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WHITEPAPER

LED INDUSTRIAL LIGHTS

Authors: Dipl.-Ing. Christian Fiebach
Executive Manager ipf electronic gmbh

Thorsten Landau
Produkt Management LED lights

IPF ELECTRONIC

TABLE OF CONTENTS

1. INTRODUCTION

LED lights are now indispensable in professional industrial applications, e.g. for the illumination of production halls, warehouses or workplaces. Here and there, so-called fluorescent tubes and halogen lamps still exist, but a replacement must be found at the latest after a defect. Here, the choice usually falls on solutions with LEDs, since the supply of halogen lamps on the market is visibly dwindling and procurement is thus becoming more difficult. On the other hand, it is foreseeable that some luminaires with tubular fluorescent lamps (fluorescent tubes) will also lose their approval in the foreseeable future, which in turn means that alternatives with LEDs will gain in importance.

Against this background, however, the question arises as to what should be considered when selecting LED industrial lights with regard to their specific locations? An answer to this question is not easy, as a great many factors play an important role with regard to a suitable LED solution. Nevertheless, in order to provide some orientation, this white paper focuses on presenting the most important parameters on the subject of light as well as lighting and, in this context, on presenting some solutions from ipf electronic's portfolio of LED industrial lights.

2. MAIN FEATURES OF PREVIOUS TECHNOLOGIES

As already mentioned in the introduction, both halogen lamps and fluorescent lamps are still used in industry at various locations. In order to be able to evaluate the properties as well as characteristics of such lighting technologies with regard to alternatives with LEDs, it is first necessary to take a closer look at their mode of operation.

2.1 HALOGEN LAMPS: PLENTY OF LIGHT FOR LARGE AREAS

Luminaires with halogen lamps (colloquially known as halogen floodlights or halogen spotlights) were and are still sometimes used to illuminate larger areas, e.g. in the area of industrial hall doors. The principle of operation of the halogen lamp is similar to the earlier incandescent lamp, in which a tungsten filament heated by means of current flow generates the light. The crucial difference is that in the halogen lamp this tungsten filament is located in a quartz glass bulb filled with the halogen gas iodine. This means that a halogen lamp can be heated to a much higher temperature than an incandescent lamp, which significantly increases its brightness.

Halogen lamps have a longer service life of up to 5,000 hours compared to the former incandescent lamp, but this is exceeded by a factor of 10 by an LED with up to a maximum of 50,000 hours. Halogen lamps also have a high heat emission due to their brightness. Here, too, an LED lamp can score with comparatively lower heat generation. Since the range of halogen lamps on the market has been significantly reduced in recent years, alternatives with LEDs are becoming increasingly interesting for professional use.

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2.2 FLUORESCENT LAMPS: THE "CLASSIC" FOR WORKPLACES

Luminaires with tubular fluorescent lamps are still used to illuminate workplaces in industry. They are generally known under the term ''fluorescent tube''. However, it is foreseeable that some fluorescent lamps will probably lose their approvals in the next few years, although adequate solutions with LEDs are also available here.

At the ends of fluorescent lamps are electrodes made of tungsten wire, which heat up during the starting phase due to the current flow, causing electrons to be emitted into the lamp tube. The so-called starter of the lamp, in conjunction with a ballast (e.g. choke coil), generates an ignition voltage between the electrodes. This accelerates the released electrons in the electric field towards the anode. This ionizes the gas in the tube, creating a plasma that generates mainly non-visible UV light. This in turn is converted into visible light by the illuminant on the inside of the tube.

As with halogen lamps, the service life of fluorescent lamps is around 5,000 hours and is also shorter than that of LEDs, whose service life is moreover not dependent on switching cycles. Furthermore, unlike LEDs, the light intensity of fluorescent lamps decreases steadily over the entire operating time.

LED lamps also produce a flicker-free light that is free of UV or infrared components, which can be important when illuminating rotating machine parts. Due to their low energy consumption, LEDs also have a higher energy efficiency than fluorescent lamps and halogen lamps.

3. IMPORTANT FACTORS FOR THE EVALUATION OF LIGHT SOURCES

In order to find a suitable LED solution for a specific area of application, a comparison of wattages or the use of any conversion forms is basically of no help. In this context, the combination of the light source and the reflector (light shaper) of the luminaire is always decisive. As a rule, the reflector is optimized for the illuminant defined in the design. However, if a lamp that does not match this design is used as a replacement, the light output of the luminaire may deteriorate dramatically. Therefore, the combination of the luminaire design and the lamp used must always be evaluated in order to meaningful comparisons can be made.

3.1 LUMINOUS FLUX

A central parameter in this context is the luminous flux, which basically describes the light output of a light source. The unit for luminous flux is lumen (lm). The so-called beam angle is suitable for evaluating how this luminous flux is ''distributed'' into the room by a luminaire. It describes the light emission angle of a luminaire or its radiation characteristics.

Whereas, for example, classic incandescent lamps not installed in a luminaire directed the luminous flux in a beam angle of almost 360°, the reflector integrated in a halogen floodlight, for example, directs the light in a desired direction. However, this redirection at the reflector causes losses in the luminous flux.

3.2 ILLUMINANCE

For direct comparison of light sources, the most suitable measurement is the so-called illuminance at a specified distance, centrally below the light source. The illuminance (unit lux - lx = lm/m2) defines the luminous flux reaching a surface. The unit lux thus represents, so to speak, the surface density of the incident luminous flux or the combination of luminous power and radiation characteristics of a luminaire.

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3.3 LIGHT COLOR

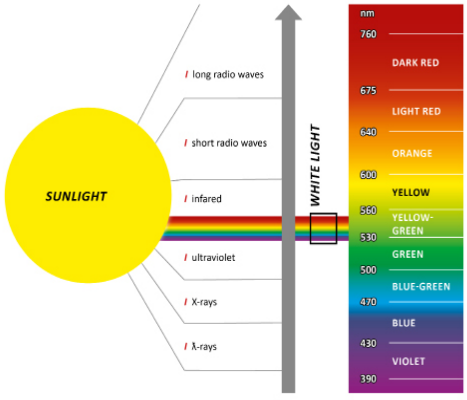
Light color is the color of a self-luminous light source and can be described by the color temperature (unit: Kelvin (K)) and by the color rendering index Ra. A halogen lamp, for example, has a color temperature of approx. 3,000K, whereas fluorescent lamps usually have a color temperature of approx. 4,000K. Depending on the composition of the electromagnetic radiation in the visible wavelength range of 390 and 780nm, people perceive the light as either ''cold'' or ''warm''. If we transfer this sensation to the corresponding color temperature of the light, the following relationships emerge:

The first white light LEDs had a color temperature of over 5,000K. Their light color was therefore referred to as ''cold white'' or also ''daylight white''. Today, LEDs are also available with color temperatures of 3,000K and less as well as above 5,000K. The spectrum thus ranges from ''neutral white'', which is in the range of fluorescent lamps, to ''warm white'', which is a light color found primarily in halogen lamps.

Sensation resp. Light source expression	**Color temperature in Kelvin**
Light source expression	under 3,300K
neutral white	between 3,300 and 5,000K
cold white / daylight white	over 5,000K

The color rendering index Ra describes the quality of the color rendering of light sources in relation to a reference light source. A value of 100 means that the color rendering matches that of the reference light source. The smaller the number, the greater the difference from the reference. However, since the index only describes the similarity with a specified reference, a high value is not synonymous with good reproduction of all colors. For example, the reference light of the incandescent lamp (color temperature 2,700K) contained only very few blue and violet light components, resulting in poorer reproduction of these colors.

For good color rendering over the visible spectrum, it is necessary not only for the color rendering index of a light source to be high, but also for it to emit electromagnetic radiation over the entire visible wavelength range. This is usually the case with the combination of a high color rendering index and color temperatures of 4,500K to 6,000K.



White light is composed of a mixture of electromagnetic radiation with different wavelengths in the range of 390 to 780nm. (All images: ipf electronic gmbh)

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4. DECISIVE ADVANTAGES OF LEDS

LEDs have a whole range of advantages, with their long service life and low energy consumption being decisive arguments in view of the increasingly important need to conserve increasingly scarce resources. LEDs can last many times longer than halogen lamps or fluorescent lamps, for example, and also have lower energy requirements. Halogen lamps also have a lower luminous efficacy and higher heat emission. In the case of fluorescent lamps, on the other hand, the light intensity decreases steadily with increasing operating time. In addition, such lamps do not produce flicker-free light, which can be problematic in some specific industrial applications. Another advantage not to be neglected is the very wide range of different LED industrial luminaires, so that a suitable solution is available for almost every application.

5. CHOOSING THE RIGHT LED LIGHT

The choice of the right lighting for professional use is fundamentally determined by its potential field of application. However, the multi-layered areas of application of LED luminaires, for example in industrial halls or at workplaces, initially make the selection of a suitable solution difficult. It is therefore advisable to clarify some basic questions in advance, including:

- Where should the LED luminaire be used?
- How large is the area that needs to be illuminated (beam angle)?
- What light intensity is required at the point of use?
- Should the light source have a ''warmer''or rather ''colder'' light color?
- Are there other factors to consider regarding the location of the LED luminaire, e.g. shock and vibration resistance, increased resistance to coolants or lubricants, high tightness or specific hygiene requirements, etc.?

In view of this abundance of possible issues, ipf electronic first recommends a detailed consultation with one of our luminaire specialists. Subsequently, an LED luminaire should be tested at its future place of use without obligation so that the user receives a truly optimal solution. In order to provide assistance in selecting such a solution, some LED luminaires and their specific characteristics from ipf electronic's very wide range of products are presented below.

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5.1 LED FLOODLIGHT WITH SAFETY GLASS

Up to 80 percent energy savings compared to conventional halogen floodlights are achieved by the LED floodlights from ipf electronic with a power consumption of approximately 20W to 50W. They provide a luminous flux in the range of 2,250lm to 6,500lm and have neutral white or daylight white light (4,000K to 6,000K). Due to the beam angle of up to a maximum of 120°, the LED spotlights are suitable for illuminating larger areas. Due to the aluminum housing, a front panel made of safety glass and the high protection class IP65, the solutions are also suitable for harsh industrial environments. The LED floodlights are designed for ambient temperatures from -20°C to +40°C or -25°C to +50°C.

LED floodlights from ipf electronic provide a luminous flux in the range of 2,250lm to 6,500lm with a power consumption of approximately 20W to 50W range from 2,250lm to 6,500lm and have neutral white or daylight white light (4,000K to 6,000K).

5.2 LED WORKSTATION LIGHTS IN A WIDE RANGE

ipf electronic has a very wide range of workstation luminaires in tubular and cuboid design as well as in profile housing with a wide variety of dimensions and a power consumption of approximately 4W to 80W. For easy mounting, for example, existing fasteners can be used. The luminaires have neutral to daylight white light (4,500K to 5,500K). The illuminance at 500mm distance is between 460lx and 8,800lx. Due to their large beam angles (up to 120°), the solutions always ensure ideal lighting conditions and the correct illumination of workstations. The workplace luminaires (up to protection class IP54) are suitable for ambient temperatures from -20°C to +45°C. Unlike conventional fluorescent lamps, the service life is independent of the circuit. In addition, special luminaires are available on request.

Workplace luminaires in various designs. For easy mounting, e.g. already existing fastenings can be used. The luminaires have neutral to daylight white light (4,500K to 5,500K).

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5.3 MACHINE LIGHTS

Working areas of machines should be well illuminated, e.g. during setup, but also for monitoring production processes. In the area of machine luminaires, ipf electronic offers a very broad selection in a wide variety of designs.

For example, the round luminaires with a color temperature of 5,500K have a highly focused radiation characteristic for illuminating work areas even from greater distances. The very compact machine luminaires (5,000K) with thread are in turn suitable for space-saving installation directly in a machine or control cabinet. The cuboid-shaped LED surface-mounted luminaires (6,500K) in IP67 can also be mounted directly in a machine.

The solutions are therefore suitable for very demanding production areas, e.g. where coolants and lubricants are used. Some of these luminaires can also be controlled directly via a PLC due to their low power consumption. This means that they do not have to be in permanent operation, but can only be active for certain activities or machine functions. High IP protection classes (up to IP67) and front screens made of tempered or borosilicate glass as well as robust housings made of aluminum or stainless steel characterize the tubular machine luminaires (5,000K).

LED machine lights in various designs and sizes for optimal illumination of machine work areas.

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5.4 COMBINED MACHINE AND SIGNAL LAMPS

If both the working area of a machine is to be illuminated and the machine status is to be displayed, then the combined LED machine and signal lights from ipf electronic are suitable for this purpose. The luminaire solutions designed for continuous operation in round and cuboid shapes are designed for operating temperatures up to a maximum of +55°C and have IP65 or IP67 protection, depending on the version. The luminaires all have cold white or daylight white light (up to 5,500K) and large beam angles of up to 120°.

The combination luminaires can illuminate the work area and indicate machine conditions at the same time.

5.5 FLEXIBLE HANDLING GOOSENECK LIGHTS

Developed for use e.g. in lathes and milling machines or automatic punching machines, the gooseneck lights from ipf electronic with their flicker-free light (without UV and IR components) always provide flexibly adjustable and thus precise illumination, which is also suitable e.g. for workbenches or test stations. The impact-resistant luminaires with daylight white light are either mounted by means of a screw-on base or fixed with a magnetic base. Due to their protection class (IP65 to IP67), the gooseneck lights are ideal for demanding industrial environments. The gooseneck lights are also complemented by a solution for 230 VAC with IP65 protection.

Articulated head and gooseneck lights (also with articulated head) can be used flexibly, e.g. in lathes and milling machines, in automatic punching machines or on workbenches as well as test stations.

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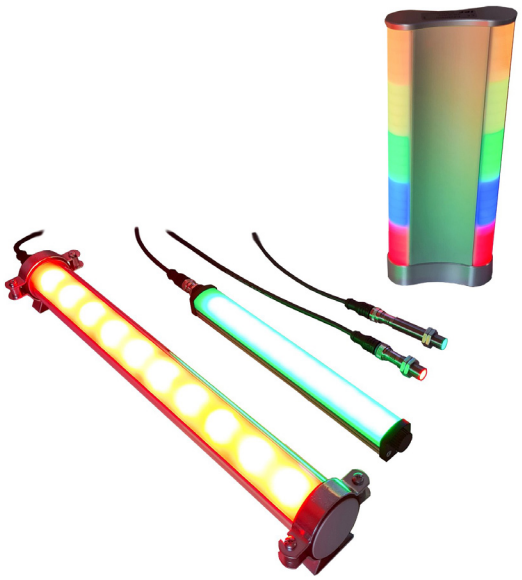
5.6 SIGNAL LAMPS WITH MULTICOLOR LED

Conventional signal lights on machines and systems cannot always be detected from a great distance. In addition, machine personnel are not always on site in automated production facilities. In order to be able to clearly identify plant conditions even from a greater distance, the tubular signal lamps from ipf electronic emit light over a large area. The solutions can be controlled via a PLC, for example, and can thus visualize different machine states with different signal colors.

The range of multi-color LED signal lamps from ipf electronic is supplemented by a solution in an aluminum housing that has five signal segments on both sides that are clearly visible all around. The segments can be controlled individually very easily and can be parameterized according to the specific application.

The colors for the individual light segments can be selected as desired, and the light area can also be flexibly divided into five, four, three and two elements or into one continuous signal element. Due to the lighting elements installed on both sides, they are perceived independently of the viewing direction.

Extremely compact solutions, meanwhile, are the LED signal lamps in cylindrical design with a thread and a length of only 47mm or 76mm (protection class IP67). The multicolor LED of these luminaires in stainless steel housings can also be controlled on a signal-specific basis.



Multi-color LED signal lamps visualize different states in different light colors. Top right, a solution with five signal segments on each side that can be individually controlled and parameterized.

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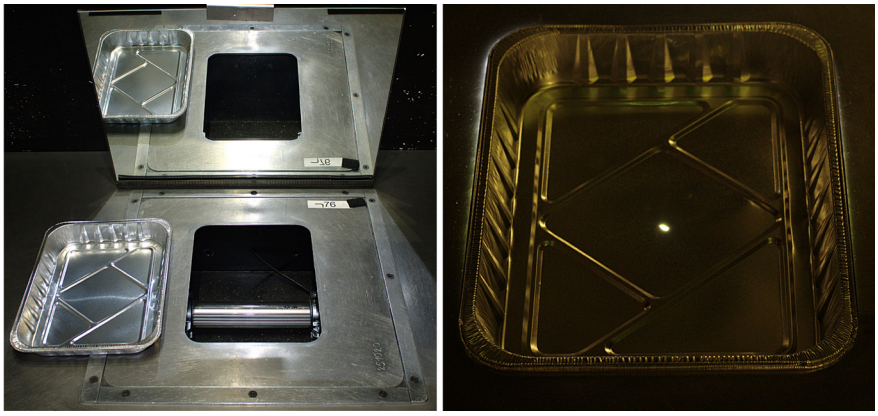
6. APPLICATION EXAMPLES

The following are some practical application examples which show, among other things, that special solutions can also be implemented for special areas of application.

6.1 LED SPECIAL LUMINAIRES FOR TESTING TASKS

A manufacturer of meal trays for the food industry developed its own inspection workstations to be able to inspect trays for the smallest cracks and holes. However, conventional light sources could not completely illuminate the underside of large trays in particular.

ipf electronic integrated LED lights with a front screen made of shatterproof plastic into the test stations, since this was an application in the food sector with special safety requirements. Since the lights were only allowed to be active when a tray was in the test station, an additional ''flash function'' was required. Therefore, ipf electronic modified the luminaires with special ballast electronics to implement a flash mode. The solution in the form of a HART circuit not only ensures reliable operation of the individual luminaires, but also increases the service life of the LEDs despite high stresses.



Test station with LED lighting solution for testing menu trays for the food industry.

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6.2 BICOLOR LED INSTEAD OF COMPLEX SIGNAL LAMP

Signal lamps provide clearly recognizable status displays on machines and systems. However, conventional solutions and thus sometimes costly installations are not always sensible, let alone necessary, as the marking of raw material containers on automated filling lines at a spice specialist from Austria shows.

Simple, compact and effective solution: The LED bicolor lights are located below the raw material containers. A green light signals the raw material container to be replaced to the forklift driver.

The company's dry products, e.g. spice blends, are packaged using fully automated equipment with two raw material bins above the filling stations, among other things. Despite the automated filling, there are always operating personnel at each plant, e.g. for set-up work or product checks. Whenever a raw material container is emptied, these employees receive a corresponding message to switch the line to another raw material container for further filling. At the same time, a forklift operator is requested to replace the empty raw material container with a filled container.

To ensure that the forklift operator knows which container is to be replaced even when the filling station is not manned by personnel, the container locations are to be equipped with signal lamps. However, conventional signal lamps with signal changes that are clearly visible from a distance were out of the question, as they would have a disturbing effect on employees working in the immediate vicinity of the plant.

The solution: A bicolor LED light from ipf electronic, which enables the color of the integrated LED to change between red and green by controlling the respective connection pins. The robust luminaire in a stainless steel housing (IP67) is very compact and could therefore be easily mounted at the container locations of the two raw material bins.

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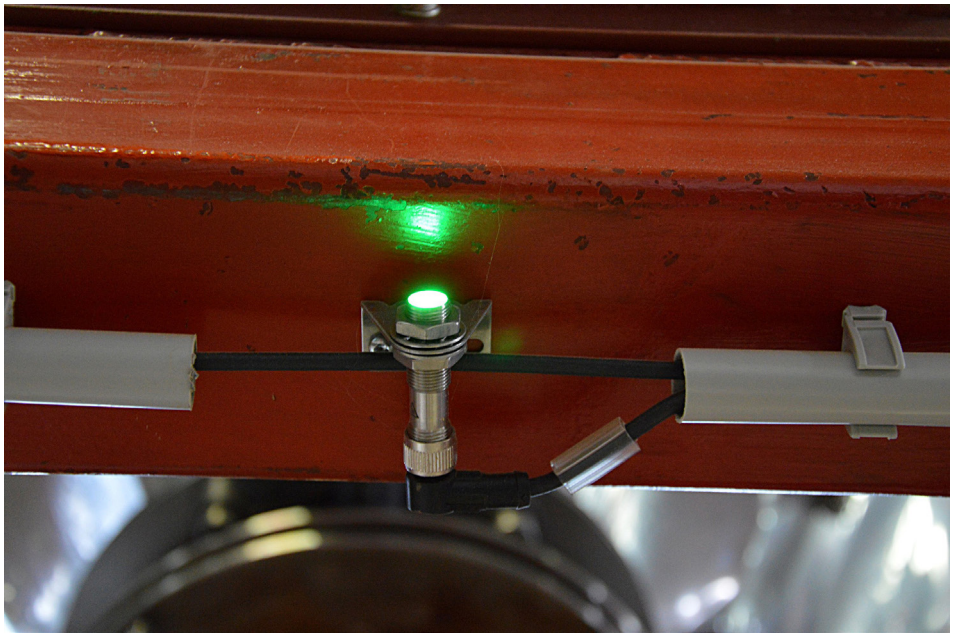

The integration of the luminaire into the system control is unproblematic, as it can be controlled with 24V signals. The connection is also simple due to the M12-connector.

If one of the raw material containers above the filling station is empty, the operating personnel requests a forklift driver and switches the LED light below the container in question to green. Since the forklift driver knows what to look for when he arrives at the filling station, he immediately recognizes the position of the container to be changed on the basis of the clear light signal, even if no employee is present at the line. Instead, a red LED light below the second container signals to him that it is still in operation.

Operational safety at the filling stations has increased significantly following the installation of the Bicolor LED lights, as misunderstandings when changing raw material containers are now ruled out thanks to the specific labeling of the containers concerned. At the same time, employees at the plant are not disturbed by the signal changes due to the low illuminance of the luminaire of 0.6lx (red) or 0.8lx (green).

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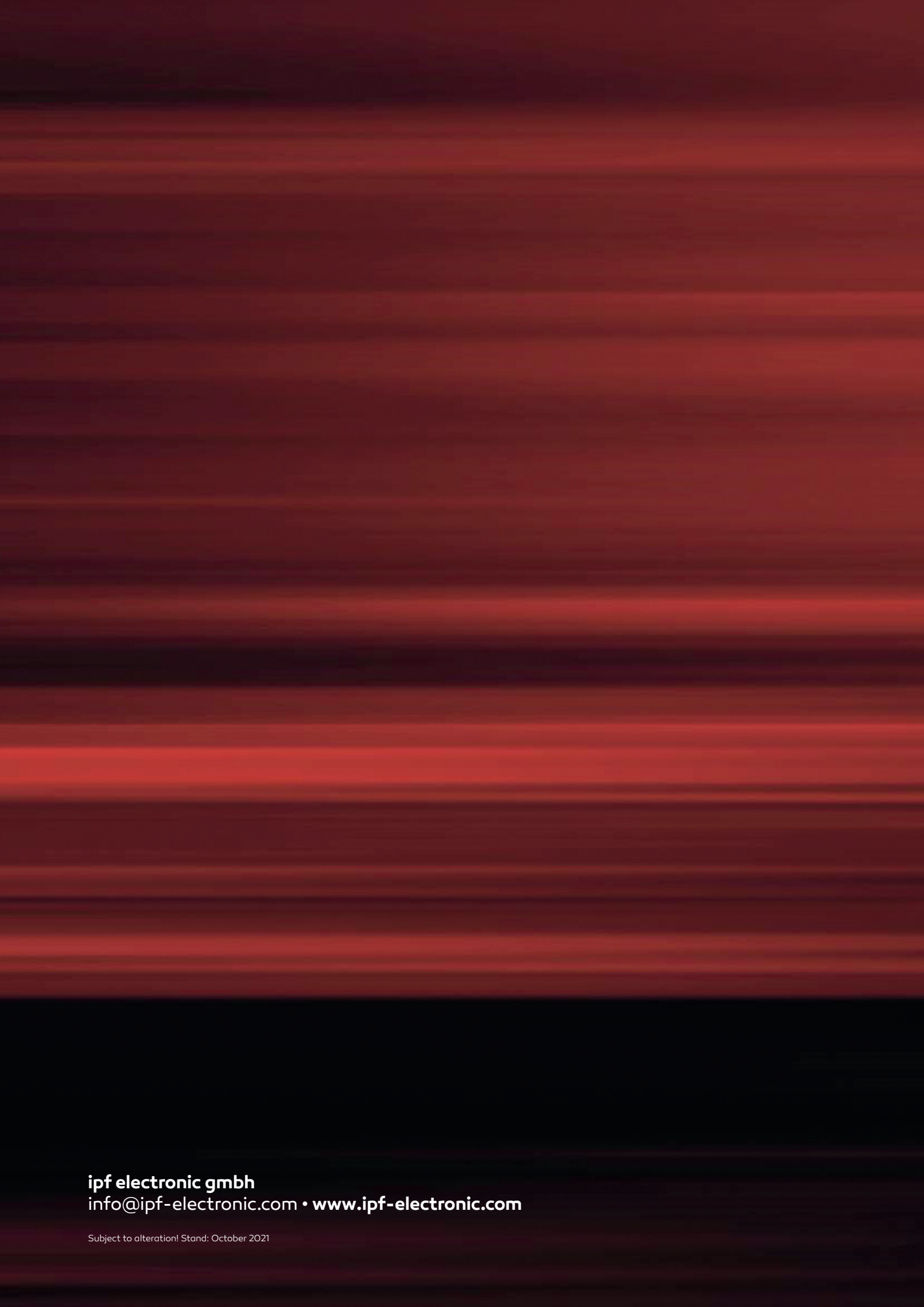

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