

*ELV: Extra Low Voltage (12Vdc)

Applications / Lights:

- Buildings

- Fluorescent tubes
- Metal halide "MH, HQI, MIB"



- Lights for homes, small shops & offices, hotels

- Incandescent bulbs + LV & ELV halogen
- Fluorescent tubes + Compact Fluorescent Lamps "CFL"
- Others: Light Emitting Diodes "LED", induction



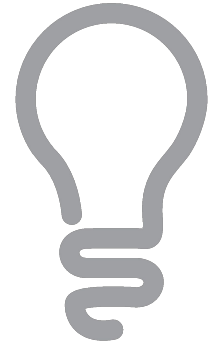
- Others (such as public lighting, outdoor lighting)

- High Intensity Discharge lights "HID"
- High Pressure Mercury "MBF"
- Low Pressure Sodium "LPS, SLP, SOX"
- High Pressure Sodium "HPS, SHP, SON"
- Metal Halide "MH, HQI, MIB"



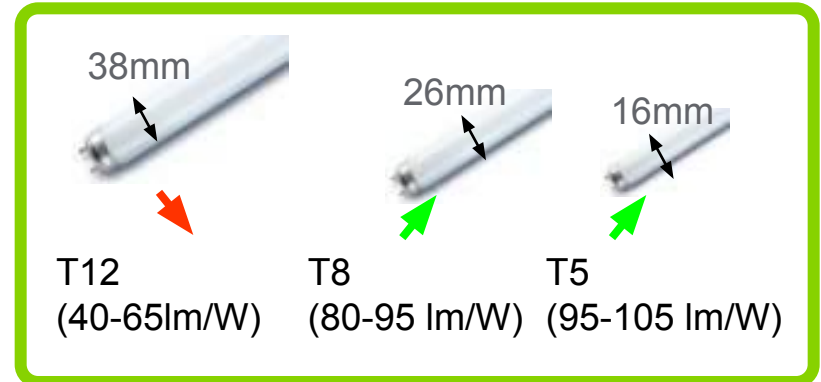
Lighting - Selection parameters

- Lighting needs in relation to end-use
 - Required brightness (lighting power level)
 - Environment (temperature, humidity, etc.)
 - Aesthetics
 - Colour rendering (capacity of lighting to render the colours of the illuminated object)
 - Lifetime (with respect to daily and yearly operating time)
 - Frequency of switching (daily on / off operations)
 - Lamp starting and warm-up times (how long it takes to reach the full light output)
 - Dimming capability (some types of lights are not dimmable)
 - Size for compatibility with existing light fixtures
 - Diffused or spot lighting, mounting height (low bay / high bay)
 - Safety, extra low voltage, CFL not too close to people's heads
 - Easy maintenance
- Overall cost (investment cost + operating cost)



Fluorescent tubes

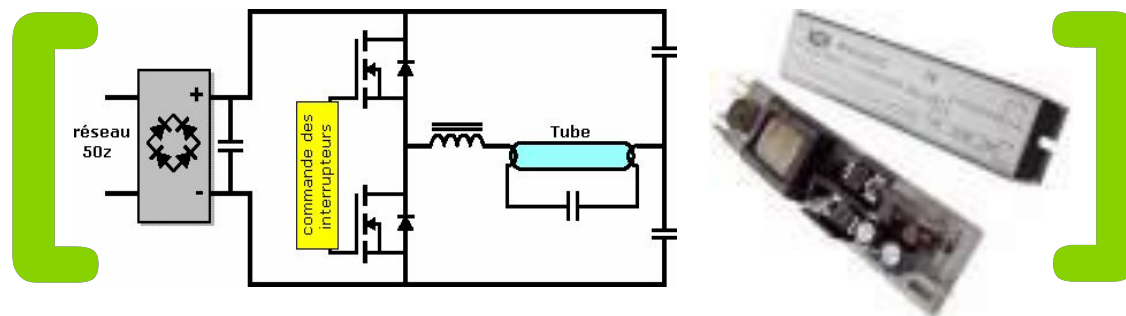
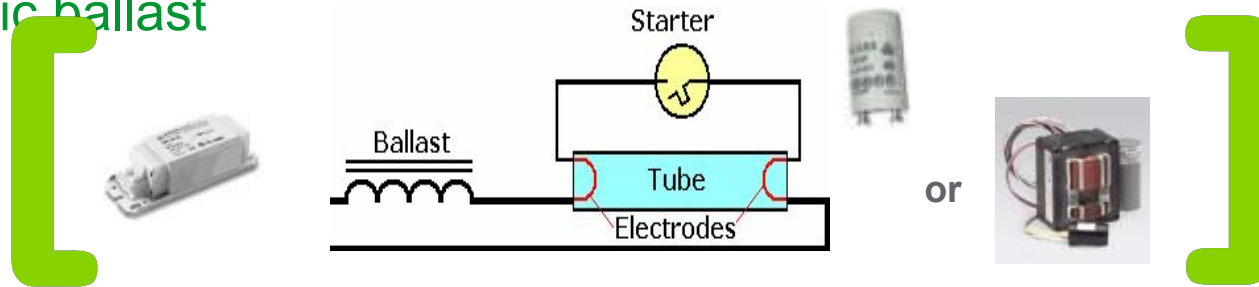
- The most frequently used!
- Accept frequent On/Off switching
- Lamp power: 4 to 140 W, light output up to 14000 Lumens
- Lifetime of fluorescent tubes depends on daily On / Off frequency and type of ballast
- Several types of fixtures according to use: 3m to 12m height (high efficiency), hanging, surface or flush mounted, single, twin or multiple tube fixture, IP 65 version...



Lighting/consumption: * * *	On/off: Frequent
Lifetime: * * *	Control: Ballast
Output: * *	Dimmable: Yes
Colour: * * *	

Control circuits for fluorescent tubes & high intensity discharge lamps

- Magnetic ballast
- Electronic ballast



Dimmable



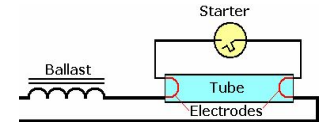
Please note: Most **Compact Fluorescent Lamps** (CFL) have an electronic ballast built into the base

Fluorescent tubes - Wiring diagrams

- **Single tube, magnetic ballast with no compensation (inductive load)**

☹ p.f. ≤ 0.5 , flicker, noise, low lifetime 8000h, inrush current $13 I_n$ / 5-10ms

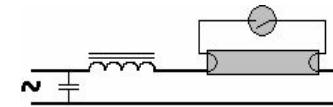
☺ simple, cheap



- **Single tube, magnetic ballast with parallel compensation**

☹ flicker, noise, very high inrush current $20-60 I_n$ / 1ms

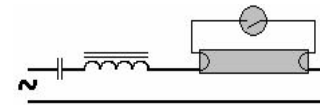
☺ p.f. ≥ 0.85 , improved lifetime



- **Single tube, magnetic ballast with serial compensation (cap. load)**

☹ flicker, noise, high inrush current $13 I_n$ / 5-10ms

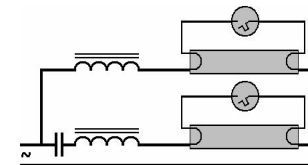
☺ p.f. ≥ 0.85 , improved lifetime



- **Twin compensated tubes with magnetic ballast**

☹ High inrush current $20 I_n$ / 1ms

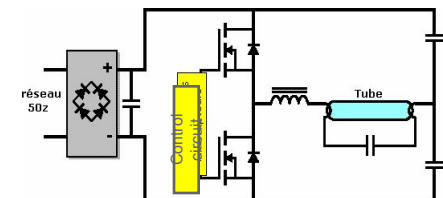
☺ Limited flicker, low noise, p.f. ≥ 0.85 , improved lifetime



- **One or more tubes with electronic ballast**

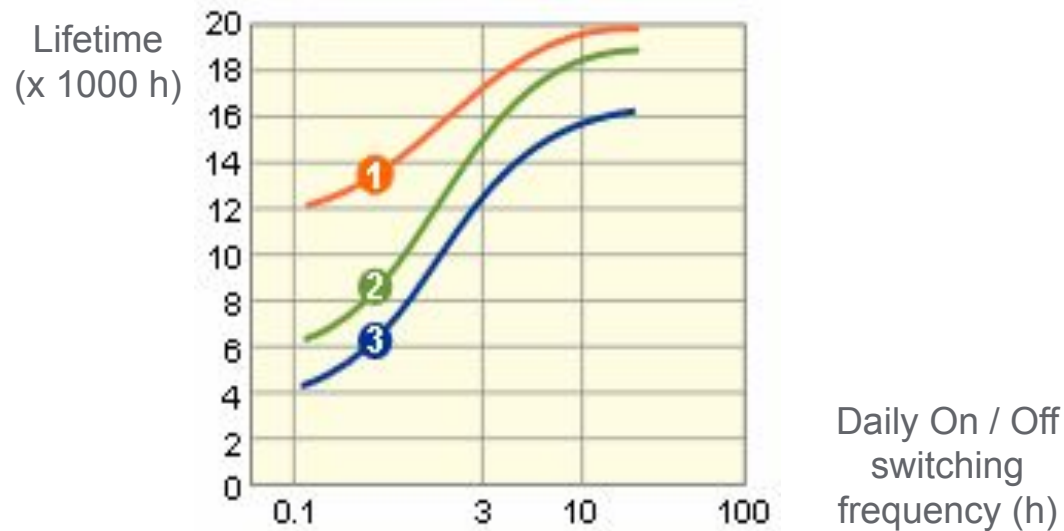
☹ Very high inrush current $30-100 I_n$ / 0.5ms, HF earth leakage detected by RCD

☺ No flicker, silent, high efficiency (+25%), longer lifetime (+ 50%), p.f. ≥ 0.9



Fluorescent tubes - Lifetime

- Fluorescent tubes lifetime
 - Daily On / Off frequency + type of ballast

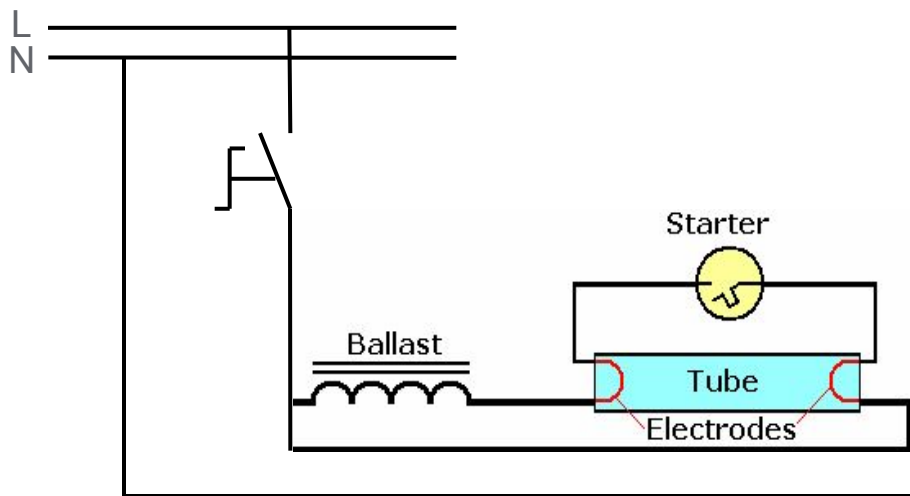


Type of control ballast:

- 1 electronic with progressive warm-up
- 2 process
- 3 compensated magnetic
non compensated magnetic

Conventional ON/OFF

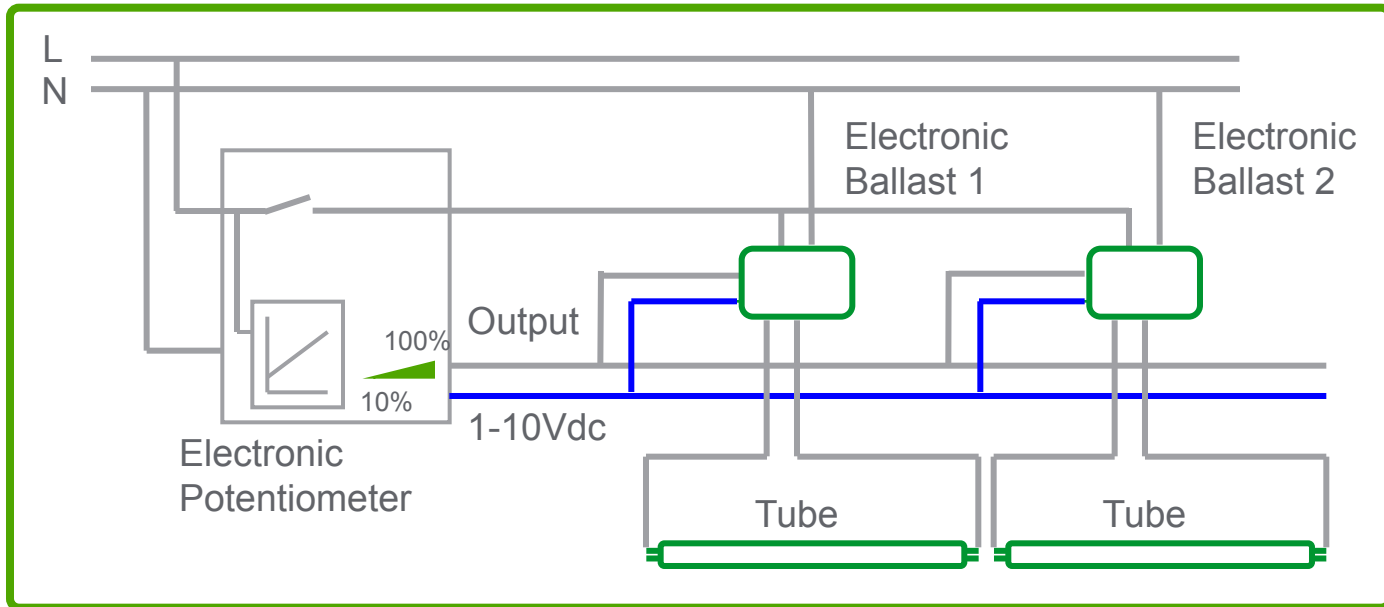
- 10 A or 16 A switch



- Can be connected to
 - Single tube, magnetic ballast with no compensation
 - Single tube, magnetic ballast with parallel compensation
 - Single tube, magnetic ballast with serial compensation
 - Twin compensated tubes with magnetic ballast
- Limited to large installations

Conventional Dimming

- Stand-Alone Electronic Potentiometer

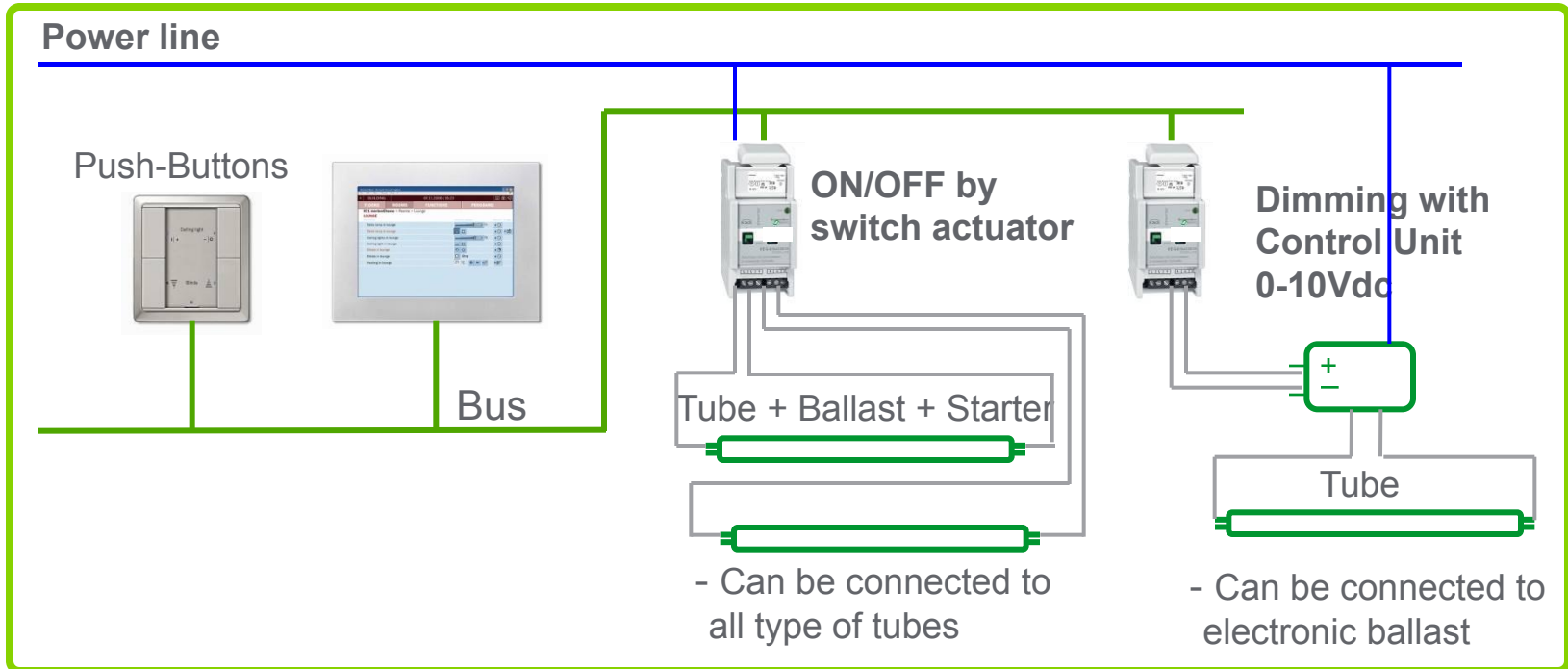


- Can be connected to electronic ballast
- Mature technology
- **Limited to large installations**



More info?
- See Basics of Dimming

Direct Control by Bus Management System (BMS):



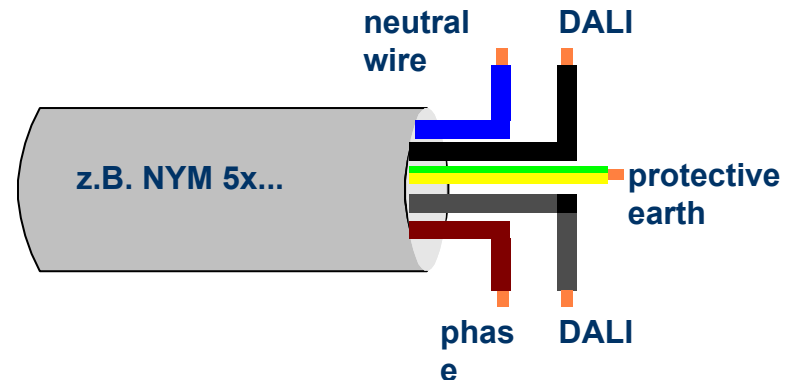
More info?

- See our KNX and LON courses

Control by lighting bus:

● DALI Bus – What is it?

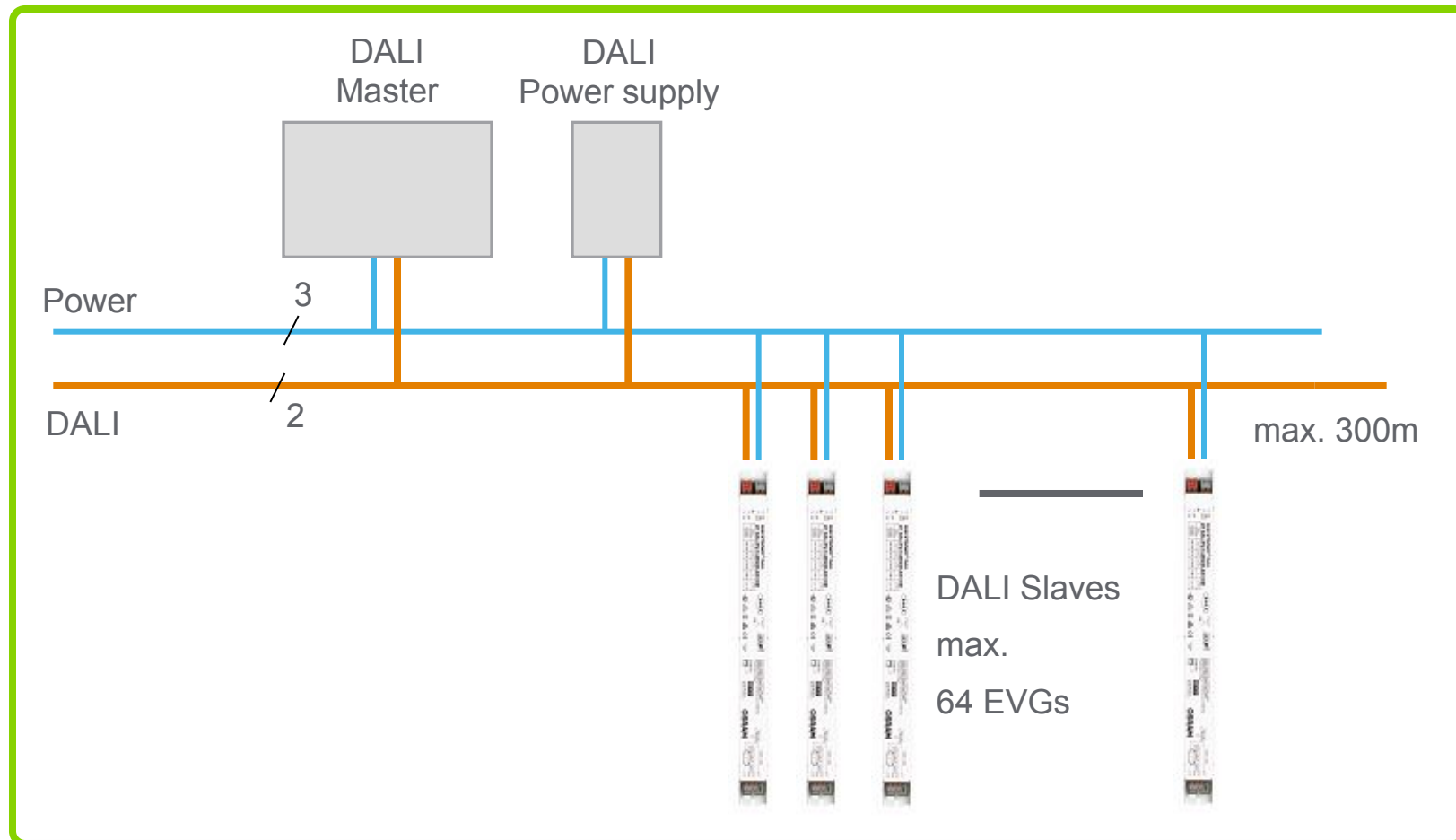
- DALI stands for:
Digital Addressable Lighting Interface
- An open protocol set out in the technical standard EN/IEC 60929
- Developed by all leading ballast manufacturers, for building installations.
- Growing technology in buildings □
Schneider has to manage it □
S-E offers gateways: KNX/Dali,
LON/DALI
- Electronic ballast for fluorescent tubes, HID, LED, and transformers for LV halogen.



More info on DALI?

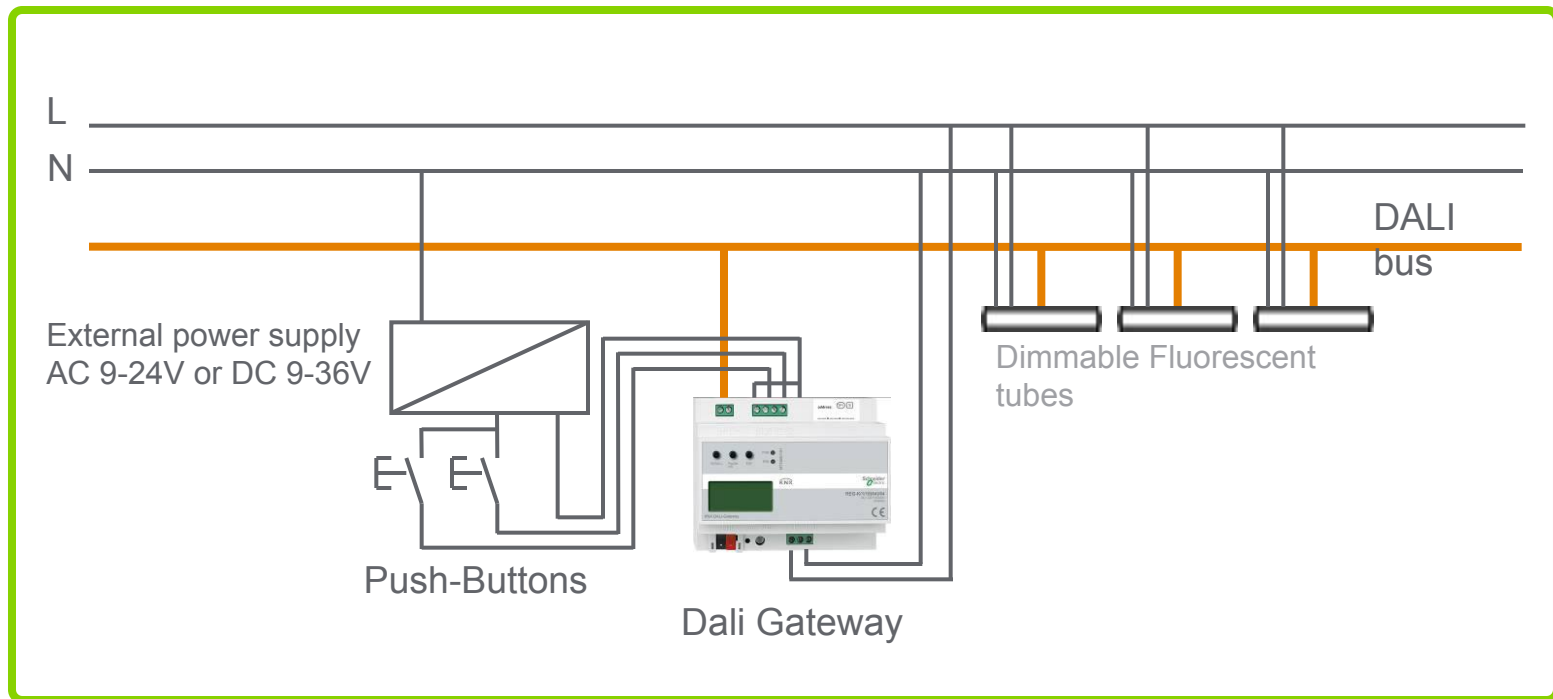
- See <http://www.dali-ag.org/>

DALI system structure

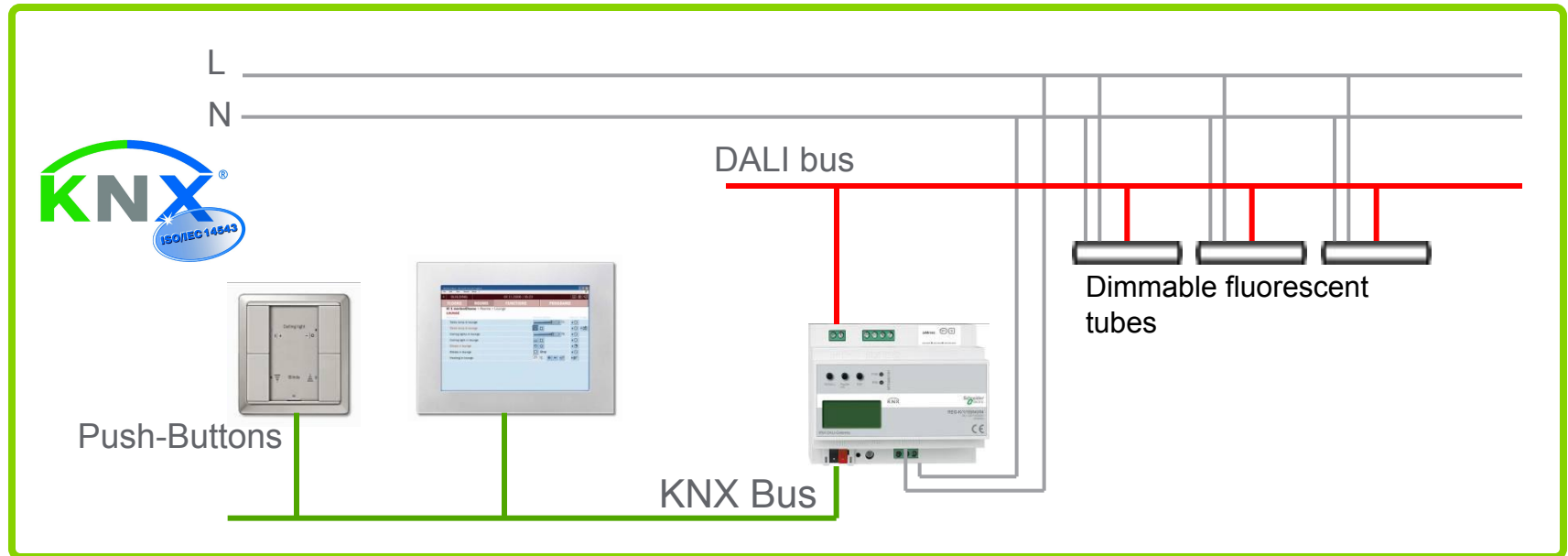


Synergy with our offer: Connection to our DALI / KNX gateway via 2 binary inputs

- Gateway for fluorescent tubes on DALI bus and conventional push-buttons.

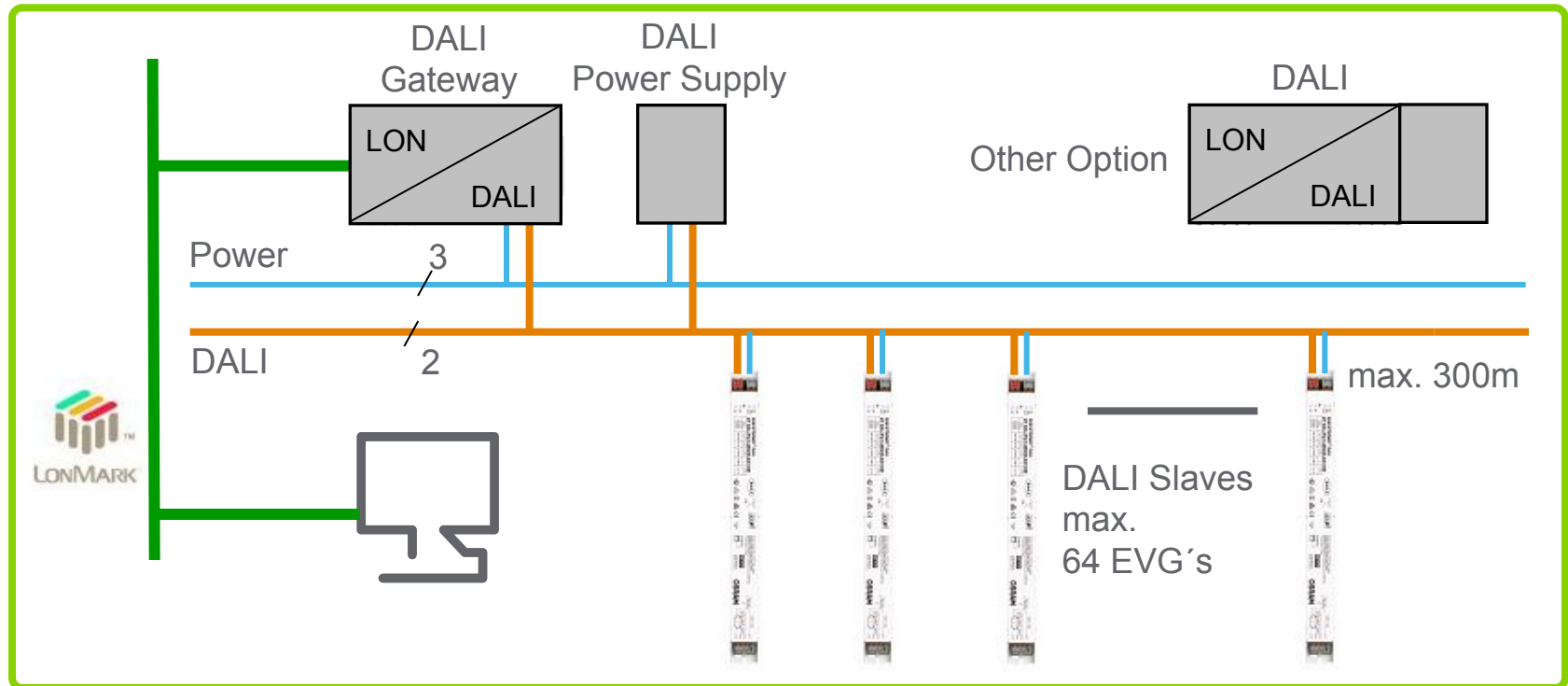


Connection to our KNX System through our DALI gateway



More info on buses or DALI gateway?
- See our KNX and LON courses

Connection to our LON DALI gateway

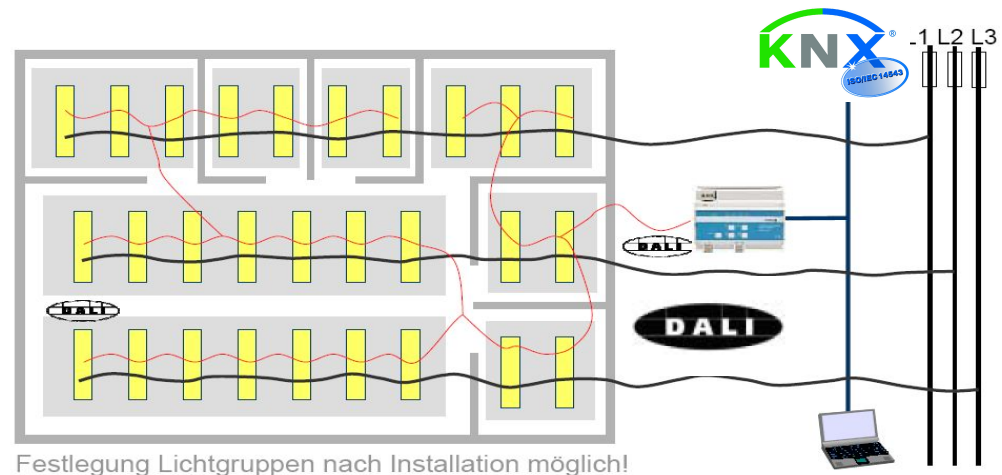
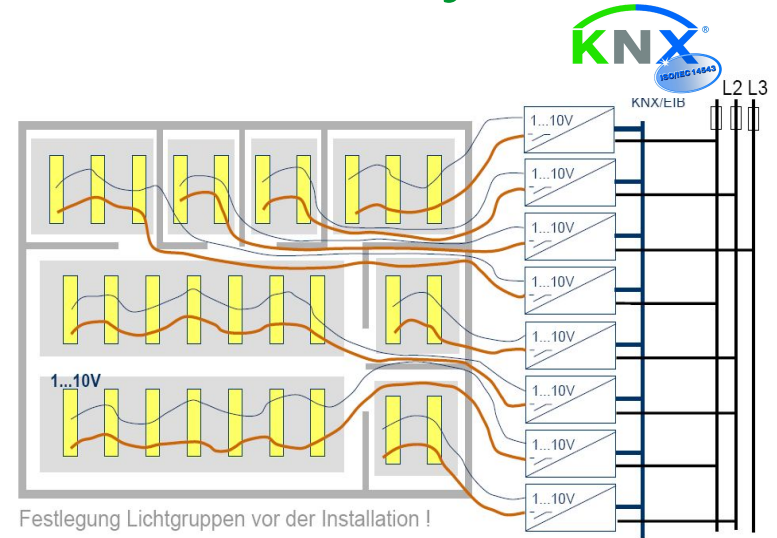


More info on LON?
- Contact ISC training team

More info on how to choose between LON and KNX?
- Discover New Way course

Benefits compared to 1-10V control systems


- Individual control of fixtures
- Multi-channelling by only one pair of control cables
- No mains switching needed
- Back channelling
- Simple DALI wiring: simple two-wire cable
- Easy system re-configuration
- Easy to add new components



Differences between DALI and BA buses (KNX, LON)



DSI for Digital Serial Protocol

- 1991 
- Proprietary system from Tridonic-Atco (Zumtobel)
- An "intelligent" central unit + All fixtures connected to it ☐ Many wires



More info on DSI?

- See www.tridonicatco.com

Introduction to home lighting

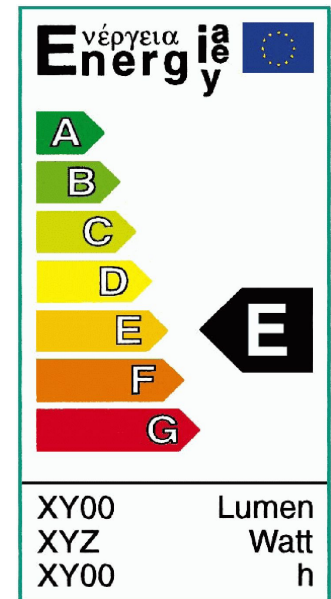


- Energy efficient lighting in homes

- Lighting may account for up to a fifth of a household's electricity consumption.
- Upgrading the lamps can reduce a household's total electricity consumption by up to 10-15%

- The Ecodesign Directive provides a framework:

- EU energy label on household lamps
- Most energy efficient bulbs are compact fluorescent lamps: A-class
- Worst: incandescent bulbs: G to E-class (Directive 1998/11/EC).



Incandescent lamp (GLS) (E-class)

- 1879 (Thomas Edison)
- Lamp power: 15 to 1000 W
- Light Output: up to 15,000 lumens
- Class G to E: **Europe has decided to remove** these lights from the EU market before 2012



Advantages	Disadvantages
Bright point light source (if transparent glass)	Energy-guzzler – very low efficiency (E, F or G-class)
Full compatibility with existing luminaries	Risks due to high operating temperature
Full dimmable on any dimmer	Short lifetime (1000 hours)
Good quality and performance	

Efficiency: *
 Lifetime: *
 Output (lm): * *
 Colour: * * * * *
 On/off : Frequent
 Control: Direct

Efficiency=
 Lighting/consumption

Conventional halogen lamps (D or E-class)

- 1980s
- 230Vac lamps or 12Vdc lamps (+ transformer)
- Improved incandescent lamp technology
- Much smaller lamp size
- Equal or slightly higher efficiency than incandescent lights
- 230Vac lamp power:
 - 25 to 2000 W, Light Output: up to 40,000 lumens



Efficiency:

*

Lifetime:

*

Output:

* * *

Colour:

* * * *

On/off :

Daily

Efficiency=

Control. Lighting/consumption

Direct

Advantages	Disadvantages
Bright point light source	Low efficiency, no or at best 15% energy Savings at mains voltage compared to incandescent lamps (D,E or F class, low voltage: C class, 25% savings)
Full compatibility with existing luminaires	Risks due to high operating temperature
Full dimmable on any dimmer	Relatively short lifetime (1000 – 3000 hours)
Good quality and performance	

Conventional halogen lamps

- 12Vdc lamps (+ transformer)
- Lamp power: 5 to 500 W, Light Output: up to 12,000 lumens
- 12Vdc lamps □ safety in humid rooms

- Magnetic transformer (LV / ELV)
 - = Inductive load

- Electronic converter ("ballast")
 - = Capacitive load



Lighting Efficiency: *

Lifetime: * *

Output: * *

Colour: * * * * *

On/off Frequent

Control: Ballast



For dimming, very important to know the type of load
(see Basics of Dimming)

Halogen lamps with xenon gas filling (C-class)



- **Recent technology**
- **With xenon gas filling, about 25% less energy / same incandescent lights**
- **Come in two versions**
 - Only the filling gas is replaced, the socket and the dimensions of the lamp are the same as for conventional halogen lights.
 - The improved halogen capsule is placed in glass bulbs shaped like incandescent lamps (sold as retrofit "energy saver lamps").

Advantages	Disadvantages
Bright point light source	25% energy savings (C class) compared to the best incandescent lamps
Full compatibility with existing luminaries	Risks due to high operating temperature
Full dimmable on any dimmer	Relatively short lifetime (2000 – 3000 hours)
Good quality and performance	

Halogen lamps with infrared coating (B-class)

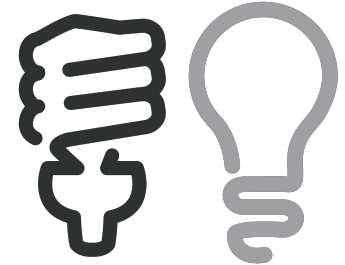


- Recent technology
- Infrared coating added to the wall of halogen lamp capsules ☐
about 45% less energy/ Same incandescent lights.
- But only possible with low voltage lamps,
 - So a transformer is needed (separate unit or integrated into the fixture or lamp for incandescent retrofit solution)
 - Both special socket capsules and incandescent retrofit lamps are available in B-class
 - Lamp with integrated transformer limited to 60W (too much heat)

Advantages	Disadvantages
Bright point light source	45% energy savings (B class) compared to the best incandescent lamps
Good quality and performance	Too large for some luminaries
Full dimmable on any dimmer	No equivalent yet to GLS > 60W
	Only one producer currently for GLS retrofit
	Relatively short lifetime (3000 hours)
	Risks due to high operating temperature

Compact fluorescent lamps (CFLs) (A-class)

- Fluorescent lamp tubes, with integrated ballast, becoming a stand-alone retrofit solution to replace incandescent lamps.
- 1980s.
- Long lifetime and high efficiency, between 65% and 80% less energy / same incandescent lights.
- Sometimes with an external envelope that hides the tubes and makes them even more similar to light bulbs (although decreasing efficiency). The envelope also shields off any unwanted ultraviolet radiation and risks connected to incorrect disposal.
- Power: 5-55 W, Light \leq 5000 Lumens



Efficiency:

Lifetime:

Output: *

Colour:

On/off: Daily

Advantages	Disadvantages
Up to 80% energy saving (A class or upper end of B class) compared to incandescent lamps	No bright point lighting
Money-saver	Often not dimmable
Environmentally-friendly	Suboptimal colour rendering
Long lifetime (6 times longer compared to incandescent lamps)	Relatively low starting and warm up time
Available with warm or cool light	Safety issues (can be avoided with proper coating)
	Too large for some luminaries

Light-emitting diodes (LEDs)

- Very long lifetime
- Quickly emerging technology with recent progress in efficiency
- For room lighting, only in the first phases of commercialisation and rarely meets all consumer expectations in terms of light output and other functions.
- Likely to become true alternative to CFLs very rapidly.
- Electric power: 0.05-0.1 W (1 LED) to several Watts (LED array), Light Output: a few Lumens (1 LED) to thousands lm (LED array)
- **Main use:** Traffic lights, signalling / display boards, decoration spotlights, portable or isolated ELV DC lighting (battery, photovoltaic), etc.



Light.
Efficiency:

*

Lifetime:

* * * * *

Output:

*

Colour:

*

On/off:

Daily

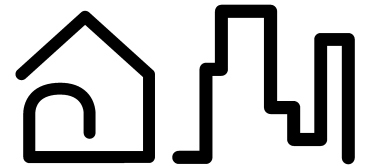
Control:

Efficiency of lamp technologies compared with incandescent lamps (E-class)

Lamp technology		Energy savings	Energy class
I.	Incandescent lamps	-	E, F, G
II.1	Conventional halogens (mains voltage 220 V)	0 – 15 %	D, E, F
II.1	Conventional halogens (low voltage 12 V)	25 %	C
II.2	Halogens with xenon gas filling (mains voltage 220 V)	25 %	C
II.3	Halogens with infrared coating	45 %	B (lower end)
III.	CFLs with bulb-shaped cover and low light output	65 %	B (higher end)
III.	CFLs with bare tubes or high light output	80 %	A

Schneider products to control this type of lighting

- Wiring Devices for essential lighting applications
- Control for advanced lighting applications



Indoor



Outdoor



Anya, Sedna, Unica, System M, Aztec, Alvais, Altira, Cedar+, Mureva, Aquadesign, Anti-vandal ...

Din Rail Stand alone electronics



Timers, dimmers, twilight switches, time switches...

Wall-mounted

Stand-alone electronics



Timers, dimmers, presence & movement detectors ,...

KNX, IHC



Wireless Solutions



High Intensity Discharge lamps (HID)

- Produce light by means of an electric arc.
- Several types:
 - [Mercury vapour](#) lamps
 - [Metal halide](#) (MH) lamps
 - [Ceramic MH](#) lamps
 - [Sodium vapour lamps](#)
 - [Xenon short-arc lamps](#)
 - [Ultra-High Performance \(UHP\)](#)
- Higher lighting efficiency than incandescent lamps or fluorescent tubes



High Pressure Mercury vapour lamps (MBF)

- Main use: Public lighting, industry, shelters, docks, with high bay fixtures



Light.
Efficiency:

* * *

Lifetime:

* * * * *

Output:

* * * *

Colour:

* * *

On/off:

Daily

Control:

ballast

- Technical characteristics: The oldest HID gas discharge lamp

- A declining trend: replaced by HP Sodium or Metal Halide lamps
- Except for ballast-free version (can directly replace standard incandescent bulbs), most mercury lamps need a ballast to work.
- Lamp power: 48 to 1000 W.
Light Output: up to 65000 Lumens



or



Low Pressure Sodium vapour lamps (LPS or SOX)

- Main use: Outdoors only, road & security lighting, with high bay fixtures



Light. Efficiency:

Lifetime:

Output:

Colour: *

On/off: Daily

Control:

ballast

- Technical characteristics: Most efficient, long life gas discharge lamp
- Trend toward replacement by High Pressure Sodium lamps.
- A ballast is required. Several minutes starting time.
- Lamp power: 18 to 185 W.
Light output: up to 35,000 Lumens



High Pressure vapour sodium (SON)



- Main use: Streets, monuments, tunnels, airports, docks, car parks, parks, shopping malls, warehouses, halls, etc. with high bay fixtures or projectors



Light
Efficiency:

Lifetime:

Output:

Colour:

**

On/off: Daily

Control:
ballast

- Technical characteristics: Long life, powerful, quite efficient **HID lamp**

- Trend toward replacement of Metal Halide for better colour rendering
- Ballast required. Several minutes to start. Work below -25°C
- Lamp power: 35 to 1000 W. Light output: up to 140,000 Lumens



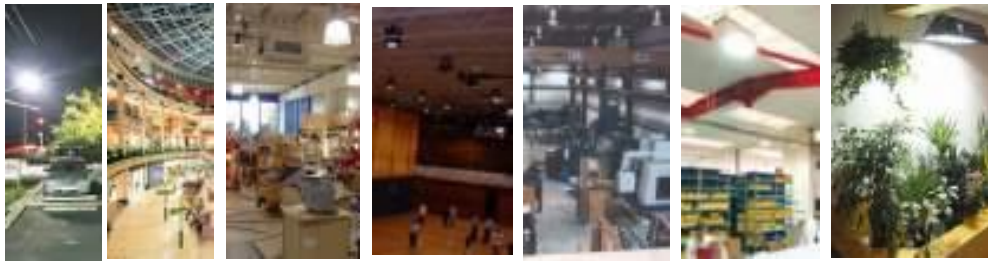
or



Metal Halide lamps (MBI)



- Main use: streets, car parks, shopping malls, shops, halls, gymnasiums, factories, workshops, warehouses, garden lights, etc. with high or low bay fixtures



Light
Efficiency:

Lifetime:

Output:

Colour:

On/off:

Daily

On/Off

Ballast

- Technical characteristics: powerful & efficient with good rendering
 - Trend toward replacement of High Pressure Sodium lamps
 - Ballast required. Several minutes to start. Work below -25°C
 - Lamp power: 30 to 2000 W. Light output: up to 180,000 Lumens

Induction lamps



- Main use: areas with difficult access or requiring high service continuity: High ceilings, tunnels, airports, uninterruptable processes, freezers, etc.



Light
Efficiency:

Lifetime:

Output: *

Colour:

On/off:

Frequent

Control:

- Technical characteristics: very long life, medium power light source.

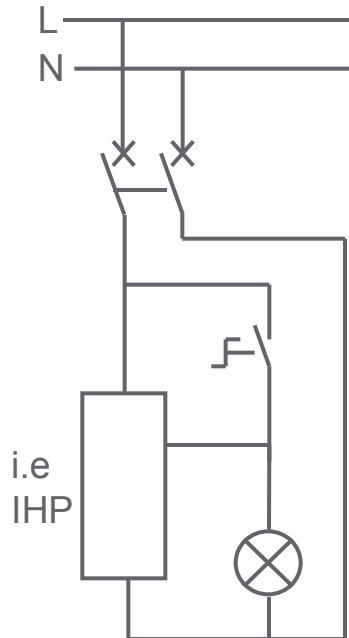
- Except for compact bulb version, this electrode-less HF fluorescent lamp needs an electronic ballast.
- Instantaneous start. Work down to -40°C.
- Lamp power: 55 to 165 W. Light output: up to 12,000 Lumens

Schneider products to control this type of lighting



- Time switches IH, IHP
- Twilight switches IC 2000, IC 2000P+, IC Astro
- Combined with power contactors

- Movement & Presence detectors



In the same set of basics

- Module 1: Basics of Lighting
- Module 2: Basic of Lighting Control Applications
- Module 3: Basics of Dimming
- Module 4: Basics of Movement Detectors

And also available

- Module 5: Basics of Shutters

ISC Learning Centre

Swebi Home page - Microsoft Internet Explorer

Adresse: <http://swebi.schneider-electric.com/>

Schneider Electric

intranet

By 2011, Schneider Electric will be
→ the global specialist in energy management

Dividend, employee shareholding and more will be highlighted on !

All Intranet sites

- Our Customers
- Our Markets
- Our Offer
- Our Process guide
- Our Communities
- Operating Division
- Businesses
- Global Functions

Customer satisfaction

Today
Very satisfied
43.5%

Top Story...

04/05/2009 - One update: How well did we do for 2009 first quarter?

What's new on the web?

Our customers discover how to boost their business in renewable energies with our Electrical Energy solutions.

Read it on your website

Select a country

International Directory

Name
First Name
Quick search

Operating Division

- Asia - Pacific
- Europe
- North America

Europe Portal

- Industrial Operations
- Installation Systems & Control
- Projects & Engineering Center
- Belgium
- France
- Germany
- Italy
- Netherlands
- Portugal
- Spain
- SNB Zone
- UK

Stock value

05/05/09 - 09:30
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CAC 40 32

About our company

- Company presentation
- The Foundation
- Organization charts
- Locations by country

About our solutions

(Internet access needed)

From Swebi

- Select "Operating division"
- Select "Europe"
- Select "Installation Systems & Control"

ISC Learning Centre

The screenshot shows the ISC BU Intranet in Microsoft Internet Explorer. The browser window title is "ISC BU Intranet - Microsoft Internet Explorer". The address bar shows the URL: <http://isc.schneider-electric.com/global/isc/sitemgr.nsf/HomePage?ReadForm>. The page features a navigation bar with links: Home, Managers Area, and Contact us. A large red banner reads "Welcome to the Installation Systems & Control Business Unit - EOD". Below this, the "ISC Learning Center" section is highlighted with a green callout box. The callout box contains the text "Then choose what you need in the menu" and points to the "ISC Learning Center" menu item in the left sidebar and the "See all news" link next to a news item. The news item is dated "26-mar-2009" and titled "New presentations for shutters and dimmers". The sidebar menu includes items like "Training Policy", "Training Catalogue", "Upcoming Classroom Trainings", "Upcoming Web Trainings", "ISC Passport", "TSG: Training Solution Guide", "Nominations & Org Charts", "Customer Attitude", and "Useful Links".

ISC BU Intranet - Microsoft Internet Explorer

Fichier Edition Affichage Favoris Outils ?

Précédente Recherche Favoris

Adresse <http://isc.schneider-electric.com/global/isc/sitemgr.nsf/HomePage?ReadForm> OK Links

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Login

ISC Learning Center

Welcome on the IS&C Learning Center Intranet area!

The IS&C Learning Center's mission is to cover the Business Unit's Product and Function offers. This Intranet area is designed for people in Training-related functions and those who need Training on our offers. We always have in mind that Training is one of the best ways to improve our business with our customers.

Do you have any questions on the IS&C training, any comments or feedback? Any stories to tell or tools to share about IS&C trainings? Please send an email to jean-louis.delage@schneider-electric.com.

Enjoy the IS&C Learning Center Intranet area!

See all news

26-mar-2009 - **New presentations for shutters and dimmers**
Merten international offer : ISC learning center has recently published two new presentations about shutters and dimmers.
[More ...](#)

[Click here to get all ISC News per email](#)

Raccourci vers javascript:OpenFrames('/GLOBAL/ISC/publication.nsf/FolderLien/89079A1D499BE679C12575010052DC74?OpenDocument','Ba

Local intranet

démarrer

FR 10:30

Where to get more info?

The screenshot shows the Planet Product - Microsoft Internet Explorer window. The address bar displays the URL: <http://planet.schneider-electric.com/intranet/products/laprod.nsf/FrameSetHP?ReadForm&Count=200&L=Us&roll=38&navID=7&>. The page features the Schneider Electric logo and a navigation menu with options like Home, Contact-us, Subscription, Global search, and Français. The main content area is titled 'Global product information' and includes a 'Product offer' section. A table of communication tools is displayed, with a green arrow pointing to the 'Communication tools' section.

Public	Title	Document ref	Lng	Date	Info	Doc
<input checked="" type="checkbox"/>	Switch onto style - Unica Top promotional leaflet	UT00471	English	10 May 2006	1 MB	
<input checked="" type="checkbox"/>	Unica Housing magazine press article	UT00443	English	28 Feb 2006		
<input checked="" type="checkbox"/>	Unica Professional press article	UT00445				
<input checked="" type="checkbox"/>	Basic to Plus white products	UT00489				
<input checked="" type="checkbox"/>	Unica Top Selling arguments	UT00455				
<input checked="" type="checkbox"/>	Unica Top pictures	UT00452				
<input checked="" type="checkbox"/>	Unica Basic to Plus pictures	UT00453				
<input checked="" type="checkbox"/>	Unica Customer presentation MG brand	UT00400				
		UT00383				
		UT00386				
		UT00385				
		UT00384				
		UT00388	English	20 Feb 2006		

A green arrow points from the text box on the left to the 'Communication tools' section in the table.

On the left, you have several choices:
Communication tools
Catalogue
Training

Lighting circuit connection diagrams: 3 basic configurations

Symbols:



Lighting load
including
ballast when applicable

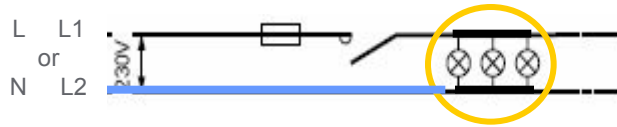


MCB (or fuse)
+ optional RCD

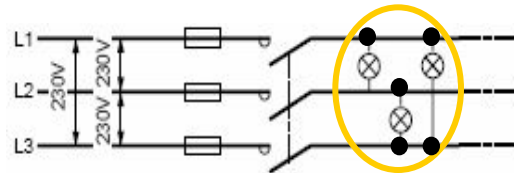


Switch, or
power contact
of contactor /
impulse relay

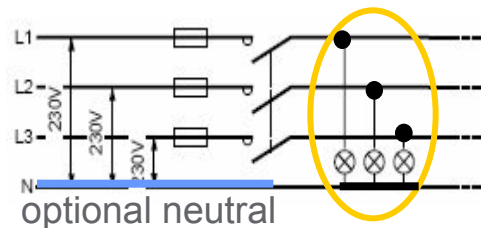
- **Single (L-N) or double phase (L-L) (100-120V or 200-250V)**



- **3 phase (L- L: 200-250 V) , delta connection (no neutral)**

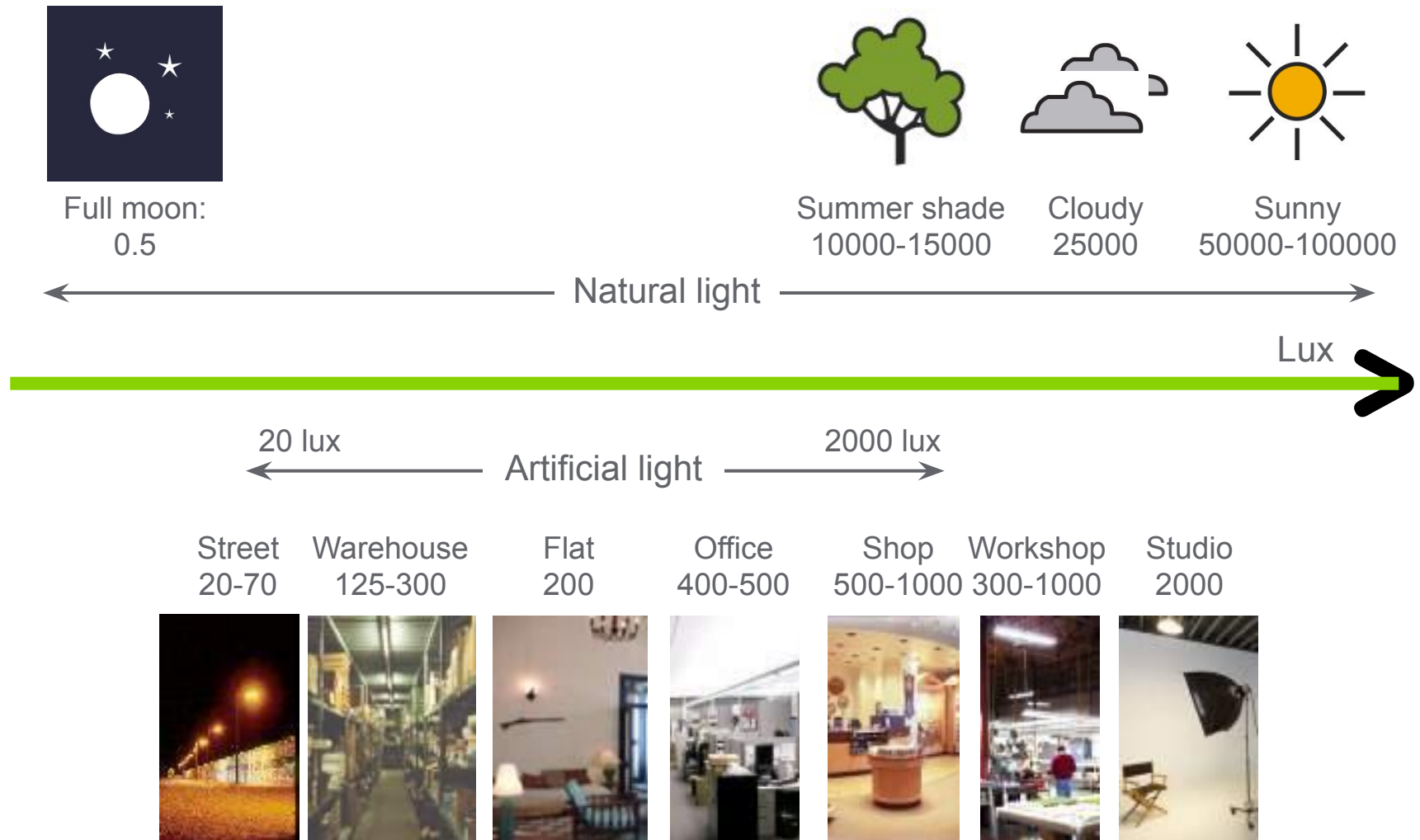


- **3 phase (L- L: 380-415 V), star connection (with or without neutral)**



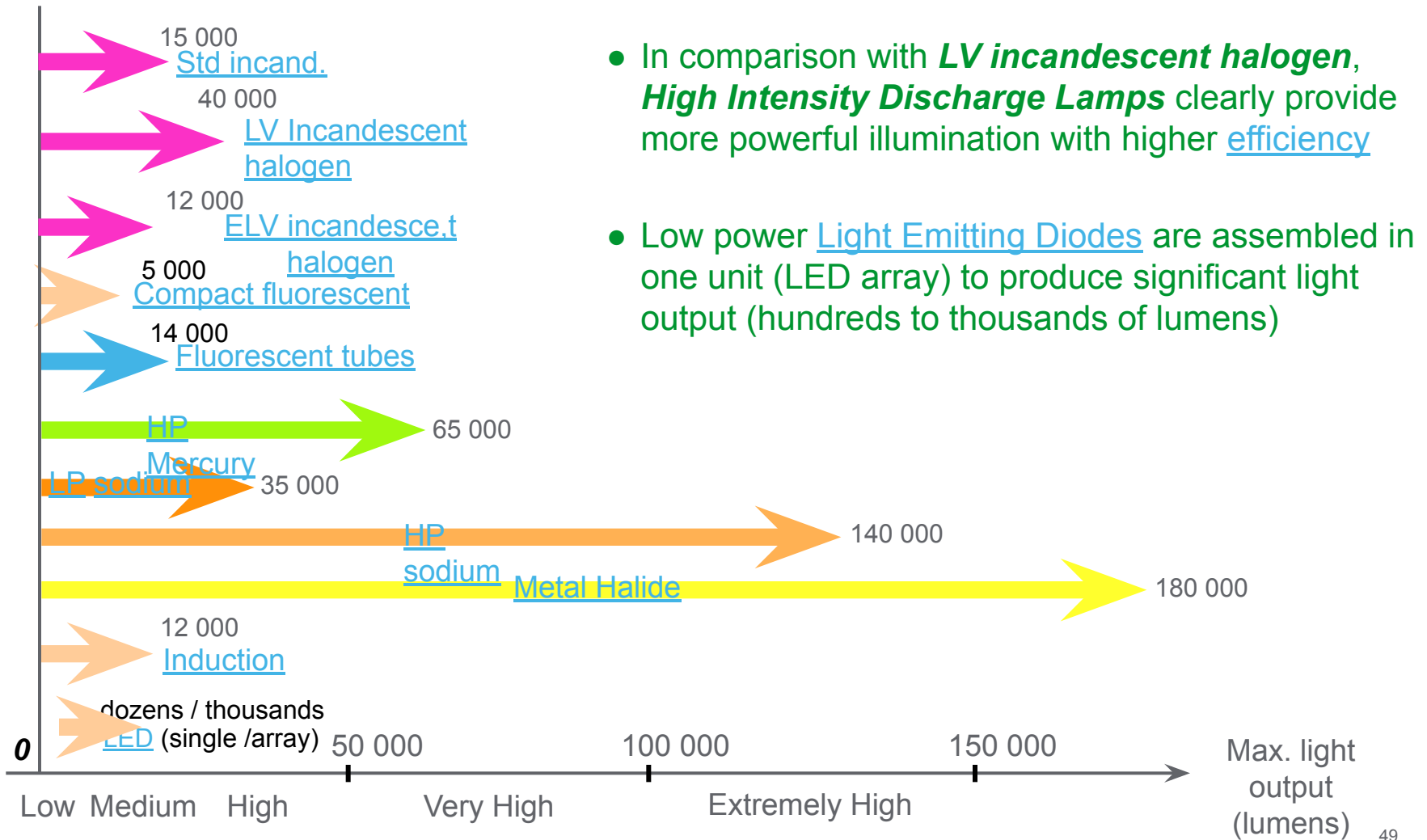
Central point may be connected
to optional neutral

Level of light: typical data and end-use requirements

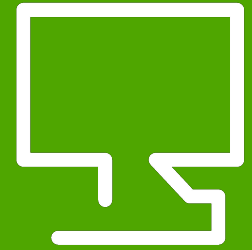


Max. light output capability of a single lamp in relation to technology

Lighting features



ISC Learning Centre



Thanks!

Make the most of your energy