3 Components for Fluorescent Lamps

Ballasts for fluorescent lamps

The operation of a fluorescent lamp depends on a ballast that stabilises the lamp's preheat current after connection to the mains and, in conjunction with the starter, also supplies the required lamp ignition voltage after preheating. After ignition, the ballast then serves to limit the lamp current. As fluorescent lamps are characterised by a negative characteristic current-voltage curve, lamp current stabilisation is essential with regard to both the lamp's stable operation and a long service life, which is also dependent on compliance with the starting conditions (preheat current and ignition voltage). Unfavourable starting conditions cause damage to the electrodes every time the lamp is started and thus reduce the lamp's service life. Furthermore, care should be taken to prevent crossdischarge in the electrode area during preheating, which also shortens lamp service life.

Electromagnetic (inductive) ballasts have to be operated in conjunction with starters for lamp ignition and capacitors for blind current compensation. In addition, capacitors for RFI suppression will also be required for certain circuits. Electronic ballasts do not require any additional components.

Electronic ballasts (EB)

VS electronic ballasts are designed for mains voltages of 220 V to 240 V (exceptions are devices for the North American market where the nominal mains voltage is 120 V or 277 V) and are used to operate fluorescent lamps at high frequencies. The lamps are ignited with an internally generated ignition voltage, thereby removing the need for an external starter. The power factor (λ) > 0.95 also removes the need for compensation, unlike with electromagnetic ballasts. The only exceptions are low-output ELXs models, which attain a power factor of 0.6. Luminaires fitted with electronic ballasts are characterised by low energy consumption as they draw substantially less system power than conventional, inductive applications. This is firstly because the lamp consumes less power to achieve the same luminous flux and secondly because the internal loss of an electronic ballast only amounts to approx. 8% to 10% of the lamp's output. Furthermore, thanks to their modern circuitry, the power input of VS electronic ballasts remains constant even in the event of mains voltage fluctuations, thus ensuring permanently low energy consumption.

VS electronic ballasts permit a broad range of applications. For instance, the VS product range includes many ballast types for multiple lamp operation. These ballasts reduce installation and component costs and thus enable particularly efficient luminaires. Twin-lamp electronic ballasts permit so-called master-slave operation. The lamps of two single-lamp luminaires are operated by a twin-lamp electronic ballast that is built into the so-called master luminaire. The lamp of the slave luminaire is electrically connected to the electronic ballast.

Multi-lamp electronic ballasts also provide an interesting advantage in that several lamps of different ratings can be connected. Electronic ballasts of this kind simplify storage and logistics.

The use of electronic ballasts makes a lighting system both more convenient and efficient to operate:

- reduced power consumption (up to 30%) at undiminished light output
- 50% longer service life
- stabilised lamp output
- overvoltage protection
- no stroboscopic effect
- flicker-free lamp start
- no need for a starter or capacitor
- low wiring effort
- no radiated electromagnetic interference
- low self-heating due to minimal power loss
- automatic shutdown of defective lamps
- automatic restart once the lamp has been changed (except ELXe series)

Vossloh-Schwabe electronic ballasts are developed on the basis of the latest technological and component standards and are produced using state-of-the-art technology, whereby consideration is taken of our customers' quality standards in our quality assurance system.

Assembly Instructions for Electronic Ballasts

For mounting and installing of electronic ballasts for fluorescent lamps

Mandatory regulations

EN 61347-1	Lamp controlgear – part 1: general and safety requirements
EN 61347-2-3	Lamp controlgear – part 2-3: particular requirements for a.c. supplied electronic ballasts for fluorescent lamps
EN 60929	AC-supplied electronic ballasts for tubular fluorescent lamps
DIN VDE 0100	Erection of low voltage installations
EN 60598-1	Luminaires – part 1: general requirements and tests
EN 61000-3-2	Electromagnetic compatibility (EMC) – part 3: maximum values – main section part 2: maximum values for mains harmonics (device input current up to and including 16 A per conductor)
EN 55015	Maximum values and methods of measurement for RFI suppression in electrical lighting installations and similar electrical appliances
EN 61547	Installations for general lighting purposes – EMC immunity requirements

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Descriptions of VS electronic ballasts (EBs)

ELXc ballasts (warm start)
In contrast to the ELXs series, ELXc ballasts have a power factor of better than 0.95 and cover the complete capacity range.
ELXc ballasts ensure the lamp is started following a defined lamp electrode preheating period of approx. 1 – 2.5 seconds using a fixed ignition voltage. This particularly gentle lamp start makes over 20,000 lamp starts possible. ELXc ballasts should be used for applications with high switching frequencies (e.g. hotels or offices) where energy savings as well as low maintenance costs are desired. The average service life of these ballasts totals 50,000 hours with a failure rate of ≤ 0.2% per 1,000 operating hours. The average life of the series ECO-EffectLine: 30.000 hours and New T5 EffectLine: 50.000 hours with a failure rate of ≤ 0.2% per 1,000 operating hours.

ELXd ballasts (dimmable)
These are warm start ballasts with an additional dimming function that is controlled via an interface fitted to the ballast. The interface of these ballasts can be either analogue (1 – 10 Volt) or digital (DALI; PUSH); the interface enables lighting to be ideally adjusted to suit the given need. Control components can also be used as long as they comply with the respective standard (Annex to IEC/EN 60929). The power factor for these ballasts is > 0.95 at 100% lamp operation. When using ELXd ballasts in a lighting system, an energy saving of 75% can be achieved if, for instance, the control inputs of the ballasts are coupled with movement detectors and light sensors. The average service life of these ballasts totals 50,000 hours with a failure rate of ≤ 0.2% per 1,000 operating hours.

To guarantee trouble-free operation and a long service life of the various types of electronic ballast, attention should be paid to the regulations and mounting instructions (page 228 – 235). In addition, the installation instructions for lighting systems must be observed when installing luminaires with electronic ballasts.

Mounting and installation instructions can be obtained from Vossloh-Schwabe on request or can be found online at **www.vossloh-schwabe.com**.

Mechanical mounting

Surface
Solid, flat surface for good heat dissipation required.
Avoid mounting on protruding surfaces.

Mounting location
Electronic ballasts must be protected against moisture and heat.
Installation in external luminaires: water protection rate of ≥ 4
(e.g. IP54 required)

Fastening
With M4 screws in the designated holes

Heat transfer
If the ballast is destined for installation in a luminaire, sufficient heat transfer must be ensured between the ballast and the luminaire casing.
Electronic ballasts should be mounted with the greatest possible clearance to heat sources or lamps. During operation, the temperature measured at the t_c point of the ballast must not exceed the specified maximum value.

Supplement for independent electronic ballasts

Mounting position Any

Clearance
Min. of 0.10 m from walls, ceilings, insulation
Min. of 0.10 m from other electronic ballasts
Min. of 0.25 m from sources of heat (lamp)

Surface
Solid; device must not be allowed to sink into insulation materials

Technical specifications

Operating voltage range
AC: 220 to 240 V (±10%)
DC: please observe the specifications on the individual product pages

Ignition time
ELXe ballasts t < 0.5 seconds (instant start)

Preheat time
ELXc, ELXs and ELXd ballasts t = 0.5 or 1.5 to 2.5 seconds (warm start)

Leak current
≤ 0.5 mA per electronic ballast

Product features

Overheating
VS EBs for fluorescent lamps are not protected against overheating

Overvoltage protection
AC: up to 48 hours at U_{NAC} = 320 V
DC: no disorders occur with input voltages of up to U_{NDC} 285 V. U_{NDC} voltages in excess of 288 V destroy the ballast.

Shutdown of defective lamps
During starting operation, the electronic ballast will detect whether a lamp is connected. If no lamp is present, the ballast will cancel the starting operation. Deactivated lamps or interrupted electrodes are detected and lead to the high-frequency supply being switched off after an unsuccessful ignition attempt. Changing a lamp during operation will lead to the high-frequency supply being switched off.

EOL effect

Up to now, it has not been possible to conclusively reproduce the end-of-life effect under laboratory conditions. However, it can be qualitatively described for fluorescent lamps as follows: when the emitter material of the cathode (i.e. the filament in conventional bi-pin lamps) has been fully consumed or has otherwise lost its emitting power, the emission of electrons is hampered, which leads to a voltage drop at the cathode. Frequent cold starts accelerate active emitter loss.

Operating a lamp with a constant current (an electronic ballasts (EB) provides a near-constant current) results in high dissipation losses that also cause the lamp base and lampholder to heat up and can even cause damage to both. This is often referred to as the EOL effect; from an electrical point of view, this is manifested in the so-called "partial rectifier effect".

The EOL cut-out ensures that a ballast is safely switched off and the lamp base does not overheat at the end of a lamp's service life.

EN 61347-2-3 (A1:2004) describes three possible tests.
The first are now in widespread use and are described in more detail here.
The third test is not conducted at VS.

1. EOL Test 1 (61347-2-3:2000 + A1:2004 + A2:2006 17.2)
   Asymmetric pulse test
2. EOL Test 2 (61347-2-3:2000 + A1:2004 + A2:2006 17.3)
   Asymmetric power test
3. EOL Test 3 (61347-2-3:2000 + A1:2004 + A2:2006 17.4)
   Exposed filament test

The first two tests attempt to simulate the rectifier effect:

- Test 1 pulse switching of rectifying effect
- Test 2 by applying a DC voltage that is constantly higher than required by the lamp.

VS EBs are capable of suitably assessing the altered voltage signal in comparison to normal operation so as to meet EOL requirements.

Protection against transient mains peaks

Values are in compliance with EN 61547 (interference immunity)
(1 kV for AC and 0.5 kV for DC and control conductors).

Electrical installation

Wiring

The wiring between the mains, electronic ballast and lamp must comply with the respective circuit diagram. Note: with ELXe models, one side of the lamp electrode is never connected to the electronic ballast.
The electronic ballast must be earthed using a toothed washer or similar (protection class I, ignition help, compliance with RFI/BCI standards).
To ensure compliance with RFI-suppression limits, mains conductors should not be wired in parallel to high-frequency carrying lamp conductors; maximum clearance should be ensured and all conductors marked with an * must be kept short. As a general rule, a maximum conductor length should not be exceeded when using conventional conductors (see table on page 239–241 for precise details). Luminaire must be tested for compliance with the RFI suppression limits stipulated by EN 55015.

Conductors must not exceed 3 m in length in the event of master-slave operation.

Dimmable electronic ballasts are unsuitable for master/slave operation.

Through-wiring of mains voltage

ELXc 257.836 (188400) devices permit through-wiring of mains voltage
The following list specifies the maximum No. of devices that may be connected to the first device:

- 2 x 57 W = max. 3 devices
- 2 x 42 W = max. 4 devices
- 2 x 32 W = max. 5 devices
- 2 x 26 W = max. 7 devices

Mains power can be through-wired with the following devices:

- ELXc 213.874: max. 39 devices
- ELXc 218.875: max. 31 devices
- ELXc 142.876: max. 23 devices
- ELXc 242.877: max. 11 devices

The number of devices always refers to maximum-load operation. In addition, the maximum number of devices per installed automatic fuse must be strictly observed.

It is permissible to connect the protective conductor of the ballast by attaching the ballast to metal conductors that are connected to the protective conductor. In doing so, care must be taken to ensure the protective conductor is contacted in accordance with EN 60598. If, however, a ballast is fitted with a connection terminal for a protective conductor without through-wiring and if this is to be used to connect the protective conductor, this connection terminal may only be used for the ballast itself.

Cord grip

EBs with cord grip can be used with the following conductors, for instance:

Designation	**Lead type**
Mains lead	H03VV-F 3X0.75 mm² or NYM 3X1.5 mm²
Control lead	H03VV-F 2X0.5 mm²
Mains and control lead in one lead	H03VV-F 5X0.75 mm²
Lamp lead	H05VV-F 4X1 mm² or 5X1 mm²

Connection terminals for automatic luminaire wiring (ALF connections)

- Use copper (not stranded) wire
- Rquired diameter for push-in connection 0.5 – 1 mm²
- Stripped lead length 8 – 9 mm
- Required diameter for IDC 0.5 mm², max. Ø 2 mm including insulation, no wire stripping required; mounting requires a special tool

Push-in terminals

The integrated terminals can be used with flexible or rigid leads with a crosssection of 0.5 – 1.5 mm². The stripped lead length ranges between 8.5 – 9.5 mm for a 3.5 mm terminal grid.

Error current

Impulse-resistant leak-current protection must be installed. Distribute the luminaires to phases L1, L2 and L3; install tri-phase FI switches. If permissible, install FI switches with 30 mA leak current; connect no more than 15 luminaires as FI switches can be triggered at half the leak current value.

Tri-phase connection of luminaires with EB

- Prior to operating newly installed lighting systems: check the mains voltage is appropriate to the electronic ballast's mains voltage range (AC, DC).
- The N-type conductor must be properly connected to all luminaires or ballasts.
- Conductors can only be connected or disconnected if the ballast is disconnected from the mains. Attention: N-type conductors must never be disconnected individually or as the first element.
- Insulation resistance test: from L to PE (L and N must not be connected)
- The neutral conductor must be reconnected after completion of the test.

Power factor/compensation

Luminaires with electronic ballasts do not require compensation: power factor ≥ 0.95.

Selection of automatic cut-outs

Dimensioning automatic cut-outs

High transient currents occur when an EB is switched on because the capacitors have to load. Lamp ignition occurs almost simultaneously. This also causes a simultaneous high demand for power. These high currents when the system is switched on put a strain on the automatic conductor cut-outs, which must be selected and dimensioned to suit.

Release reaction The release reaction of the automatic conductor cut-outs comply with VDE 0641, part 11, for B and C characteristics.

No. of electronic ballasts (see the table on pages 239–241)

The maximum number of VS ballasts applies to cases where the devices are switched on simultaneously. Specifications apply to single-pole fuses. The number of permissible ballasts must be reduced by 20% for multi-pole fuses. The considered circuit impedance equals 400 mΩ (approx. 20 m of conductor [2.5 mm²] from the power supply to the distributor and a further 15 m to the luminaire). Doubling circuit impedance to 800 mΩ increases the possible number of ballasts by 10%.

EB output voltage Electronic ballasts bear the information "U_{OUT}" on their type plates. All subsequently connected components must be designed for this EB output voltage. When using T5 lamps, any components connected to the output side of the EB must be approved for a voltage of ≥ 430 V (especially lampholders). This also applies to dimmable T5 EBs.

Lamps and dimmed operation

For lighting systems with dimmable electronic ballasts, Vossloh-Schwabe recommends that fluorescent lamps always be replaced as a full complement to maintain uniform lighting levels and colour impressions. New lamps must be burnt in at maximum brightness for approx. 100 hours.
Without restrictions, VS electronic ballasts can be used to operate ECO T5 fluorsecent lamps (except for with types ELXc 135.856 and ELXc 235.857) and T8 fluorescent lamps.
A two-lamp dimmable electronic ballast can only be used with lamps of a single lamp manufacturer. The following EBs are restricted in their suitability for dimmer operation of amalgam lamps: ELXd 118.802, 218.803, 142.806, 242.807.

Dimming interface

DC 1–10 V according to EN 60929 with power source 0.5 mA (protected in the event of mains voltage connection); designed to enable connection of control and regulation units.
Dimming range: 3–100% of lamp power

DALI (Digital Addressable Lighting Interface) dimming interface

Polarity reversible dimmer interface – protected in accordance with EN 60929 given mains voltage supply – for connecting control devices that work according to the standard digital protocol. Dimming range: 1–100% of the lamp's rating

Potential interference with IR systems

Operating lamps at frequencies of 20 to 50 kHz can cause interference with infrared systems (remote controls, sound transmission, personal pager systems). Countermeasures: optical filters, switching to infrared systems with higher carrier frequencies (over 400 kHz).

Electromagnetic Compatibility (EMC)

Vossloh-Schwabe's electronic ballast range was developed in accordance with valid EMC standards (interference, interference immunity and mains harmonics) and specially designed to ensure safe compliance with the limiting values.
It is assumed that that any remarks regarding conductor wiring and conductor length in the instructions for installing electronic ballasts in luminaires or for independent ballasts will be observed.

Vossloh-Schwabe electronic ballasts are also tested in commercially available luminaires in addition to the CISPR 30 sample luminaires.

Mains harmonics: the maximum values laid down in EN 61547 (Interference Immunity) are satisfied.

Additional information

Information on the installation of electronic ballasts for optimising EMC

To ensure good radio interference suppression and the greatest possible operating safety, the following points should be observed when installing electronic ballasts:

- Conductors between the EB and the lamp (HF conductors) must be kept short (reduction of electromagnetic interference). High-potential lamp conductors must be kept as short as possible, in particular with tubular lamps. Lamp conductors of this kind are labelled with an * in the wiring diagram on the type plate (see page 239–241).
- Mains and lamp conductors must be kept separate and if possible should not be laid in parallel to one another. The distance between HF and mains conductors should be as large as possible, ideally > 5 cm. (This prevents the induction of interference between the mains and lamp conductors.)
- The mains conductor within the luminaire must be kept short (to reduce the induction of interference).
- Devices must be properly earthed. EBs require secure contacts to the luminaire casing or must be earthed using a PE connection. This PE connection should be effected using an independent conductor to achieve better dissipation of the leak current. EMC improves at frequencies greater than 30 MHz.
- The mains conductor must not be laid too close to the EB or the lamp (this is especially important in the event of through-wiring).
- Mains and lamp conductors must not be crossed. Should this be impossible to avoid, conductors should be crossed at right angles to one another to avoid inducing interference between mains and HF conductors.
- Should conductors be wired through metal parts, such conductors must always be additionally shielded (e.g. with an insulating sleeve or grommet).

Temperature

Reference point temperature t_c

The safe operation of electronic ballasts is dependent on the maximum permissible temperature not being exceeded at the measuring point. Vossloh-Schwabe has determined a casing temperature measuring point – $t_{c\ max.}$ – on all EB casings. To avoid shortening the service life or diminishing operating safety, the stipulated maximum temperature must not be exceeded at this t_c point. This point is determined by testing the convertor during normal, IEC-standardised operation at the specified ambient temperature (t_a), which is also indicated on the type plate. As both the design-related ambient temperature and the ballast's inherent heat, as determined by the installed load, are subject to great variation, the casing temperature should be tested at the t_c point under real installation conditions.

Ambient temperature t_a

The ambient temperature – as specified on every EB – denotes the permissible temperature range within the luminaire.

Reliability and service life

If the max. temperature at the t_c reference point (as specified on the type plate and the technical documentation of the ballast) is not exceeded, the defined service life can be expected to be achieved, assuming a switching cycle of 165 minutes on and 15 minutes off.
See page 229 for service life details regarding the various electronic ballast families.

Emergency lighting

All Vossloh-Schwabe EBs that are suitable for DC voltage operation can be used in emergency lighting systems. Consideration must, however, be taken of system requirements.

VS Dimmable Electronic Ballasts

Vossloh-Schwabe's range of electronic ballasts is rounded off by dimmable ballasts for fluorescent lamps The standardised interfaces "1 – 10 V" and "DALI" are used for this purpose. Coupled with sensors, electronic ballasts fitted with a "1 – 10 V" interface make it easy to create intelligent luminaires and room lighting systems, whereby the luminaires are "programmed" via the wiring to the control units, i.e. via the hardware.

The digital interface "DALI" (Digital Addressable Lighting Interface) constitutes a further development of the "1 – 10 V" analogue interface. This digital interface was jointly developed by leading manufacturers of electronic ballasts in order to create a uniform standard for the lighting industry. The uniform interface and telegram definition dictates the function of a DALI operating device or DALI consumer and ensures exchangeability of operating devices made by various manufacturers.

Each VS DALI ballast is additionally fitted with the so-called PUSH function. The data input DA (DALI & PUSH) is used as a control input for both signal structures, with the exception of devices featuring separate inputs. When used as a DALI ballast, control is effected via the DALI protocol; when used as a PUSH ballast, control is effected via a push key and is achieved via current flow times of differing duration.

VS DALI electronic ballasts provide the convenience of a bus system that is both easy to install and operate.

Due to the working principle involved, dimming compact fluorescent lamps causes a negligible drop in colour temperature. However, sudden larger changes in the dimmer setting can temporarily cause greater variation in colour temperature. The dimmer function is optimised to minimise this subjective visual change in colour temperature when the dimmer setting is suddenly subjected to larger change.

VS DALI electronic ballasts are characterised by the following performance feature

- Two-strand, potential-free, polarity-independent control input
- Dimmer curve analogue to the light sensitivity of the human eye
- Addressing options: total system, group-wise or individually
- Scene memory
- Feedback in the event of defective lamps

DALI and PUSH must not be used at the same time!

Switching mains voltage to the DALI conductors within a DALI system will lead to the destruction of both the DALI power supply and the DALI master!

These features ensure a number of advantages for lighting systems

- No group wiring needed
- Each DALI ballast can be individually addressed
- No need for scene memory modules
- Synchronised scene transitions
- Operating devices provide reports on lamp status
- Simple integration into facility management systems

PUSH function characteristic

- Just one key for dimming and ON/OFF
- Polarity- and phase-independent control
- Control input with large working voltage range
- Suitable for multi-layer control
- Fully DC-compatible – no functional restrictions during DC operation
- After disconnection from the primary voltage the ballast will reproduce the last stored lighting level
- Soft start
- Automatic recognition of DALI and PUSH signals

PUSH operating voltage ranges during control signal input

EB type	ELXd 117.715, ELXd 217.717, ELXd 118.705, ELXd 218.707, ELXd 142.709, ELXd 242.711	All other DALI/PUSH ballasts
AC	220–240 V ±10%	10–230 V
DC	198–264 V	–
	Failing to observe these working voltage ranges can lead to non-recognition of the signals; exceeding the maximum voltages can lead to the destruction of the data inputs.	

PUSH control signals (key activation)

Short push	(80 ms < t < 460 ms)	(0 ms < t < 500 ms)
	Is used to switch between ON/OFF lighting states. After the device is switched on, the last selected lighting level is restored and the next dimming direction will be upwards.	
Long push	(460 ms < t < 10 s)	(500 ms < t < ∞)
	Is used to dim upwards or downwards; a long push will change the dimming direction. Thus, a long push will reverse the dimming direction until the upper or lower limit is reached. If the light was off, a long push will switch it on and the dimmer will start at the lowest light intensity.	
Push to synchronise	(t > 10 s)	long – short – long
	Light is dimmed to the preset factory level and the next dimming direction will be upwards.	Starting situation: luminaires are switched off. The "long – short – long" combination first switches the lamp on, then off and finally on again, after which it gets gradually brighter. The EBs will be synchronised again after this procedure.
Synchronisation	Any 1-key dimmer that does not feature a central control module (as each ballast will have its own controls) can develop asynchronous behaviour (e.g. children might play with the key). The system will then be out of sync, i.e. some lamps will be on, others off or the dimming direction will differ from lamp to lamp.	
	Two methods of synchronisation can be used: • Push the key for more than 10 seconds, after which the light will be dimmed to a preset level and the next dimming direction will be upwards. • Start with a long push of the key so that all lamps are switched on. Follow with a short push to turn the system off. The system will now be resynchronised.	

Wiring examples for PUSH function

Note **Not permissible**: N-type conductors must not be used as PUSH potentials for multi-phase systems. Example: if the PUSH key is not activated, the series connection of the internal resistors of the DA inputs will approach the delta voltage of 400 V (voltage between L2 and L3) (Fig. 1).

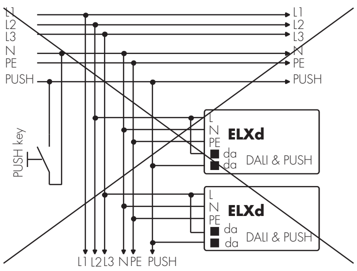


Fig. 1
N conductor must not be used as a PUSH potential

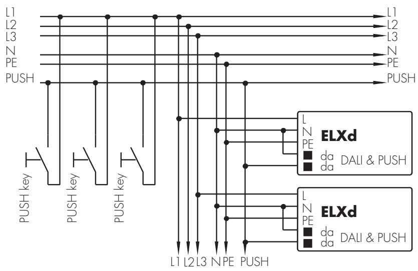


Fig. 2
Standard application for T5 and T8 lamps

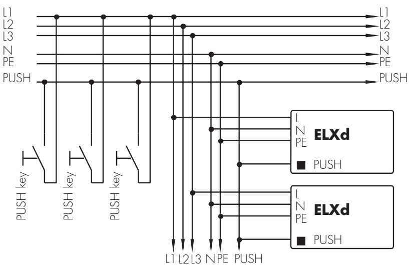


Fig. 3
Standard application for TC lamps

General information on PUSH and DALI

Mains voltage and interface conductors must not be wired in parallel to the lamp conductors so as to avoid capacitive bridging of the mains filter.

If more than one device is operated with a single key during PUSH operation, asynchronous behaviour can occur, which will require manual resynchronisation using the method described. Should this be unacceptable, a DALI control module will have to be used instead. It is recommended not to control more than four devices using a single key.

When using dimmable devices, new lamps should generally be burnt in for at least 100 hours at full brightness before they are dimmed. This process can become necessary again should the lamps be physically relocated (e.g. transport).

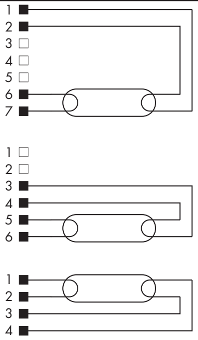
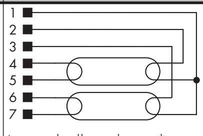
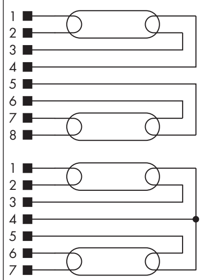
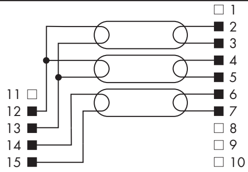
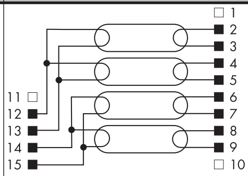
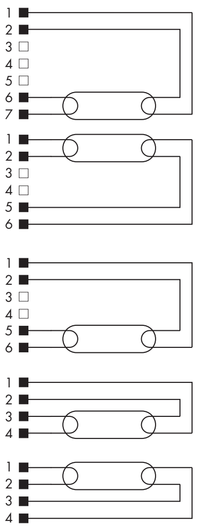
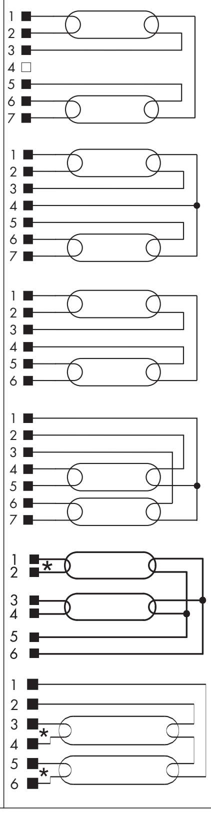
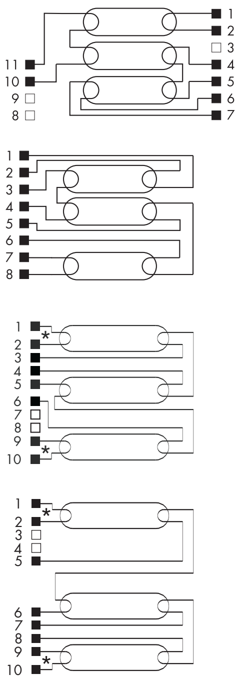
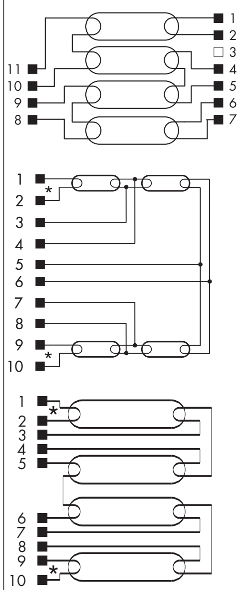
After initial operation of a DALI system (address assignment, luminaire allocation, group formation, scene settings) it is recommended to disconnect the primary voltage of the DALI control units at the circuit breaker for at least 3 seconds and then to reconnect it. The devices will detect this disconnection from the mains and store the settings.

DALI devices with a PUSH function must be operated with a control module (DALI control module or key pad with PUSH function). DALI devices with a PUSH function must not be operated with an open or bridged DALI/PUSH input.

To ensure the ballast does not distort and misinterpret signals when operated in PUSH mode, connected PUSH buttons must not feature a control lamp.

Circuit diagrams for Vossloh-Schwabe electronic ballasts

The circuit diagrams shown here are wiring examples for Vossloh-Schwabe electronic ballasts, whereby the number and configuration of the contacts differ. See the table on page 239–241 for details.

EB	1 lamp	2 lamps	3 lamps	4 lamps
ELXd		 Linear ballast shape*  Compact ballast shape		
ELXc				

* ELXc devices can also be wired under observation of the circuit diagram on the ballast.

Explanation of circuit diagrams for Vossloh-Schwabe electronic ballasts (see page 238)

Electronic ballasts Ref. No.	Type	Lamp Quantity	Electronic ballasts Terminals 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Max. lead length hot* (m/pf)	cold (m/pf)	Operation frequency kHz	Output voltage U_{OUT} V	THD %	Possible quantity of EB/automatic cut-outs B (10A)	B (16A)	C (10A)	C (16A)
ELXc																										
183039	ELXc 424.223	3	x*	x*	–	x	x	x	x	–	–	x	x	–	–	–	–	1/100	2/200	44	400	< 10	9	14	14	22
		4	x*	x*	–	x	x	x	x	x	x	x	x	–	–	–	–	1/100	2/200	44	400	< 10	9	14	14	22
183040	ELXc 226.878	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	45	300	< 10	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	45	300	< 10	11	18	18	30
183108	ELXc 226.878	1	x	x	–	–	x*	x*	–		–	–	–	–	–	–	–	1/100	1.5/150	45	300	< 10	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	45	300	< 10	11	18	18	30
183109	ELXc 414.227	3	x*	x*	x	x	x	x	x	x	x*	x*	–	–	–	–	–	1/100	2/200	45	350	< 15	7	12	12	20
		4	x*	x*	x	x	x	x	x	x	x*	x*	–	–	–	–	–	1/100	2/200	45	350	< 15	7	12	12	20
183110	ELXc 424.228	3	x*	x*	x	x	x	x	x	x	x*	x*	–	–	–	–	–	1/100	2/200	47	350	< 15	7	12	12	20
		4	x*	x*	x	x	x	x	x	x	x*	x*	–	–	–	–	–	1/100	2/200	47	350	< 15	7	12	12	20
183111	ELXc 228.229	1	x*	x*	x	x	x	x	–	–	–	–	–	–	–	–	–	1/100	2/200	47	350	< 15	9	15	15	25
		2	x*	x*	x	x	x	x	–	–	–	–	–	–	–	–	–	1/100	2/200	47	350	< 20	9	15	15	25
183112	ELXc 328.230	2	x*	x*	x	x	x	x	x	x	x*	x*	–	–	–	–	–	1/100	2/200	45	350	< 15	7	12	12	20
		3	x*	x*	x	x	x	x	x	x	x*	x*	–	–	–	–	–	1/100	2/200	45	350	< 15	7	12	12	20
183113	ELXc 135.231	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	47	400	< 15	11	18	18	30
183114	ELXc 235.232	2	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	–	1/100	2/200	46	400	< 15	9	15	15	25
183115	ELXc 239.233	1	x*	x*	x	x	x	x	–	–	–	–	–	–	–	–	–	1/100	2/200	47	350	< 15	7	12	12	20
		2	x*	x*	x	x	x	x	–	–	–	–	–	–	–	–	–	1/100	2/200	47	350	< 15	7	12	12	20
183116	ELXc 149.234	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	47	250	< 15	9	15	15	25
183117	ELXc 249.235	2	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	–	1/100	2/200	47	350	< 15	7	12	12	20
183118	ELXc 254.236	1	x*	x*	x	x	x	x	–	–	–	–	–	–	–	–	–	1/100	2/200	48	350	< 15	7	12	12	20
		2	x*	x*	x	x	x	x	–	–	–	–	–	–	–	–	–	1/100	2/200	48	350	< 15	7	12	12	20
183119	ELXc 180.237	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	46	350	< 15	9	15	15	25
183122	ELXc 114.238	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	45	380	< 20	8	17	17	28
183123	ELXc 128.239	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	45	380	< 20	8	17	17	28
183124	ELXc 214.240	2	x	x	x	x	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	2/200	45	380	< 20	8	17	17	28
183125	ELXc 228.241	2	x	x	x	x	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	2/200	45	380	< 20	4	7	7	12
183126	ELXc 414.242	4	x*	x*	x	x	x	x	x	x	x*	x*	–	–	–	–	–	1/100	2/200	45	430	< 20	4	7	7	12
183127	ELXc 118.243	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	45	390	< 20	8	17	17	28
183128	ELXc 136.244	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	45	390	< 20	8	17	17	28
183129	ELXc 158.245	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	45	390	< 20	4	7	7	12
183130	ELXc 218.246	2	x*	x*	x	x	x	x	–	–	–	–	–	–	–	–	–	1/100	2/200	45	390	< 20	8	17	17	28
183131	ELXc 236.247	2	x*	x*	x	x	x	x	–	–	–	–	–	–	–	–	–	1/100	2/200	45	390	< 20	4	7	7	12
183132	ELXc 258.248	2	x*	x*	x	x	x*	x*	x	–	–	–	–	–	–	–	–	1/100	2/200	45	390	< 20	2	5	5	8
183133	ELXc 418.249	4	x*	x*	x	x	x	x	x	x	x*	x*	–	–	–	–	–	1/100	2/200	45	390	< 20	4	7	7	12
183134	ELXc 118.879	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	45	380	< 20	8	17	17	28
183135	ELXc 126.880	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	45	380	< 20	8	17	17	28
183136	ELXc 218.881	2	x*	x*	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	2/200	45	380	< 20	4	7	7	12
183137	ELXc 226.882	2	x*	x*	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	2/200	45	380	< 20	4	7	7	12
188093	ELXc 135.856	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	44	330	< 10	11	18	18	30
188094	ELXc 235.857	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	1/100	2/200	45	330	< 10	9	15	15	25
188095	ELXc 149.858	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	28	330	< 10	11	18	18	30
188140	ELXc 140.862	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	45	250	< 10	11	18	18	30
188142	ELXc 154.864	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	34	300	< 10	9	15	15	25
188144	ELXc 180.866	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	45	300	< 10	9	15	15	25
188438	ELXc 414.868	3	x*	x*	–	x	x	x	x	–	–	x	x	–	–	–	–	1/100	2/200	45	400	< 10	7	12	12	20
		4	x*	x*	–	x	x	x	x	x	x	x	x	–	–	–	–	1/100	2/200	45	400	< 10	7	12	12	20
188589	ELXc 128.869	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	1.5/150	54	450	< 10	11	18	18	30
188590	ELXc 128.869	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	1.5/150	54	450	< 10	11	18	18	30
188595	ELXc 336.214	3	x	x	x	x	x	x	x*	x*	–	–	–	–	–	–	–	1/100	2/200	70	370	< 10	6	11	11	18
188616	ELXc 240.863	2	x*	x*	x	–	x	x	x	–	–	–	–	–	–	–	–	1/100	2/200	46	360	< 15	7	12	12	20
188617	ELXc 249.859	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	1/100	2/200	43	480	< 10	7	12	12	20
188618	ELXc 254.865	2	x*	x*	x	–	x	x	x	–	–	–	–	–	–	–	–	1/100	2/200	43	390	< 10	7	12	12	20
188619	ELXc 280.538	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	1/100	2/200	50	420	< 10	–	10	–	10
188643	ELXc 242.837	2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	43	440	< 15	7	12	12	20
188680	ELXc 155.378	1	x	x	x*	x*	–	–	–	–	–	–	–	–	–	–	–	1/100	1.5/150	47	250	< 15	7	12	12	20
188681	ELXc 155.378	1	x	x	x*	x*	–	–	–	–	–	–	–	–	–	–	–	1/100	1.5/150	47	250	< 15	7	12	12	20
188687	ELXc 242.837	2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	43	440	< 15	7	12	12	20

Electronic ballasts		Lamp	Electronic ballasts															Max. lead length		Operation	Output	THD	Possible quantity of			
Ref. No.	Type	Quantity	Terminals															hot*	cold	frequency	voltage		EB/automatic cut-outs			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				U_{OUT}		B	B	C	C
																		(m/pf)	(m/pf)	kHz	V	%	(10A)	(16A)	(10A)	(16A)
ELXc																										
188698	ELXc 213.870	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	42	250	< 20	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	42	250	< 20	11	18	18	30
188699	ELXc 218.871	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	35	350	< 12	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	35	350	< 12	11	18	18	30
188700	ELXc 142.872	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	44	480	< 15	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	44	480	< 15	11	18	18	30
188704	ELXc 136.207	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	–	–	48	350	< 20	11	18	18	30
188705	ELXc 236.208	2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	–	–	45	250	< 20	11	18	18	30
188706	ELXc 158.209	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	–	–	33	250	< 20	9	15	15	25
188707	ELXc 258.210	2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	–	–	48	350	< 20	7	12	12	19
188712	ELXc 213.870	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	42	250	< 20	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	42	250	< 20	11	18	18	30
188713	ELXc 218.871	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	35	350	< 12	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	35	350	< 12	11	18	18	30
188714	ELXc 142.872	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	44	480	< 15	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/100	1.5/150	44	480	< 15	11	18	18	30
188744	ELXc 418.204	3	x*	x*	–	x	x	x	x	–	–	x	x	–	–	–	–	1/100	2/200	44	480	< 10	7	12	12	20
		4	x*	x*	–	x	x	x	x	x	x	x	x	–	–	–	–	1/100	2/200	44	480	< 10	7	12	12	20
188886	ELXc 213.874	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	44	250	< 10	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	44	250	< 10	11	18	18	30
188887	ELXc 218.875	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	37	350	< 10	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	37	350	< 10	11	18	18	30
188888	ELXc 142.876	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	44	480	< 10	11	18	18	30
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	44	480	< 10	11	18	18	30
188889	ELXc 242.877	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	45	480	< 10	7	12	12	20
		2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	45	480	< 10	7	12	12	20
188912	ELXc 136.216	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	47,5	430	< 20	17	28	28	46
188913	ELXc 236.217	2	x*	x*	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	45	430	< 10	17	28	28	46
188914	ELXc 158.218	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	34	430	< 10	17	28	28	46
188915	ELXc 258.219	2	x*	x*	x	x	x*	x*	–	–	–	–	–	–	–	–	–	1/75	1.5/100	52	430	< 10	17	28	28	46
188921	ELXc 135.220	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/150	41	300	<10	11	18	18	30
188922	ELXc 235.221	2	x	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	1/100	2/150	41	300	< 10	11	18	18	30
ELXd																										
183059	ELXd 235.735	2	x*	x+	x	x	x	x*	x*	–	–	–	–	–	–	–	–	1/100	2/200	42	300	< 5	10	17	18	28
188329	ELXd 124.600	1	x	x	–	–	–	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	76-120	430	< 10	17	28	28	46
188330	ELXd 224.601	2	x	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	53-120	430	< 10	17	28	28	46
188331	ELXd 139.602	1	x	x	–	–	–	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	85-120	430	< 10	17	28	28	46
188332	ELXd 154.603	1	x	x	–	–	–	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	83-120	430	< 10	17	28	28	46
188333	ELXd 254.604	2	x	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	44-120	430	< 10	8	13	13	21
188334	ELXd 180.605	1	x	x	–	–	–	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	91-120	430	< 10	12	19	19	31
188335	ELXd 249.606	2	x	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	44-120	430	< 10	8	13	13	21
188336	ELXd 124.607	1	x	x	–	–	–	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	76-120	430	< 10	17	28	28	46
188337	ELXd 224.608	2	x	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	53-120	430	< 10	17	28	28	46
188338	ELXd 139.609	1	x	x	–	–	–	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	85-120	430	< 10	17	28	28	46
188339	ELXd 239.610	2	x	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	53-120	430	< 10	17	28	28	46
188340	ELXd 154.611	1	x	x	–	–	–	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	83-120	430	< 10	17	28	28	46
188341	ELXd 254.612	2	x	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	44-120	430	< 10	8	13	13	21
188342	ELXd 180.613	1	x	x	–	–	–	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	91-120	430	< 10	12	19	19	31
188343	ELXd 249.614	2	x	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	44-120	430	< 10	8	13	13	21
188350	ELXd 239.621	2	x	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	53-120	430	< 10	17	28	28	46
188431	ELXd 226.801	2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.75/75	50-90	470	< 10	7	12	12	20
188490	ELXd 226.801	2	x	x	x	x	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.75/75	50-90	470	< 10	7	12	12	20
188549	ELXd 218.803	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	0.5/50	0.75/75	60-99	300	< 10	11	18	18	30
188550	ELXd 242.807	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	0.5/50	0.75/75	45-95	400	< 10	7	12	12	20
188564	ELXd 118.802	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.75/75	60-105	400	< 10	11	18	18	30
188565	ELXd 142.806	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.75/75	40-95	400	< 10	11	18	18	30
188597	ELXd 324.623	3	–	x*	x*	x*	x*	x*	x*	–	–	–	–	x*	x*	x*	x*	0.5/50	–	67-120	430	< 10	8	13	13	21
188598	ELXd 424.624	4	–	x*	x*	x*	x*	x*	x*	x*	x*	–	–	x*	x*	x*	x*	0.5/50	–	45-120	430	< 10	8	13	13	21
188600	ELXd 324.626	3	–	x*	x*	x*	x*	x*	x*	–	–	–	–	x*	x*	x*	x*	0.5/50	–	67-120	430	< 10	8	13	13	21
188601	ELXd 318.627	3	–	x*	x*	x*	x*	x*	x*	–	–	–	–	x*	x*	x*	x*	0.5/50	–	45-120	430	< 10	17	28	28	46
188602	ELXd 424.628	4	–	x*	x*	x*	x*	x*	x*	x*	x*	–	–	x*	x*	x*	x*	0.5/50	–	45-120	430	< 10	8	13	13	21
188604	ELXd 280.630	2	x	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	44-120	430	< 10	5	9	9	15

Electronic ballasts Ref. No.	Type	Lamp Quantity	Electronic ballasts Terminals 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Max. lead length hot* (m/pf)	cold (m/pf)	Operation frequency kHz	Output voltage U_{OUT} V	THD %	Possible quantity of EB/automatic cut-outs B (10A)	B (16A)	C (10A)	C (16A)
ELXd																										
188605	ELXd 280.631	2	x	x	x	x*	x*	x*	x*	–	–	–	–	–	–	–	–	1/100	1.5/150	44-120	430	< 10	5	9	9	15
188694	ELXd 118.802	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.75/75	60-105	400	< 10	11	18	18	30
188695	ELXd 142.806	1	x	x	–	–	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.75/75	40-95	400	< 10	11	18	18	30
188696	ELXd 218.803	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	0.5/50	0.75/75	60-99	300	< 10	11	18	18	30
188697	ELXd 242.807	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	0.5/50	0.75/75	45-95	400	< 10	7	12	12	20
188717	ELXd 135.823	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/75	1.5/100	45	420	< 10	30	50	30	50
188864	ELXd 117.715	1	–	–	x*	x*	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	1.5/150	47-80	400	< 10	10	15	15	25
188865	ELXd 117.715	1	–	–	x*	x*	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	1.5/150	47-80	400	< 10	10	15	15	25
188866	ELXd 217.717	2	x*	x*	x*	x*	x*	x*	x*	–	–	–	–	–	–	–	–	0.5/50	1.5/150	34-94	250	< 10	11	18	18	30
188867	ELXd 217.717	2	x*	x*	x*	x*	x*	x*	x*	–	–	–	–	–	–	–	–	0.5/50	0.5/50	34-94	250	< 10	11	18	18	30
188873	ELXd 118.718	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1.5/150	2,0/200	55-113	300	< 5	15	24	25	40
188874	ELXd 218.719	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	1.5/150	2,0/200	42-114	400	< 5	17	27	28	46
188875	ELXd 136.720	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1.5/100	2,0/200	47-105	300	< 5	15	24	25	40
188876	ELXd 236.721	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	1.5/100	2,0/200	42-107	400	< 5	17	27	27	44
188877	ELXd 158.722	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1.5/100	2,0/200	47-105	300	< 8	15	24	25	40
188878	ELXd 258.723	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	1.5/150	2,0/200	45-110	400	< 10	11	18	19	31
188923	ELXd 142.709	1	–	–	x*	x*	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.5/50	41-104	400	< 10	8	12	12	20
188924	ELXd 142.709	1	–	–	x*	x*	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.5/50	41-104	400	< 10	8	12	12	20
188932	ELXd 135.724	1	x*	x*	x	x	–	–	–	–	–	–	–	–	–	–	–	1/100	2/200	43	330	< 10	11	17	18	29
188933	ELXd 235.725	2	x*	x*	x	x	x	x*	x*	–	–	–	–	–	–	–	–	1/100	2/200	43	330	< 5	10	17	18	28
188952	ELXd 118.705	1	–	–	x*	x*	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.5/50	47	250	< 10	13	20	21	34
188953	ELXd 118.705	1	–	–	x*	x*	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.5/50	47	250	< 10	13	20	21	34
188954	ELXd 218.707	2	x*	x*	x*	x*	x*	x*	x*	–	–	–	–	–	–	–	–	0.5/50	0.5/50	41	250	< 10	12	20	21	33
188955	ELXd 218.707	2	x*	x*	x*	x*	x*	x*	x*	–	–	–	–	–	–	–	–	0.5/50	0.5/50	41	250	< 10	12	20	21	33
188974	ELXd 242.711	2	x*	x*	x*	x*	x*	x*	x*	–	–	–	–	–	–	–	–	0.5/50	0.5/50	40	250	< 10	12	20	21	33
188975	ELXd 242.711	2	x*	x*	x	x*	x*	x*	–	–	–	–	–	–	–	–	–	0.5/50	0.5/50	40	250	< 10	12	20	21	33

Electromagnetic ballasts

Electromagnetic (inductive) ballasts are active components that in conjunction with starters preheat the lamp electrodes, supply the ignition voltage and stabilise lamp currents during operation. Series or parallel capacitors are required to compensate blind current.

For installation in luminaires, consideration must be taken of the mains voltage and mains frequency, the dimensions and maximum thermal values as well as any potential noise generation. To fulfil these special requirements, Vossloh-Schwabe provides a large variety of different ballasts.

VS magnetic ballasts have been optimised with regard to their magnetic fields and loads so that usually so that noise cannot usually be perceived. However, the luminaire design can cause magnetic vibrations to affect large areas. When designing luminaires, it might therefore be necessary to fit a concertina section or grooves to prevent vibrations from spreading and thus from noise being generated.

The service life of an inductive ballast is mainly determined by the material chosen for the winding insulation. The maximum winding temperature denotes the temperature (tw) that the insulation will withstand for a period of 10 years given continuous operation under rated conditions. This maximum winding temperature must not be exceeded in real conditions to ensure the ballast can achieve its full service life. The winding temperature of the ballast that is measured in the luminaire is made up of the ambient temperature of the luminaire, the thermal conditions within the luminaire and the power loss of the ballast. The Δt marking on the ballast type plate provides a measure of the power loss of the ballast. In addition to this, the power loss of ballast-lamp circuits is measured in accordance with EN 50294. This test method forms the basis for the CELMA energy classification of ballasts and is also applied in European Regulation 245/2009/EG "Definition of eco-design requirements regarding fluorescent lamps without an integrated ballast, high-pressure discharge lamps as well as ballasts and luminaires in their operation and the invalidation of Directive 2000/55/EC" (see pages 251–253 for further details).

1 2 3 4 5 6 7 8 9 10

As a result of their design features, inductive ballasts cause leak current that is discharged via the earth conductor of the luminaire. The maximum permissible leak current for protection class I luminaires is 1 mA, a value of which all Vossloh-Schwabe electronic ballasts fall clearly short. Values of max. 0.1 mA are measured per electromagnetic ballast. However, as these values accumulate with the number of installed ballasts, this should be taken into account when dimensioning the F1 protective switch.

Starters for fluorescent lamps

As mentioned above, the operation of fluorescent lamps also requires starters in addition to ballasts. A distinction is made between glow starters, which are also available with automatic cut-outs, and electronic starters. The correct choice of voltage and power range is crucial. Starters are available for 220–240 V and for 110–127 V mains voltage. The latter are also required for twin-lamp operation (e.g. 2x18 W at 230 V).

Operating SL-series VS ballasts (100–127 V) depends on the use of a 220–240 V starter as these operating devices are high-reactance transformers that supply higher voltages to the lamp. Starters should only be used with starter contacts with a hardness value of at least HB 100.

Assembly Instructions for Electromagnetic Ballasts

For mounting and installing of electromagnetic ballasts for fluorescent lamps

Mandatory regulations

DIN VDE 0100	Erection of low voltage installations
EN 60598-1	Luminaires – part 1: general requirements and tests
EN 61347-1	Operating devices for lamps – part 1: general and safety requirements
EN 61347-2-8	Operating devices for lamps – part 2-8: special requirements for ballasts for fluorescent lamps
EN 60921	Ballasts for fluorescent tube lamps – performance requirements
EN 50294	Methods for measuring the total input power of ballast-lamp circuits
EN 55015	Maximum values and methods of measurement for RFI suppression in electrical lighting installations and similar electrical appliances
EN 61000-3-2	Electromagnetic Compatibility (EMC) – part 3: maximum values – main section part 2: maximum values for mains harmonics (device input current up to and including 16 A per conductor)
EN 61547	Installations for general lighting purposes – EMC immunity requirements

Technical specifications

Operating voltage range
VS ballasts can be operated at the specified mains voltage within a tolerance range of ±10%

Leak current ≤ 0.1 mA per ballast

1 2 3 4 5 6 7 8 9 10

Error current
Impulse-resistant leak-current protection must be installed. Distribute the luminaires to phases L1, L2 and L3; install tri-phase FI switches. If permissible, install FI switches with 30 mA leak current; connect no more than 15 luminaires as FI switches can be triggered at half the leak current value.

Power factor
Inductive ballasts: λ ≤ 0.5
Parallel-compensated ballasts: λ ≥ 0.85

Compensation
VS recommends the use of parallel capacitors owing to their technical advantages and power balance.

Possible interference with IR systems
Are not known to occur

Mechanical mounting

Mounting position
Any

Mounting location
Ballasts are designed for installation in luminaires or comparable devices.
Independent ballasts do not need to be installed in a casing.

Fastening
Preferably using screws ∅ 4 mm

Maximum temperatures
The stipulated winding temperature (tw 130, tw 140 and tw 150, respectively) must not be exceeded during normal operation. The corresponding maximum values (232°C, 248°C and 264°C, respectively) must be observed during anomalous operation. These values must be checked by measuring resistance during operation.

Temperature increase
The lamp current flowing through the ballast generates a power loss that leads to an increase in winding temperature. The Δt values for normal and abnormal operation provide a measure of this temperature increase. The Δt values are ascertained using standardised connections for measurement and are provided on the ballast type plate in Kelvin.

Example: Δt = 55 K/140 K:
The first Δt value indicates the temperature increase for normal operation at the lamp's operating current. The second value, 140 K in this case, denotes the temperature increase of the winding that results from the current that flows when the lamp's discharge path is short-circuited. The current that flows in this state is the preheat current through the lamp's electrodes.

Electromagnetic compatibility (EMC)

Interference
Interference voltage measurements have to be taken at the connection terminals for luminaires with magnetic ballasts as these are systems that operate with lamp voltages of under 100 Hz. These low-frequency interference voltages are generally not critical with magnetic ballasts.

Interference immunity
Thanks to the robust design and choice of materials, magnetic ballasts provide a high degree of interference immunity and are not impaired by admissible mains power interference.

Mains Harmonics After every zero crossing of the lamp current, fluorescent lamps experience a re-ignition peak as the lamps go out for a brief (imperceptible) moment. These re-ignition peaks generate mains harmonics that are smoothed by the ballast's impedance. The right design, i.e. determining the operating point of the magnetic ballast, ensures mains harmonics are limited to the maximum values permitted by EN 61000-3-2. VS electromagnetic ballasts all comply with the stipulated maximum values.

Selection of automatic cut-outs for VS electromagnetic ballasts

Dimensioning automatic cut-outs
When a ballast is switched on, high transient current peaks occur due to parasite capacitances that can accumulate with the number of luminaires. These high system switch-on currents put a strain on the automatic conductor cut-outs. For this reason, only surge-current-proof automatic cut-outs should be used for lighting systems.

Release reaction The release reaction of the automatic conductor cut-outs comply with VDE 0641, part 11, for B and C characteristics.

No. of ballasts The following values are meant as guidelines only and may vary depending on the respective lighting system. The maximum number of VS ballasts applies to cases where the devices are switched on simultaneously. Specifications apply to single-pole fuses. The number of permissible ballasts must be reduced by 20% for multi-pole fuses. The considered circuit impedance equals 400 mΩ (approx. 20 m of [2.5 m²] conductor from the power supply to the distributor and a further 15 m to the luminaire). Doubling circuit impedance to 800 mΩ increases the possible number of ballasts by 10%. The values quoted in the following tables are guidelines and can be affected by system-specific factors.

Possible number of ballasts connected to automatic cut-outs for compact fluorescent lamps (single lamp operation)

Lamp output	10 A (B)		16 A (B)	
W	Inductive	Parallel compensation	Inductive	Parallel compensation
5/7/8/9/10/11/13	50	90	80	130
18 (TC-L)	27	32	43	51
18 (TC-D)	40	65	65	110
24	25	32	40	51
26	27	32	43	51
36	23	32	37	51

Possible number of ballasts connected to automatic cut-outs for tubular and U-shaped fluorescent lamps (single lamp operation)

Lamp output	10 A (B)		16 A (B)	
W	Inductive	Parallel compensation	Inductive	Parallel compensation
4/6/8/10	50	90	80	130
13	45	80	70	115
15/18/20	27	32	43	51
30/36/38/40	23	32	37	51
58/65	15	20	22	32
70	13	18	20	30

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10

Reliability and service life

Provided the specified maximum values for the winding temperature are complied with, a service life of 10 years can be expected. Failure rate: ≤ 0.025%/1,000 hours.

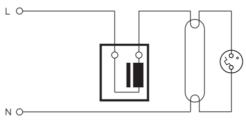
Electrical installation

Connection terminals (combination terminals)

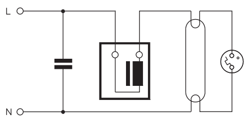
- Use copper (not stranded) wire
- Required diameter for push-in connection 0.5–1 mm²
- Stripped lead length 8 mm
- Required cross-section for IDC zone 0.5 mm²; max. Ø 2 mm including Insulation, no wire stripping required; mounting requires a special tool

Push-in terminals	The integrated terminals can only be used with rigid leads. Rigid leads: 0.5–1.5 mm². The stripped lead length totals 8 mm.
Wiring	The wiring between the mains, ballasts and lamps must comply with the respective circuit diagram.

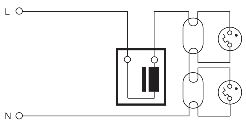
Circuit diagrams for the operation of fluorescent lamps with Vossloh-Schwabe electromagnetic ballasts



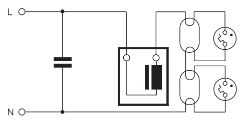
Inductive single circuit



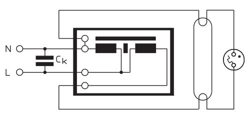
Parallel-compensated single circuit



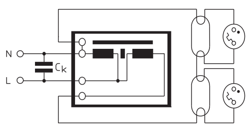
Inductive tandem circuit



Parallel-compensated tandem circuit



Parallel-compensated single circuit with high-reactance transformer



Parallel-compensated tandem circuit with high-reactance transformer

Connection terminals
In the interest of ensuring firm contacts and long component service life, Vossloh-Schwabe uses only top-quality materials for plastic or metal parts during the production of connection terminals. These quality features apply to both Vossloh-Schwabe's luminaire connection terminals as well as to the terminals fitted to ballasts and lampholders.

Notes on connection terminals on electronic ballasts
Vossloh-Schwabe electronic ballasts are fitted with installation-friendly push-in connectors. In addition, many models for linear fluorescent lamps are also available with IDC terminals (for solid conductors 0.5 mm²) and supplementary push-in terminals (for solid conductors 0.5 – 1 mm²), stripped length 8 – 9 mm. IDC terminals permit automated luminaire wiring and testing using the ALF system and are thus particularly efficient.

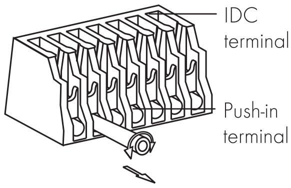
Notes on connection terminals on electromagnetic ballasts
Standard issue Vossloh-Schwabe electromagnetic ballasts are fitted with installation-friendly IDC/push-in terminals (combination terminals) or push-in terminals. The terminals are designed for use with solid conductors with cross-sections of 0.5 – 1 mm² (combination terminals) or up to 1.5 mm² (push-in terminals) and are approved for current loads of up to 6 A (combination terminal) and 16 A (push-in terminal). The lead stripping length totals 7 – 9 mm for push-in terminals; leads do not need to be stripped for IDC terminals.
On request, many ballasts can also be provided with screw terminals (current load up to 16 A) for conductor cross-sections of 0.5 to 2.5 mm².

Notes on connection terminals on lampholders
Vossloh-Schwabe usually equips lampholders for T and TC lamps as well as starter lampholders with installation-friendly push-in terminals for solid conductors of 0.5 – 1 mm². Most lampholders are fitted with twin push-in terminals and thus permit through-wiring. The required lead stripping length amounts to 8 – 9 mm for all types.

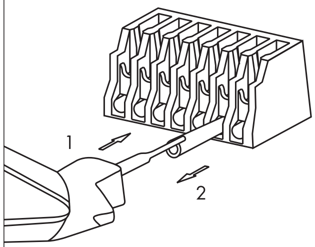
IDC terminals
In order to fully exploit the vast potential for rationalisation offered by automated wiring and testing with the ALF system, a totally new component family was developed that is equipped with the VDE-tested IDC terminal technology. This technology has already been used very successfully on a large scale in other branches of industry. This connection technology dispenses with the stripping of conductors that is required for the push-in, screw or crimping methods. The tried-and-tested IDC terminal technology has created the foundation for efficient automation as it ensures both high connection quality and rapid contacting. Components equipped in this fashion make it possible to through-wire several terminals with a single conductor. This constitutes a further economic advantage as it significantly reduces the required conductor lengths. Furthermore, this design principle makes it possible to use adapters to simply and reliably make electrical contact from above for a VDE-compatible final luminaire inspection.

ALF connection
Height: 12 mm

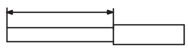
Release by twisitng
and pulling the conductor
at the same time



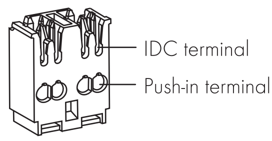
1. Insert release tool above the conductor
2. Pull out the conductor



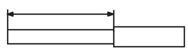
Stripping the conductor for push-in terminal 0.5 – 1 mm²:
8 – 9 mm



IDC/Push-in terminal for electromagnetic ballasts



Stripping the conductor for push-in terminal 0.5 – 1 mm²:
7 – 9 mm



Lampholders for Fluorescent Lamps

Lampholders for compact fluorescent lamps

Vossloh-Schwabe produces the majority of lampholders for TC lamps using PBT, a thermoplastic material. This highly heat-resistant material is responsible for the T140 temperature rating. Leading lamp manufacturers also use PBT for the lamp bases they produce. This material harmonisation in conjunction with fatigue-free, stainless steel lamp mounting springs ensures a permanently secure lamp fit.

Lampholders for double-ended fluorescent lamps

VS lampholders for T lamps are characterised by a number of technical features that guarantee a high degree of reliability and safety. The heat-resistant PBT rotor with which most VS lampholders are fitted is a recognised trademark. In addition to the lampholders with the field-tested large rotor, VS also provides a new generation of lampholders featuring innovative "Rotoclic" rotor technology. This new VS technology constitutes a further milestone in the development of highly heat-resistant rotor systems.

Among the special features of this new technology is a T140 temperature rating thanks to a front plate made entirely of PBT as well as a clearly audible click when the lamp is inserted or replaced. As a result, the motion of turning the lamp from "replacement" to "operating" position is aided acoustically.

In addition to this, VS produces a further series of lampholders with a rotor-like function, whose front plates are also made of highly heat-resistant PBT and have similarly been given a T140 temperature rating.

The maximum permissible temperature at the back of all lampholders is T_m 110 °C. Another key feature common to all VS lampholders is a highly effective support for the lamp pin that reliably prevents any base pin deflection, even with older lamps, and guarantees a durable and firm contact.

Push-through lampholders

Push-through lampholders are inserted from below through a cut-out in the luminaire casing and are secured by lateral catches. This type of lampholder is frequently used in luminaires on which the lampholder remains visible from the outside, e.g. in so-called strip lighting. The electrical leads are laid beneath the sheet metal level. Luminaire directive EN 60598-1 Para. 8.2 must be observed with regard to the luminaire.

Push-fit lampholders

This lampholder type, which is frequently found in surface-mounted ceiling and built-in luminaires, is pushed into the luminaire casing from above. The lampholder foot should protrude by no more than 4 mm to match the usual height of the spacing cams in the luminaire casing. These lampholders are mostly wired above the luminaire casing to the side of the lampholder. However, there are also lampholders on which the wiring runs through the lampholder foot, with the leads laid beneath the luminaire casing.

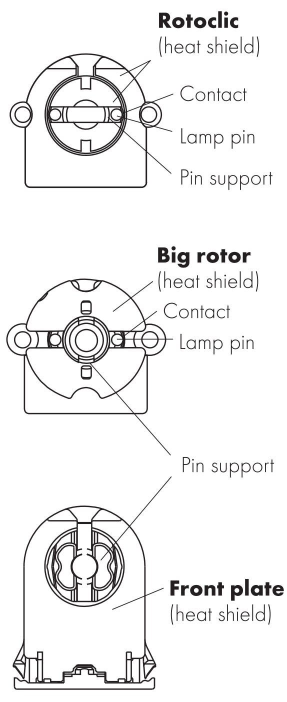
Built-in lampholders

This design is also predominantly used for recessed ceiling and surface-mounted luminaires. However, unlike push-fit lampholders, built-in lampholders are usually fitted at the ends of the luminaire boxes. In addition to the usual fixing with split pins attached to the rear, there are also countless versions with fixing clips, push-fit studs or screw-in holes, which are also available with spring-loaded length compensation. Built-in lampholders offer luminaire designers a wealth of scope regarding the choice of lamp position in relation to the reflector. This enables great variation in light distribution as the lampholder does not dictate the distance of the centre of the lamp from the metal casing.

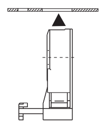
Surface-mounted lampholders

The fastening system of surface-mounted lampholders usually consists of screws or rivets above a fixing level, along which the wiring is also laid. As this type of installation is usually too costly nowadays for large unit numbers, these lampholders are used almost exclusively for special applications, e.g. displays or illuminated advertisements.

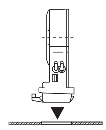
VS lampholders for the UL market and UL approved leads are available for all common lamp types. Further information can be found at www.unvlt.com.



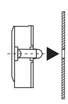
Push-through lampholder



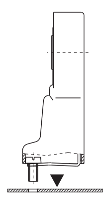
Push-fit lampholder



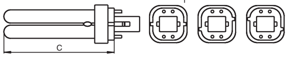
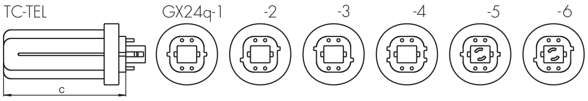
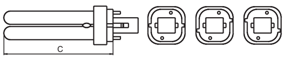
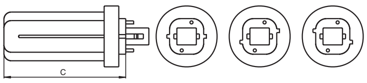
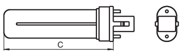
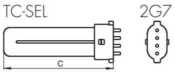
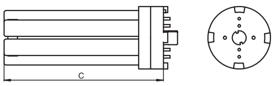
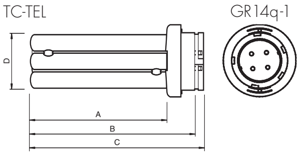
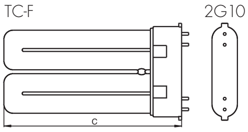
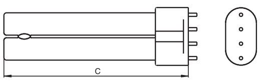
Built-in lampholder



Surface-mounted lampholder

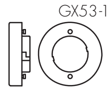
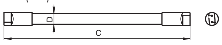
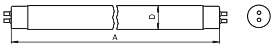
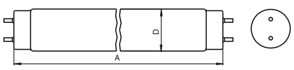
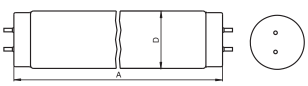


Lamp Table – Fluorescent Lamps

Lamp type/lamp base	Base	Output (W)	Max. length (C) acc. to IEC			
TC-DEL G24q-1 -2 -3 	G24q-1	10 13	95 130			
	G24q-2	18	140			
	G24q-3	26	160			
TC-TEL GX24q-1 -2 -3 -4 -5 -6 	GX24q-1	13	90			
	GX24q-2	18	110			
	GX24q-3	26 32	130 145			
	GX24q-4	42	155			
	GX24q-5	57	191			
	GX24q-6	70	219			
TC-D G24d-1 -2 -3 	G24d-1	8 10 13	73* 95 130			
	G24d-2	18	140			
	G24d-3	26	160			
TC-T GX24d-1 -2 -3 	GX24d-1	13	90			
	GX24d-2	18	110			
	GX24d-3	26	130			
TC-S G23 	G23	5 7 9 11	85 115 145 215			
TC-SEL 2G7 	2G7	5 7 9 11	85 115 145 215			
TC-TEL 2G8-1 	2G8-1	60 85 120	167 208 285			
TC-TEL GR14q-1 			A	B	C	D
	GR14q-1	14 17	99.7 121.7	120 142	126.6 148.6	41* 41*
TC-DD GR8 GR10q GRY10q-3 GRZ10d GRZ10t 			A	B		
	GR8	16 28	138 205	141 207		
	GR10q	10 16 21 28 38	92 138 138 205 205	95 141 141 207 207		
	GRY10q-3	55	205	205*		
	GRZ10d	18	137	141*		
	GRZ10t	30	202	206*		
TC-F 2G10 	2G10	18 24 36	122 165 217			
TC-L 2G11 	2G11	18 24 34 36 40 55 80	225 320 533* 415 535 535 565			

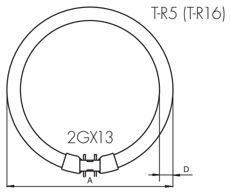
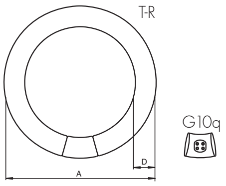
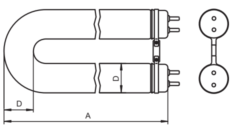
*not included in IEC standard (non-committal specifications)

Lamp Table – Fluorescent Lamps

Lamp type/lamp base	Base	Output (W)	Ø D (mm)	Length A/C (mm) acc. to IEC 60081/ 60901 (for circular lamps B)
GX53-1 	GX53-1	7		
		9		
T2 (T7) W4.3 	W4.3x8.5d	6	7	219.3
		8	7	320.9
		11	7	422.5
		13	7	524.1
T5 (T16) G5 	G5	4	16	135.9
		6	16	212.1
		8	16	288.3
		13	16	516.9
		14	16	549.0
		20	16	549.0
		21	16	849.0
		24	16	549.0
		25	16	1149.0
		28	16	1149.0
		32	16	1449.0
		34	16	849.0
		35	16	1449.0
		39	16	849.0
		45	16	1449.0
		49	16	1449.0
		50	16	1449.0
		54	16	1149.0
		73	16	1449.0
		80	16	1449.0
T8 (T26) G13 	G13	10	26	470.0*[2]
		14	26	360.0*[2]
		15	26	437.4
		16	26	589.8
		16	26	720.0*[2]
		18	26	589.8
		20*[1]	26	438.0*[2]
		23	26	970.0*[2]
		30	26	894.6
		32	26	1199.4
		33	26	1149.0
		34	26	1047.0*[2]
		36	26	1199.4
		36	26	970.0*[2]
		38	26	1047.0
		50	26	1500.0
		51	26	1500.0
		58	26	1500.0
		70	26	1763.8
T12 (T38) G13 	G13	20	38	589.8
		25	38	970.0
		30	38	894.6
		40	38	1199.4
		65	38	1500.0
		75	38	1763.8
		80*[1]	38	1500.0
		85	38	2374.3
		85*[1]	38	1763.8
		100	38	2374.3
		100*[1]	38	1800.0*[2]
		115	38	1200.0*[2]
		125	38	2374.3
		140	38	1500.0*[2]
		140*[1]	38	1800.0*[2]
		160*[1]	38	1800.0*[2]

*[1] UV solarium lamps
*[2] Not included in IEC standard (non-committal specifications)

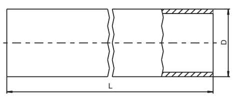
Lamp Table – Fluorescent Lamps

Lamp type/lamp base	Base	Output (W)	Ø D (mm)	A (mm)
	2GX13	22 40 55 60	16 16 16 16	230.0 305.0 305.0 379.0
	G10q	22 32 40 60	29 29 29 30	215.9 304.8 406.4 408.8*
	2G13-92	18 36 58	26 26 26	304* 566, 601* 566, 759*

* Not yet included in IEC standard (non-committal specifications)

Tube lengths of plastic and glass protective tube

Ø D (mm)	Length L (mm)
$38^{\pm0.5}$	$L = A - 20^{\pm1}$
$50^{\pm0.8}$	$L = A - 30^{\pm1}$



Key to lamp designations

TC-S	Tube Compact-Single
TC-SEL	Tube Compact-Single Electronic
TC-D	Tube Compact-Double
TC-DEL	Tube Compact-Double Electronic
TC-T	Tube Compact-Triple
TC-TEL	Tube Compact-Triple Electronic
TC-Q	Tube Compact-Quad
TC-QEL	Tube Compact-Quad Electronic
TC-DD	Tube Compact-Double D-Shape
TC-L	Tube Compact-Long
TC-F	Tube Compact-Flat
T2 (T7)	Tube Ø 2/8" (7 mm)
T5 (T16)	Tube Ø 5/8" (16 mm)
T8 (T26)	Tube Ø 8/8" (26 mm)
T12 (T38)	Tube Ø 12/8" (38 mm)
T-U	Tube, U-Shape
T-R	Tube, Ring-Shape
T-R5 (T-R16)	Tube, Ring-Shape Ø 5/8" (16 mm)

Energy efficiency classification

Together with the amendments in Commission Regulation (EU) 2015/1428 dated 25. August 2015, Commission Regulation (EU) 245/2009 dated 18. March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to defining ecodesign requirements for fluorescent lamps without integrated ballast, high-pressure discharge lamps and for ballasts and luminaires needed for their operation, and repealing Directive 2000/55/EC of the European Parliament and of the Council (official title), has created a legal framework in the EU that defines fundamental requirements for operating efficient lighting technology products.

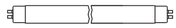
Although the Regulation predominantly applies to general lighting, it is also product-orientated and thus independent of any specific application. The efficiency and performance requirements (specifications governing performance features) apply to fluorescent lamps without integrated ballast, high-pressure discharge lamps as well as ballasts and luminaires needed to operate these lamps.

Energy efficiency classification

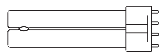
The following table taken from Regulation 245/2009/EC provides an overview of (1st- and 2nd-stage) ballast requirements, ordered according to efficiency values:

Lamp data					Ballast efficiency (P_{Lamp}/P_{Input}) (non-dimmable ballasts)				
Type	Nominal output W	ILCOS-Code	Typical rating 50 Hz W	HF W	A2 BAT %	A2 %	A3 %	B1 %	B2 %
T8	15	FD-15-E-G13-26/450	15	13.5	87.8	84.4	75.0	67.9	62.0
	18	FD-18-E-G13-26/600	18	16	87.7	84.2	76.2	71.3	65.8
	30	FD-30-E-G13-26/900	30	24	82.1	77.4	72.7	79.2	75.0
	36	FD-36-E-G13-26/1200	36	32	91.4	88.9	84.2	83.4	79.5
	38	FD-38-E-G13-26/1050	38.5	32	87.7	84.2	80.0	84.1	80.4
	58	FD-58-E-G13-26/1500	58	50	93.0	90.9	84.7	86.1	82.2
	70	FD-70-E-G13-26/1800	69.5	60	90.9	88.2	83.3	86.3	83.1
TC-L	18	FSD-18-E-2G11	18	16	87.7	84.2	76.2	71.3	65.8
	24	FSD-24-E-2G11	24	22	90.7	88.0	81.5	76.0	71.3
	36	FSD-36-E-2G11	36	32	91.4	88.9	84.2	83.4	79.5
TC-F	18	FSS-18-E-2G10	18	16	87.7	84.2	76.2	71.3	65.8
	24	FSS-24-E-2G10	24	22	90.7	88.0	81.5	76.0	71.3
	36	FSS-36-E-2G10	36	32	91.4	88.9	84.2	83.4	79.5
TC-D/ TC-DE	10	FSQ-10-E-G24q=1 FSQ-10-I-G24d=1	10	9.5	89.4	86.4	73.1	67.9	59.4
	13	FSQ-13-E-G24q=1 FSQ-13-I-G24d=1	13	12.5	91.7	89.3	78.1	72.6	65.0
	18	FSQ-18-E-G24q=2 FSQ-18-I-G24d=2	18	16.5	89.8	86.8	78.6	71.3	65.8
	26	FSQ-26-E-G24q=3 FSQ-26-I-G24d=3	26	24	91.4	88.9	82.8	77.2	72.6
TC-T/ TC-TE	13	FSM-13-E-GX24q=1 FSM-13-I-GX24d=1	13	12.5	91.7	89.3	78.1	72.6	65.0
	18	FSM-18-E-GX24q=2 FSM-18-I-GX24d=2	18	16.5	89.8	86.8	78.6	71.3	65.8
	26	FSM-26-E-GX24q=3 FSM-26-I-GX24d=3	26.5	24	91.4	88.9	82.8	77.5	73.0
TC-DD/ TC-DDE	10	FSS-10-E-GR10q FSS-10-L/P/H-GR10q	10.5	9.5	86.4	82.6	70.4	68.8	60.5
	16	FSS-16-E-GR10q FSS-16-I-GR10q FSS-10-L/P/H-GR10q	16	15	87.0	83.3	75.0	72.4	66.1
	21	FSS-21-E-GR10q FSS-21-I-GR10q FSS-21-L/P/H-GR10q	21	19	89.4	86.4	79.2	73.9	68.8
	28	FSS-28-E-GR10q FSS-28-I-GR10q FSS-28-L/P/L-GR10q	28	26	89.7	86.7	81.3	78.2	73.9
	38	FSS-38-E-GR10q FSS-38-L/P/L-GR10q	38.5	36	92.3	90.0	85.7	84.1	80.4
TC	5	FSD-5-I-G23 FSD-5-E-2G7	5.4	5	72.7	66.7	58.8	49.3	41.4
	7	FSD-7-I-G23 FSD-7-E-2G7	7.1	6.5	77.6	72.2	65.0	55.7	47.8
	9	FSD-9-I-G23 FSD-9-E-2G7	8.7	8	78.0	72.7	66.7	60.3	52.6
	11	FSD-11-I-G23 FSD-11-E-2G7	11.8	11	83.0	78.6	73.3	66.7	59.6
T5	4	FD-4-E-G5-16/150	4.5	3.6	64.9	58.1	50.0	45.0	37.2
	6	FD-6-E-G5-16/225	6	5.4	71.3	65.1	58.1	51.8	43.8
	8	FD-8-E-G5-16/300	7.1	7.5	69.9	63.6	58.6	48.9	42.7
	13	FD-13-E-G5-16/525	13	12.8	84.2	80.0	75.3	72.6	65.0
T9-C	22	FSC-22-E-G10q-29/200	22	19	89.4	86.4	79.2	74.6	69.7
	32	FSC-32-E-G10q-29/300	32	30	88.9	85.7	81.1	80.0	76.0
	40	FSC-40-E-G10q-29/400	40	32	89.5	86.5	82.1	82.6	79.2

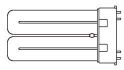
Lamp types



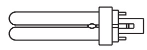
T8



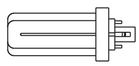
TC-L



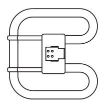
TC-F



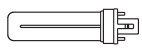
TC-D/TC-DE



TC-T/TC-TE



TC-DD/TC-DDE

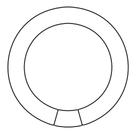


TC

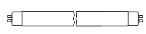
T5

Lamp data					Ballast efficiency (P_{Lamp}/P_{Input}) (non-dimmable ballasts)				
Type	Nominal output W	ILCOS-Code	Typical rating 50 Hz W	HF W	A2 BAT %	A2 %	A3 %	B1 %	B2 %
T2	6	FDH-6-L/P-W4.3x8.5d-7/220		5	72.7	66.7	58.8	–	–
	8	FDH-8-L/P-W4.3x8.5d-7/320		7.8	76.5	70.9	65.0	–	–
	11	FDH-11-L/P-W4.3x8.5d-7/420		10.8	81.8	77.1	72.0	–	–
	13	FDH-13-L/P-W4.3x8.5d-7/520		13.3	84.7	80.6	76.0	–	–
	21	FDH-21-L/P-W4.3x8.5d-7		21	88.9	85.7	79.2	–	–
	23	FDH-23-L/P-W4.3x8.5d-7		23	89.8	86.8	80.7	–	–
T5-E	14	FDH-14-L/P-G5-16/550		13.7	84.7	80.6	72.1	–	–
	21	FDH-21-L/P-G5-16/850		20.7	89.3	86.3	79.6	–	–
	24	FDH-24-L/P-G5-16/550		22.5	89.6	86.5	80.4	–	–
	28	FDH-28-L/P-G5-16/1150		27.8	89.8	86.9	81.8	–	–
	35	FDH-35-L/P-G5-16/1450		34.7	91.5	89.0	82.6	–	–
	39	FDH-39-L/P-G5-16/850		38	91.0	88.4	82.6	–	–
	49	FDH-49-L/P-G5-16/1450		49.3	91.6	89.2	84.6	–	–
	54	FDH-54-L/P-G5-16/1150		53.8	92.0	89.7	85.4	–	–
	80	FDH-80-L/P-G5-16/1150		80	93.0	90.9	87.0	–	–
	95	FDH-95-L/P-G5-16/1150		95	92.7	90.5	84.1	–	–
	120	FDH-120-L/P-G5-16/1450		120	92.5	90.2	84.5	–	–
T5-C	22	FSCH-22-L/P-2GX13-16/225		22.3	88.1	84.8	78.8	–	–
	40	FSCH-40-L/P-2GX13-16/300		39.9	91.4	88.9	83.3	–	–
	55	FSCH-55-L/P-2GX13-16/300		55	92.4	90.2	84.6	–	–
	60	FSCH-60-L/P-2GX13-16/375		60	93.0	90.9	85.7	–	–
TC-LE	40	FSDH-40-L/P-2G11		40	91.4	88.9	83.3	–	–
	55	FSDH-55-L/P-2G11		55	92.4	90.2	84.6	–	–
	80	FSDH-80-L/P-2G11		80	93.0	90.9	87.0	–	–
TC-TE	32	FSMH-32-L/P-GX24q=3		32	91.4	88.9	82.1	–	–
	42	FSMH-42-L/P-GX24q=4		43	93.5	91.5	86.0	–	–
	57	FSM6H-57-L/P-GX24q=5 FSM8H-57-L/P-GX24q=5		56	91.4	88.9	83.6	–	–
	70	FSM6H-70-L/P-GX24q=6 FSM8H-70-L/P-GX24q=6		70	93.0	90.9	85.4	–	–
	60	FSM6H-60-L/P-2G8=1		63	92.3	90.0	84.0	–	–
	62	FSM8H-62-L/P-2G8=2		62	92.2	89.9	83.8	–	–
	82	FSM8H-82-L/P-2G8=2		82	92.4	90.1	83.7	–	–
	85	FSM6H-85-L/P-2G8=1		87	92.8	90.6	84.5	–	–
	120	FSM6H-120-L/P-2G8=1 FSM8H-120-L/P-2G8=1		122	92.6	90.4	84.7	–	–
TC-DD	55	FSSH-55-L/P-GR10q		55	92.4	90.2	84.6	–	–

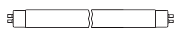
Lamp types



T9-C



T2



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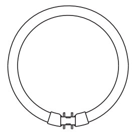

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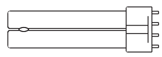

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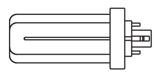

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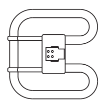

TC-DD

At the very latest, the following energy efficiency formula for ballasts will be introduced to coincide with the 3rd stage:

If	$P_{Lamp} \leq 5$ W	$EBb_{FL} = 0.71$
If	5 W < P_{Lamp} < 100 W	$EBb_{FL} = P_{Lamp}/(2 * \text{sqrt}(P_{Lamp}/36)+38/36 * P_{Lamp}+1)$
If	$P_{Lamp} \geq 100$ W	$EBb_{FL} = 0.91$

The following limiting values must be observed:

$\eta_{Ballast}$	Energy efficiency classes
$\geq EBb_{FL}$	A2 and A1BAT
$\geq 1-0.75*(1-EBb_{FL})$	A2 BAT

The graph illustrates the difference between Classes A2, A1 BAT and A2 BAT (BAT = best available technology).