FTM

FUTURE TECHNOLOGY MAGAZINE

FUTURE ELECTRONICS

20-iii EMEA

LATEST

TE Connectivity's infrared digital thermopiles for accurate contactless temperature measurement

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INTELLIGENT LIGHTING

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How a simple circuit can prevent high-power LEDs from overheating

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TECH VIEW

Machine learning: the knowledge and skills gaps that developers must bridge

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New Bluetooth Low Energy MCUs include optional NFC connectivity

NXP Semiconductors has announced the availability of its QN9090 and QN9030 Bluetooth® 5 Systems on Chip (SoCs), which offer fast processing capability backed by generous memory provision, along with optional NFC wireless connectivity.

These latest additions to NXP's QN series of Bluetooth Low Energy devices provide a platform for the creation of next-generation intelligent connected devices. They offer ultra-low power consumption, and integrate a high-capacity Arm® Cortex®-M4 core running at 48MHz with a comprehensive mix of analog and digital peripherals.

In the QN9090, the processor is supported by 640kbytes of on-board Flash memory for code storage, and 152kbytes of fast SRAM memory. This provides sufficient storage and flexibility for complex applications and safe over-the-air updates. The QN9030 has 320kbytes of Flash and 88kbytes of SRAM.

The MCU's built-in 2.4GHz Bluetooth Low Energy 5.0 transceiver supports data-transfer rates up to 2Mbits/s, and up to eight concurrent Bluetooth connections. The MCUs also support the mesh networking capability in the latest version 5.0 of the Bluetooth Low Energy specifications.

The QN series devices' high performance and built-in wireless connectivity help accelerate development and time-to-market for developers creating feature-rich IoT products, smart personal devices, and beacons and mesh networks.

The QN9090T and QN9030T variants of the series include NFC tag capability. The user can quickly establish a Bluetooth Low Energy connection by tapping an IoT device based on the QN9090T to a smartphone, tablet or other NFC reader, greatly simplifying the pairing process.

The built-in NFC tag also offers opportunities for diagnostics or device commissioning even when the host SoC is powered down.

The QN9090 and QN9030 are notable for low power consumption, intelligent responses to audio trigger events via a digital microphone interface, and a wide operating-temperature range of -40°C to 125°C.

Development tool support includes NXP's MCUXpresso software development kit for QN devices, which is compatible with the latest toolchains from IAR, and the MCUXpresso integrated development environment.

FREE DEVELOPMENT BOARDS

The QN9090 DK board integrates buttons and an LED for resetting the QN9090 chip and indicating its status. The board also provides useful interfaces such as a USB port for UART communication, and CMSIS debug.

Orderable Part Number: QN9090-DK006

Apply at: www.my-boardclub.com

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APPLICATIONS

- Wearable devices
- Personal healthcare devices
- Sports and fitness trackers
- Human-interface devices
- Remote controls
- Toys
- Gaming peripherals
- Building and home automation
- Retail advertising beacons

FEATURES

- RF performance
  - -97dBm sensitivity
  - Up to 11dBm Transmit power
  - 4.3mA Receive current at 3V
  - 7.4mA Transmit current at 0dBm output power
  - 20.5mA Transmit current at 10dBm
  - Antenna diversity support
- Security
  - AES256 encryption with hardware-protected key
  - SHA256 hash engine
  - Code read-out protection
- Quad SPI NOR Flash memory controller for external storage
- Supply-voltage range: 1.9V to 3.6V
- Junction-temperature range: -40°C to 125°C

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Robust, high-temperature SCR thyristors provide for high power density

STMicroelectronics has extended its portfolio of high-temperature Silicon-Controlled Rectifiers (SCRs), also known as thyristors, with the TN3015H-6 line, which offers high noise immunity of 1,000V/µs. These parts, which are notable for their low power losses, are intended for use in small, power-efficient modules.

The TN3015H-6 SCRs, which are rated for operation at a maximum junction temperature of 150°C and a maximum current of 30A_{rms}, enable system designers to achieve higher power density. The high temperature rating enables a circuit to draw a higher current, or to use a smaller heat-sink, than competing SCRs when used in applications such as in-rush current limiters, power converters and solid-state relays.

Drawing on advanced ST semiconductor fabrication technology, the TN3015H-6 parts are able to combine high transient immunity with a low gate-triggering current.

The TN3015H-6 series is available in three versions:

- TN3015H-6G in a D^2PAK package
- TN3015H-6I in an isolated TO-220 package
- TN3015H-6T in a non-isolated TO-220 package

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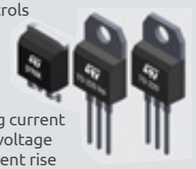
APPLICATIONS

- General-purpose AC line load switching
- In-rush current-limiting circuits
- Motor-control circuits and starters
- Heating resistor controls
- Solid-state relays
- Lighting



FEATURES

- 15mA gate-triggering current
- 600V peak off-state voltage
- 100A/µs turn-on current rise

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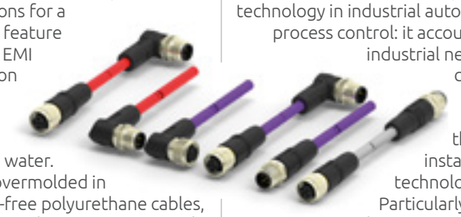
M8/M12 cable assemblies provide robust performance in Fieldbus networks

TE Connectivity (TE) has introduced M8/M12 cable-assembly solutions for Fieldbus data communications, complementing its sensor/actuator cable assemblies for industrial networks.

The new A- and B-coded M8/M12 cable assemblies conform to the specifications of the Profibus, DeviceNet and CC-link protocols, offering multiple options for a variety of needs. They feature 360° shielding against EMI for complete protection of signal and data transmissions, and are rated IP67 for resistance to dust and water.



The assemblies are overmolded in either PVC or halogen-free polyurethane cables, suitable for drag chain applications or torsional stress, depending on the requirements of the application. They come in standard cable-length options from 0.5m to 15m.

Assemblies can be produced in many customer-specific plug-and-play configurations to provide design flexibility and enable quick installation in most industrial environments.

Fieldbus is the most widely used network technology in industrial automation and process control: it accounts for 42% of the industrial network market, and continues to grow at around 6% per year. Most of the growth is from installations of Profibus technology.

Particularly useful in applications around the base of the automation pyramid, Fieldbus is a critical element of the Industrial Internet of Things, for devices which do not require large bandwidth but which benefit from having power and signals in the same cable.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Industrial communications
- Industrial machinery
- Industrial automation
- Machine tools
- Robotics
- Material handling
- Process control systems

FEATURES

- Rated for 100 mating cycles
- Voltage and current ratings:
  - 250V/4A for 2- and 4-pole assemblies
  - 60V/4A for 5-pole assemblies
- Cable length options: 0.5m, 1m, 2m, 4m, 6m, 8m, 10m, 15m

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New M12 industrial Ethernet cable assemblies

TE has extended its line of industrial Ethernet cable assemblies to include M12 assemblies as well as its existing M8 Ethernet cabling. The TE assemblies are compatible with the Profinet, EtherCAT®, Ethernet/IP & SERCOS-III industrial Ethernet protocols.

In the TE range are Ethernet assemblies which can withstand up to 1 million flexes, or which resist machine oils, abrasion and UV radiation. A compact full-metal housing with crimp flange/crimp sleeve provides 360° shielding against EMI.

The hexagonal crimp of the sleeve gives a vibration-resistant and torsion-proof cable strain relief, in accordance with IEC 61373, Category 1, Class B, as well as safe shield termination.

- 100Mbits/s maximum data-transfer rate
- Cable length options from 0.5m to 30m

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M8/M12 cable assemblies for sensors and actuators used in harsh environments

TE offers M8/M12 cable assemblies for applications such as sensors, robotics and production equipment, to be used in extreme temperatures and harsh environments.

The TE cable assemblies can be installed quickly, helping to reduce downtime and maintain continuous operation in critical areas.

The M8/M12 sensor cable assemblies have a protection rating of IP67, which means they are dustproof, and waterproof to a depth of 1m. They also protect against EMI, chemicals and mechanical stress.

Customers can choose between single- and double-ended cable assemblies, including M8/M12 versions. M12 configurations are available with two, three, four, five or eight poles, while M8 configurations have three or four poles.

Options include straight or angled connectors and shielded and non-shielded variants.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Industrial communications
- Machinery
- Automation
- Machine tools
- Process control systems
- Vision systems
- Factory equipment

FEATURES

- Standard cable lengths: 0.5m, 1m, 1.5m, 3m, 5m, 7m and 10m
- Compatible with TE's male/female connectors and I/O modules

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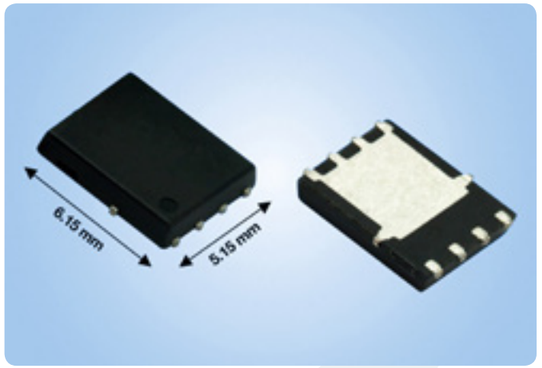
TE Connectivity, TE and TE Connectivity (logo) are trademarks.

New 80V MOSFET raises efficiency of AC-DC and DC-DC power converters

Vishay Intertechnology has introduced the SiR680ADP, an 80V, fourth-generation TrenchFET® power MOSFET which offers best-in-class on-resistance times gate charge, a key figure of merit for MOSFETs used in power-conversion applications.

The SiR680ADP may be used in DC-DC and AC-DC converters to support synchronous rectification, primary-side switching, buck-boost converters, resonant-tank switching converters, and ORing functionality.

Its figure of merit, 12.2% lower than that of the closest competing product, and 22.5% lower than that of the third-generation TrenchFET MOSFET, makes it particularly well suited to the implementation of efficient 48V input/12V output DC-DC converters.



Vishay's SiR680ADP: Supports various power-conversion topologies

The device's specifications are fine-tuned to reduce the power losses from switching, channel conduction and diode conduction, resulting in increased efficiency.

The SiR680ADP is supplied in a 6.2mm x 5.2mm PowerPAK® SO-8 package.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS
- Telecoms and server power supplies
- Solar micro-inverters
- Motor drives
- Battery switching in battery-management modules

FEATURES
- Typical on-resistance:
  - 2.35mΩ at 10V
  - 2.70mΩ at 7.5V
- Gate charge
  - 55nC at 10V
  - 43nC at 7.5V
- 95nC output charge
- 614pF output capacitance

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Mains power converter ideal for use in flyback or buck topologies

STMicroelectronics' VIPer122 is a high-voltage converter which implements PWM control, and provides a regulated output via an avalanche-rugged power MOSFET which has a breakdown voltage of 730V. The VIPer122 is ideal for use in auxiliary switch-mode power supplies.

ST's guidance suggests that the VIPer122 can supply a continuous load of 9W when operating from a 230V AC input in an enclosed, non-ventilated power adapter, and 11W in an open-frame unit at an ambient temperature of 50°C. In the same conditions but operating across an input-voltage range of 85V to 265V AC, the continuous power ratings are 5W for a power adaptor, and 6W for an open-frame design.

The VIPer122 is intended for use in flyback or buck topologies. Specified with a current limit of 450mA, it supports a higher output current when operating in the buck topology than in the flyback. The converter operates at a switching frequency of 60kHz, implementing jittering to reduce EMI and allow the use of a smaller filter. It is notable for its low power consumption. It implements a burst mode which draws very low input power at no load, and provides high efficiency at light loads.

The device embeds high-voltage start-up and current-sense circuitry, reducing the number of external components required in the power circuit.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS
- Home appliances
- Consumer goods
- Industrial equipment
- Lighting

FEATURES
- 3.3V reference voltage
- 40mW no-load input power at 230V AC
- Short-circuit protection
- Thermal shut-down protection

FREE DEVELOPMENT BOARD

The STEVAL-VP12201B evaluation board implements a 3W buck converter providing a 15V output from an input ranging between 85V and 265V AC. It provides tight line and load regulation over the entire input and output range.

Orderable Part Number: STEVAL-VP12201B

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Complete Bluetooth Low Energy radio module accelerates time-to-market

The BlueNRG-M2 is a certified Bluetooth® Low Energy wireless networking module based on the BlueNRG-2 System-on-Chip (SoC). It conforms to the specifications of version 5.0 of the Bluetooth standard.

The BlueNRG-M2 module can act at the same time as a Bluetooth master and slave device. The module implements the entire Bluetooth Low Energy protocol stack, which is programmed into its memory.

By using the BlueNRG-M2 module, system developers can dramatically reduce development time and advance time-to-market compared to an implementation which uses discrete RF components. The module integrates a 2.4GHz radio, antenna, balun and high-frequency oscillators into a small surface-mount package which has a footprint of 11.5mm x 13.5mm.

The BlueNRG-2 SoC is a wireless microcontroller based on an Arm® Cortex®-M0 processor core. It is backed by 256kbytes of embedded Flash memory, and 24kbytes of embedded RAM with data retention.

The BlueNRG-M2 can be powered directly with a pair of AAA batteries, or by any power source at a voltage between 1.7V and 3.6V.

BlueNRG-M2 module: Integrated antenna and supporting circuitry

FREE DEVELOPMENT BOARD

The X-NUCLEO-BNRG2A1 Bluetooth Low Energy expansion board can be plugged into an STM32 Nucleo microcontroller development board through its Arduino UNO R3 connectors.

Orderable Part Number: X-NUCLEO-BNRG2A1

Apply at: www.my-boardclub.com

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS
- Internet of Things
- Smart home equipment
- Building and industrial automation
- Smart lighting
- Remote controls
- Access control
- Fitness, wellness and sports equipment
- Consumer medical devices
- Security and proximity systems
- Assisted living
- PC and smartphone peripherals

FEATURES
- Up to 96dB link budget for excellent link reliability
- Interfaces:
  - 1 x UART, 1 x I²C, 1 x SPI, 14 x GPIOs
- On-board antenna:
  - Chip antenna on the BLUENRG-M2SA model
  - PCB antenna on the BLUENRG-M2SP model
- AES security co-processor
- Certifications:
  - CE qualified
  - FCC, IC modular approval certified
  - TYPE qualified
  - BQE qualified
- Operating-temperature range: -40°C to 85°C

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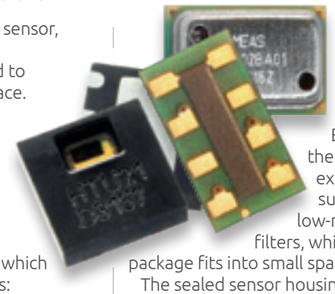
Digital thermopile sensors perform accurate contactless temperature measurement

TE Connectivity's (TE) TSD digital thermopile sensor products, which perform contactless temperature measurement, are highly regarded for their accuracy, speed, low power consumption, and small dimensions.

The TSD sensors include an infrared sensor, or thermopile, and a sensor signal conditioner. They may be connected to any microcontroller via an I²C interface. They are accurate to ±1°C across a temperature range of 10°C to 85°C.

TSD sensors provide a cost-effective alternative to analog sensors which require additional components to deliver similar functionality and results. They are suitable for use in various functions which call for temperature sensing, such as:
- Environmental monitoring
- Industrial process measurement and control
- Motion and occupancy sensing
- NDIR gas sensing



In these applications, TE Connectivity's TSD temperature sensors offer superior resistance to EMI. They also reduce the requirement for external components such as a low-offset/low-noise amplifier and filters, while their small TO5 package fits into small spaces.

The sealed sensor housing and contactless mode of measurement help eliminate problems with dust, dirt, and debris faced by contacting temperature sensors.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS
- Aerospace
- Industrial equipment
- Medical devices
- Appliances
- Smart home devices
- Mobile devices

FEATURES
- Supply-voltage range: -0.3V to 3.63V
- Maximum current into supply and I/O pins: -100mA to 100mA
- ESD rating: -2kV to 2kV
- Field-of-view options: 10° or 88°

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Low-cost 32-bit MCUs integrate multiple features in low pin-count packages

The STM32G030 series of mainstream microcontrollers integrate many features to enable manufacturers to implement a wide range of applications in the consumer, industrial and appliance domains while making them ready for the IoT.

Based on a high-performance Arm® Cortex®-M0+ 32-bit core operating at up to 64MHz, the STM32G030 devices incorporate a memory protection unit, up to 64kbytes of Flash program memory and 8kbytes of SRAM, and a DMA controller.

Standard communications options include two I²C interfaces, two serial peripheral interfaces multiplexed with one I²S and two USARTs.

STM32G030 offers mainstream MCU functions at low cost

Up to 19 channels of analog input can be routed through the on-chip 12-bit ADC, which digitizes up to 2.5Msamples/s.

Flexible packaging and memory options enable designers to do more in less space, and to reduce costs. A novel power-distribution architecture reduces external power and ground connections to just a single pair of pins, allowing more of the package pins, a precious resource in many embedded projects, to be allotted to user connectivity.

Package options for the STM32G030 parts range from the smallest 8-pin variant, ideal for developers who want to upgrade an aging 8-bit MCU design, to the largest, a 48-pin, 7mm x 7mm low-profile quad flat package.

The devices operate in an ambient temperature of between -40°C and 85°C, and on a supply voltage of 2.0V to 3.6V. They feature power-saving innovations which trim consumption close to that of specialised ultra low-power MCUs.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Smart kitchen equipment and appliances
- Air-conditioning units
- Motor controls
- IoT devices
- Rechargeable connected devices
- Drones
- Lighting

FEATURES

- 100µA/MHz current in run mode
- 16-bit timer for motor control
- Four general-purpose 16-bit timers
- Two watchdog timers
- SysTick timer

FREE DEVELOPMENT BOARD
Orderable Part Number: NUCLEO-G031K8
Apply at: www.my-boardclub.com

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Miniature 10A relay offers high inrush-current capability

TE Connectivity (TE) has introduced the OJT series of relays, which are rated for a continuous output current of 10A at 250V AC.

These compact relays offer a high 117A inrush-current capability, and are UL TV-8 rated. Featuring an 18.2mm x 10.2mm footprint, the OJT relay is supplied in three versions, rated for a coil voltage of either 5V, 12V or 24V DC. The products require 450mW of coil power.

The OJT relays' contacts are configured in a 1 Form A normally open arrangement. The relays have through-hole terminals, providing a robust and durable board-mounting option.

OJT series: Three versions of the relay with 5V, 12V or 24V coil voltage

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Home appliances
- HVAC equipment
- Industrial controls and machinery
- Lighting
- Motors
- Power supply controls
- Printers
- Smart plugs

FEATURES

- 15.2mm mounted height
- ≥4kV dielectric strength between contacts and coil
- Complies with IEC 61810
- UL recognized
- VDE approved
- CQC certified
- Ambient-temperature range: -40°C to 85°C

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Miniature waterproof plastic circular connectors feature IP67/68 ratings

Hirose has introduced the HR30, a series of miniature waterproof plastic circular connectors for use outdoors and in electronics equipment which requires an Ingress Protection (IP) rating of IP67 or IP68.

The HR30 range consists of small, lightweight plastic plugs, including the overmold type of plug, receptacles, jacks and accessories.

Hirose supplies the HR30 series in various configurations:

- The three- and six-contact versions are in a 12.6mm diameter shell
- The ten- and 12-contact versions are in a 15.5mm diameter shell

Further options include solder-bucket, crimp or through-hole contacts.

The innovative connector design incorporates gaskets, seals and built-in strain relief. A user-friendly push-pull locking mechanism securely locks the mated connectors. Mating is confirmed by an audible click. The connectors are simply pushed together and then quickly and easily disconnected by pulling on the plug's release collar, which has grooves for improved grip. Furthermore, white arrows and multiple polarizing keys ensure correct alignment and mating engagement.

Gaskets and seals make the Hirose HR30 connector waterproof

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Servo motors
- Industrial robots
- Satellite positioning devices
- Measurement instruments
- LED lighting

FEATURES

- 5A current rating
- Rated voltage:
  - 100V AC/140V DC for parts with three or six contacts
  - 30V AC/42V DC for parts with ten or 12 contacts
- Cable size: AWG 26 to AWG 30
- Operating-temperature range: -25°C to 85°C
- 1,000 mating cycles

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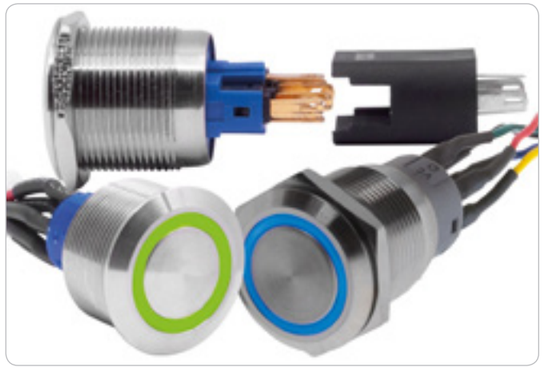
Anti-vandal on-off switches withstand dust and moisture

E-Switch's new PVT4 series of anti-vandal switches provides a crisp tactile response when engaging the actuator.

The switch function is a momentary off-(on) configuration with a single-pole, single-throw contact arrangement. The PVT4 switches carry an IP65 ingress-protection rating.

The PVT4 series offers a ring lens style and five LED illumination color options. It is also available with three LED voltage options of 6V, 12V or 24V. The PVT4 switches are supplied with one of two termination options: solder lug or 300mm wire leads. The switch may be mounted in a 19mm-diameter panel cut-out.

The introduction of the PVT4 extends E-Switch's broad portfolio of anti-vandal switches, which also includes, the PV3, PV4, PV7, PV8 and PV9 series of illuminated, sealed anti-vandal switches, which offer long operating life. E-Switch also supplies UL-recognized anti-vandal switches, the ULV4 and ULV7.



PVT4 series of switches: Various color LED illumination options

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Consumer electronics
- Security equipment
- Industrial controls
- Kiosk panels
- Home appliances
- Medical equipment

FEATURES (PVT4)

- Electrical rating: 50mA, 24V DC
- 500,000 switching cycles
- 50mΩ maximum contact resistance
- 1,000MΩ minimum insulation
- 250V AC dielectric strength
- 490g actuation force
- 0.5mm travel
- Operating-temperature range: -25°C to 55°C

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How a simple auto-dimming circuit can provide thermal protection for LED arrays

By Mike Donnelly, Principal Engineer at Mentor, a Siemens Business
and Alain Stas, Product Marketing Engineer at Vishay Intertechnology

While automotive LED lighting technology is more efficient than traditional incandescent lamps, thermal management of these systems can still present substantial design challenges. Innovative designers can exploit the characteristics of LEDs to address some of these issues.

For example, to limit the maximum temperature inside a lamp's enclosure, dimming techniques can be used to extend the ambient operating-temperature range of LED lighting circuits.

To implement dimming, designers can choose between analog and digital techniques. Analog dimming is generally avoided because it can affect the color of the LED's light output.

Digital dimming through the application of PWM control is normally preferred because the nominal current is applied during the On cycle. The amount of light and heat generated by an LED is reduced as the PWM duty cycle is decreased. The frequency response of the human eye is limited, at 15Hz for rods, which are sensitive to the intensity of light, and 60Hz for cones, which are sensitive to color. This means that visible flicker can be avoided by maintaining the PWM frequency higher than 200Hz.

A PWM signal may be generated by a microcontroller, or by a simple 555 timer. This second approach is shown in Figure 1, using the web-based simulation platform SystemVision Cloud from Mentor, a Siemens business. The platform hosts thermistor models from Vishay Intertechnology.

In Figure 1, the LED driver circuit and three LEDs are assumed to be in an enclosure which has a Nylon 6 polymer lens. It is desirable to keep the enclosure temperature below the glass-transition temperature, Tg, to avoid potential deformation of the lens when the outside temperature rises.

Vishay's high-fidelity thermistor models allow for self-heating and external thermal coupling behavior. That is, each thermistor model includes a thermal terminal, shown as a red connection in Figure 1, so they can be attached to an external thermal network representing the system's dynamic thermal characteristics. One of those models, an NTCS0402, is used in the circuit shown in Figure 1.

The Vishay NTCS0402 senses the temperature of the enclosure, which depends on the flow of dissipated heat from the power circuit, as well as the outside air temperature, which increases in steps. The electrical feedback from the thermistor, which is used in a bridge configuration, controls the PWM dimming of the LEDs.

In this way it limits the internal temperature rise when operating at a high ambient temperature.

For this nominal configuration, PWM dimming begins when the outside temperature is 50°C, and the LEDs are completely off when it reaches 70°C, eliminating all self-heating.

The PWM switching frequency was intentionally reduced from the practical value of 260Hz to 2.6Hz, to provide fast simulations and realistically long thermal time constants. This was accomplished by increasing the value of the 555 timer's capacitor from 100nF to 10µF. This is still well below the relevant thermal time constants, and will therefore have no impact on the thermal static or settling behavior. The capacitor value should be restored to 100nF in a real-world implementation.

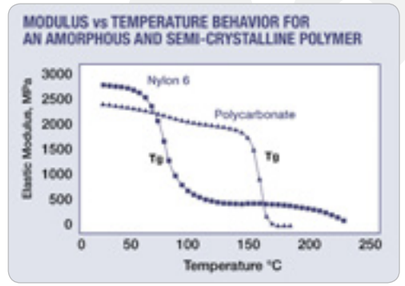


Fig. 2: Tg for Nylon 6 generally occurs between 50°C and 100°C

As Figure 2 shows, the value of Tg for Nylon 6 and other polycarbonates can vary widely, so the shut-down temperature limit may also vary. This design can accommodate that variance by adjusting the resistance 'r_offset'. For instance, a change in the offset resistance value from 1kΩ to 2.5kΩ causes the PWM dimming operation to begin when the outside temperature is approximately 30°C, and the LEDs to be nearly completely off when the temperature reaches 50°C.

This Design Note shows that electronic simulation of an LED dimming circuit is an ideal way to explore both the theoretical aspects of LED system design, and the practical options for circuit design. This can potentially save engineering time when designers come to build the real circuit.

To achieve this, accurate models of the sensing components, as provided by Vishay, and a multi-discipline simulation environment such as SystemVision Cloud are needed.

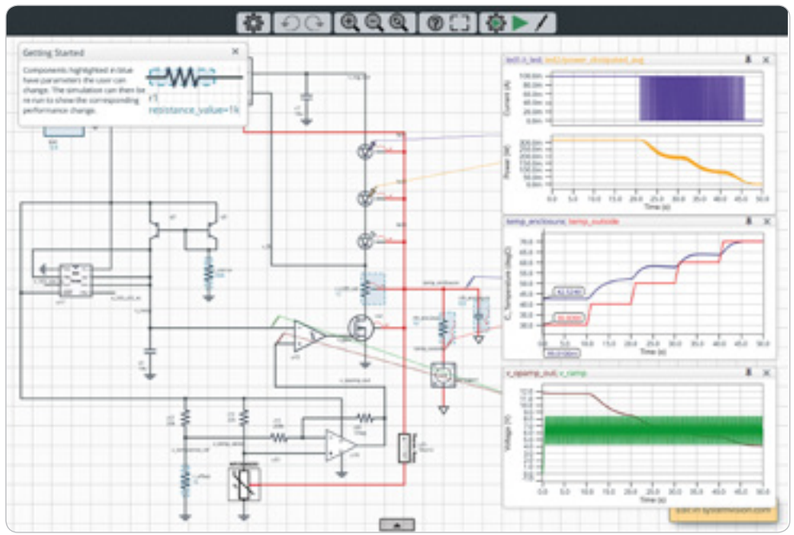
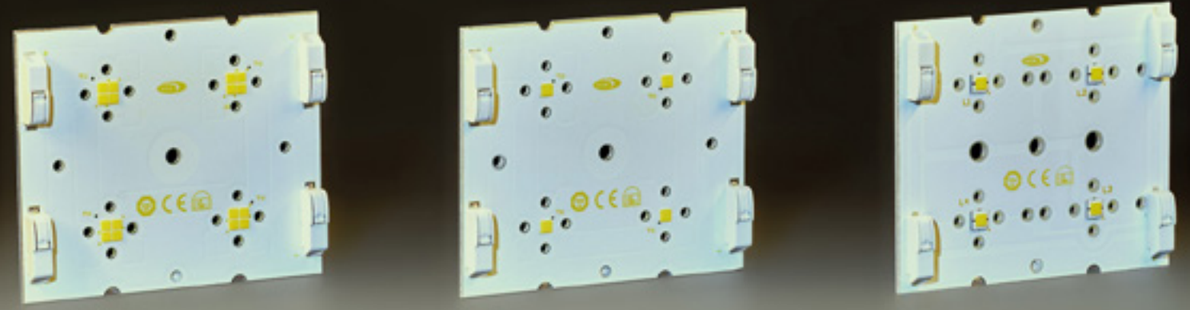


Fig. 1: An LED dimming circuit designed in SystemVision Cloud



Off-the-shelf LED modules offer fast time-to-market and easy design implementation

SEOUL SEMICONDUCTOR

Seoul Semiconductor supplies a wide range of complete, off-the-shelf LED modules which provide the fastest time-to-market and the lowest design risk for developers of LED-based luminaires.

The modules, which offer an attractive combination of high performance and low cost, are available in more than 100 different versions, offering customers a choice of footprints, performance and cost.

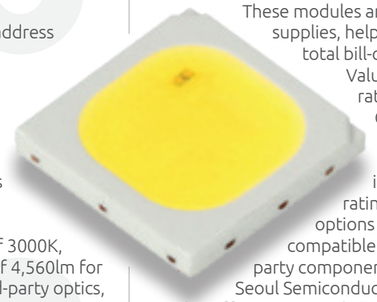
Seoul Semiconductor categorizes its module offerings to address market requirements. Module categories include:

- High-performance modules
- Value solution modules
- Eco solution modules

In the **high-performance line**, Seoul Semiconductor offers a 25W streetlight module consisting of 5050 packaged LEDs in a 2 x 6 configuration. This module, the SMJD-3625012F-XX00, has a footprint of 147mm x 45mm.

Supplied in Correlated Color Temperature (CCT) options of 3000K, 4000K, 5000K, 5600K and 6500K, it produces peak output of 4,560lm for efficacy of 181lm/W. The modules are compatible with third-party optics, and conform to the specifications of the Zhaga standard.

Seoul Semiconductor's high-performance line also includes flat and linear modules based on 3030 packaged LEDs.



The **value solution line** of modules, based on 3528 packaged LEDs, is supplied in linear form factors which are 280mm or 560mm long. These modules are compatible with industry-standard power supplies, helping luminaire manufacturers to reduce their total bill-of-materials cost.

Value solution modules are available in power ratings of 3W, 6W, 9W, 12W and 18W, and in CCT options of 3000K, 4000K and 5000K.

The **eco solution line** of linear modules is also based on 3528 packaged LEDs, and is supplied in linear form factors. Power ratings are 4W, 8W 12W, 16W and 25W in CCT options of 4000K and 5000K. These modules are compatible with the Zhaga standard for use of third-party components. Minimum CRI is 80.

Seoul Semiconductor, working with Future Lighting Solutions, can also offer customized LED modules on request. A custom part may be a complete LED module, an LED engine with lens and driver, or an LED engine with lens.

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Wicop

Space-saving holder for CoB LEDs integrates constant-current driver

TE connectivity

TE Connectivity's (TE) LUMAWISE drive LED holder type Z50 DALI-2 enables luminaire designers to remove the driver box from spot and track lighting, creating a more aesthetically pleasing lighting solution.

LUMAWISE drive LED holders bring integrated functionality to TE's successful Zhaga-inspired range of LED holders. By incorporating an LED's constant-current driver into the LED holder assembly, lighting equipment manufacturers can realize an elegant luminaire design.

Operating from a 48V DC input, LUMAWISE drive LED holders work with a wide range of readily available constant-voltage power supplies, so that multiple fixtures may be powered by a single supply unit.

The LUMAWISE drive LED holder Type Z50 DALI-2 can be controlled with DALI signals. DALI lamp fixtures are intelligent, dimmable and can be controlled, monitored and maintained using a two-wire open standard protocol.

Output Current	Part Number	LED/CoB Size (mm)	Global Trade Item Number
350mA	2316511-1	24 x 24	9421027422100
350mA	2316511-2	20 x 24	9421027422117
350mA	2316511-3	19 x 19	9421027422124
350mA	2316511-4	16 x 19	9421027422131
500mA	1-2316511-1	24 x 24	9421027422148
500mA	1-2316511-2	20 x 24	9421027422155
500mA	1-2316511-3	19 x 19	9421027422162
500mA	1-2316511-4	16 x 19	9421027422179

Output Current	Part Number	LED/CoB Size (mm)	Global Trade Item Number
700mA	2-2316511-1	24 x 24	9421027422186
700mA	2-2316511-2	20 x 24	9421027422193
700mA	2-2316511-3	19 x 19	9421027422209
700mA	2-2316511-4	16 x 19	9421027422216
1,050mA	3-2316511-1	24 x 24	9421027422223
1,050mA	3-2316511-2	20 x 24	9421027422230
1,050mA	3-2316511-3	19 x 19	9421027422247
1,050mA	3-2316511-4	16 x 19	9421027422254

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Spotlights, downlights and tracklights

FEATURES

- Compatible with Zhaga Book 12
- Dimming down to 3% of maximum current
- <5% flicker percentage
- Supports logarithmic and linear dimming
- 135° allowable beam angle

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High-power LED housed in robust package for use in exterior applications

LUMILEDS

Lumileds has unveiled the LUXEON 5050 Square, a multi-die emitter with a square Light Emitting Surface (LES) which provides high flux and efficacy in directional lighting applications.

The LUXEON 5050 Square offers 25% higher flux than the LUXEON 5050 Round emitter. Its efficacy is higher than that of any 5050 package on the market.

The LUXEON 5050 Square also offers superior corrosion resistance, resulting in substantially lower flux degradation and less color shift when used in harsh environments.

Producing higher brightness from a standard 5050 footprint, the LUXEON 5050 Square allows for drop-in replacement in existing systems, or the design of new, more robust fixtures.

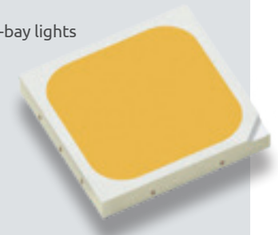
Typical flux of the LUXEON 5050 Square 5000K at a drive current of 160mA is 825lm at 170lm/W. High efficacy means that lighting equipment manufacturers can achieve higher system efficiency, or use fewer emitters for a more compact design. The design of compact fixtures is facilitated by the low thermal resistance of the substrate, just 1.4°C/W, enabling the use of a smaller heat-sink.

LUXEON 5050 Square: Superior corrosion resistance

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Streetlights
- High- and low-bay lights
- Floodlights
- Wall packs
- Spotlights
- Downlights



FEATURES

- Color-temperature options: 2200K, 2700K, 3000K, 3500K, 4000K, 5000K, 5700K, 6500K
- Minimum 70 CRI
- Voltage options: 6V, 30V
- 3- and 5-step MacAdam ellipse binning structure

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Ripple-current suppressor maintains flicker-free professional LED lighting

Diodes Incorporated has introduced the AL5822, an LED ripple-current suppressor which provides high levels of suppression while maintaining a high power factor.

The introduction of the AL5822 comes in response to customers' requirement to comply with regulations, such as the California Energy Commission Title 24, governing the suppression of ripple in LED lighting at low frequencies between 100Hz and 120Hz.

The AL5822 delivers a high level of ripple-current suppression in single-stage, high-power LED installations, even when triac or PWM dimming techniques are being used to vary the lights' brightness. This ensures there is no sign of flicker or strobing at any brightness, while still maintaining a high power factor.

The AL5822 complies with the requirement specified in the Title 24 building code to maintain flicker at less than 30% of its maximum value: tests show that the AL5822 suppresses more than 97% of ripple while still achieving a power factor of higher than 0.9.

Monitoring the current flowing through the LEDs, the AL5822 compensates for ripple by adjusting the drive voltage at the external MOSFET. This control loop keeps the MOSFET operating in its saturation region to produce a constant-current output.

Diodes AL5822: Suppresses more than 97% of ripple current

Offering support for various pre-stage circuits, the AL5822 can work with a number of drivers, such as the Diodes AL1665 single-stage PFC flyback buck/boost controller. The integrated features of the AL5822 remove the need for discrete magnetic components, minimizing the overall bill-of-materials cost and component count.

ENERGY **INDUSTRIAL** **LIGHTING** MEDICAL TRANSPORT SECURITY **CONSUMER** TELECOMS

APPLICATIONS

- Commercial lighting
- Industrial lighting
- LED power modules

FEATURES

- Input-voltage range: 24V AC to 305V AC
- Short-circuit protection
- Over-temperature protection
- Over-current protection

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High-voltage flyback controller produces high power factor in mains-supplied LED drivers

The HVLED001B from STMicroelectronics is a controller for LED drivers which offers a high power factor and very low standby power consumption.

The HVLED001B implements enhanced peak current-mode control via primary-side regulation. Although mainly intended for use in flyback or buck-boost topologies, it can also be used to control power circuits configured in buck, boost or SEPIC topologies.

The controller is suitable for LED drivers which implement single-stage flyback conversion with a high power factor in secondary-side regulation. It can also be used in two-stage LED drivers, where it controls the first, AC-DC flyback conversion stage with power factor correction in primary-side regulation.

The HVLED001B offers high conversion efficiency and high output stability across a wide range of input-voltage and output-current values.

Primary-side regulation and optocoupler control can be applied independently on the chip: both techniques provide for precise regulation, and offer very low standby power consumption when there is no load. The output stage provides sufficient power to drive a high-current MOSFET, and can control LED drivers supplying loads up to 150W.

Innovative ST high-voltage semiconductor technology allows the HVLED001B to be connected directly to the input voltage to both start up the device and to monitor the input without the need for external components.

FREE DEVELOPMENT BOARD

The EVAL-PSR01B-35W is a reference design board which provides a stable, insulated 48V output from an input voltage in the range 90V to 265V_{rms}. It is rated for a maximum output power of 35W.

Orderable Part Number: EVAL-PSR01B-35W

Apply at: www.my-boardclub.com

ENERGY **INDUSTRIAL** **LIGHTING** MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Single-stage LED drivers with high power factor
- Two-stage LED drivers

FEATURES

- Maximum 800V start-up voltage
- Programmable frequency fold-back
- Compatible with 0 to 10V and PWM dimming controls
- Automatic restart timer
- Remote control pin
- Protection functions:
  - Over-current
  - Brown-out
  - Over-power
  - Input and output over-voltage


EVAL-PSR01B-35W

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FUTURE Lighting Solutions

Making LED Lighting Solutions Simple™

	TECHNOLOGY / MANUFACTURER	ERP	Inventronics	Ledil	Lumileds	Nichia	Osram DS	Rena	Seoul Semiconductor	Seoul Viosys	Sylvair	TE Connectivity	AMS	AVX	Bender & Wirth	Bridgelux	Carclo	Danlers	Diodes Inc.	Efore	Fraen	General Luminaire	Herculux	Littelfuse	Luminus	Magnum	McWong	Melexis	Microchip	Murata	Panasonic	ON Semiconductor	Power Integrartions	Rohm Semiconductor	STMicroelectronics	u-blox	Vishay
LED Light Source	Low/Mid-Power LED				•	•			•							•									•									•			•
	Hi-Power LED				•	•			•							•									•												
	CoB LED				•	•			•							•									•												
	CSP LED				•	•			•																•												
	Color LED				•	•			•																•												•
	Horticulture LED				•	•			•							•									•												
	Infra Red LED				•																				•												•
	Ultra Violet LED				•	•				•															•												•
	LED Light Engine and Module				•		•	•	•	•						•						•														
Optic	Lens & Reflector			•			•		•								•				•	•	•													
	Light Guide				•																															
LED Driver	Mains LED Driver	•	•				•	•								•				•		•														
	DC/DC LED Driver						•	•				•								•		•														
	AC Direct LED Driver							•	•													•														
	Surge Protection		•				•	•						•								•		•												•
	Driver IC																		•									•	•			•	•		•		•
Light Management	Motion & Presence Detector						•	•				•	•					•				•				•	•	•		•	•	•					
	Light Sensor						•	•		•		•	•					•				•				•	•			•	•			•			•
	Wired Lighting Management						•	•										•				•				•	•			•							
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	Controller IC												•			•													•						•		
	Wireless Connectivity IC & Module																											•	•	•	•				•	•	
eMech	Connector											•		•																							
	CoB Holder			•			•					•			•																						

Connected Lighting Platform kit speeds design of industrial LED lighting

ON Semiconductor has launched the Connected Lighting Platform, a modular kit which supports the development of energy-efficient or batteryless LED lighting solutions. The platform, which is easy for lighting equipment manufacturers to use in product design projects, supports wired and wireless connections to LED lighting via an Ethernet or Bluetooth® Low Energy network.

In creating the Connected Lighting Platform, which has the part number Lightning-1-GEVK, ON Semiconductor has drawn on technologies and products which are widely used in the industrial and commercial sectors. These include the RSL10 System-in-Package (SIP), an integrated Bluetooth Low Energy radio system. The RSL10 SIP reduces time-to-market by eliminating the need for the user to implement a discrete antenna circuit. The ready-to-use RSL10 SIP features an integrated antenna, RSL10 radio System-on-Chip (SoC), and all passive components in a single, miniature package.

The Connected Lighting Platform also features an LED driver board based on the ON Semiconductor FL7760, an efficient step-down controller for lighting applications which operate in Continuous Current Mode (CCM).

The FL7760 can operate from an input ranging between 8V and 60V DC. It supports both 12-bit PWM and analog dimming via its Dim pin, dimming down to 0.025% of full brightness.

In the Connected Lighting Platform, the FL7760 driver board is fed by either an AC-DC power supply or via Power over Ethernet (PoE). The AC-DC converter board operates from a universal mains input-voltage range and produces an output of 55V DC to support loads up to 70W. The AC-DC converter's power factor is >0.99 at full load. The power system achieves conversion efficiency of better than 90% at full load.

A PoE power module, the Lightning-Power-POE-GEVB, is available separately to provide Ethernet connectivity and a power supply to the LEDs of up to 90W at efficiency of more than 99%. The power and control boards drive an LED module which consists of independently controlled strings of 16 warm-white and 16 cool-white LEDs. In total, they produce a maximum light output of 7,000 lumens.

The Connected Lighting Platform provides several ways to implement LED control, including the RSL10 Sense and Control mobile app. Available for the iOS® and Android™ mobile operating systems, the app can be used to control LED functions such as dimming, on/off and telemetry, and to monitor power consumption.

Firmware Over The Air (FOTA) updates can be easily sent through the RSL10 FOTA app. A comprehensive development environment, including a CMSIS-Pack featuring customizable firmware and the FreeRTOS™ operating system, supports the platform. It can also be used with an energy harvesting Bluetooth Low Energy switch to develop batteryless applications.

Product	Description	Component Parts
Lighting-1-GEVK	Connected lighting platform for LED control	ES1JFL, ES3D, FCPF400N80Z, FDC3535 FDD10N20LZTM, FL7740MX FL7760BM6X GBU6K MM3Z18VT1G, MMSZ22T1G, MMSZ4V3T1G NCH-RSL10-101S51-ACG, NCP10671BD100R2G NCP161ASN330T1G NSBC114EPDXV6T1G RURP1560-F085, US1MFA
Lighting-Power-POE-GEVB	PoE power module for the connected lighting platform	2N7002LT1G, BC846BDW1T1G, BC846BPDW1T1G FDMQ8205A FXL6408UMX, LC03-6R2G, MM3Z5V1B MMBZ27VALT1G NCP1096PAG, NSP4201MR6T1G NSR30CM3T5G

ENERGY · INDUSTRIAL · LIGHTING · MEDICAL · TRANSPORT · SECURITY · CONSUMER · TELECOMS

APPLICATIONS

- Industrial LED lighting

FEATURES

- High-power lighting features
  - Dual independent LED channels
  - White balance control
- Complies with multiple industry standards
- Flexible, modular design with multiple power options

FREE DEVELOPMENT BOARDS
Orderable Part Numbers:
LIGHTING-1-GEVK
LIGHTING-POWER-POE-GEVB
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REFERENCE NUMBER **20-iii 21**

New CoB LEDs offer higher intensity in spotlights and downlights

LUMILEDS

Lumileds has extended its range of integrated Chip-on-Board (CoB) emitters, launching products which offer a higher light output than earlier products and stronger 'punch', giving high brightness from a small Light-Emitting Surface (LES).

The LUXEON CX Plus CoB (Gen 2) arrays feature a 14% flux improvement over the previous generation of CX Plus CoB products. They are supplied in a choice of LES options: 4.5mm, 6mm, 12mm or 14mm diameter. Correlated color temperature options range from 2700K to 5000K. Efficacy is higher than 140lm/W at 3000K for the 80 CRI version, and 122lm/W for the 90 CRI version.

Lumileds has also introduced two high-density versions of the LUXEON CX Plus CoB. The LUXEON CX Plus CoB – High Density and LUXEON CX Plus CoB – High Density (Below BBL) products are drop-in upgrades for existing arrays from Lumileds or competing manufacturers.

The High Density version of the LUXEON CX Plus CoB provides industry-leading punch (measured as center beam candle power), and is available in on-Blackbody Locus (BBL) coordinates for halogen-like illumination, or below-BBL for ceramic metal halide-like illumination.

For high punch, the LUXEON CX Plus CoB – High Density provides output of up to 1,150lm at 3000K in the 90 CRI version from the smallest LES of 4.5mm. Flux is 10% higher than competing CoBs from the versions with an LES of 6mm or 9mm.

Offered in three LES options of 4.5mm, 6mm or 9mm, and mounted on a 13.35mm x 13.35mm substrate, the arrays cover a range of color temperatures between 2700K and 5000K with a minimum of 80 or 90 CRI. Color control is maintained within a 3- or 2-step MacAdam ellipse.

For the below-BBL versions, the color-temperature range is 2700K to 4000K at a minimum of 95 CRI with color control within a 3- or 2-step MacAdam ellipse. This below-BBL option is ideal for illuminating artwork, because it combines very high color fidelity with slightly saturated colors to produce a stunning visual effect.

ENERGY **INDUSTRIAL** **LIGHTING** MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Spotlights, downlights and tracklights

FEATURES

- Metal-core PCB substrate
  - Resists cracking during assembly
  - Excellent thermal dissipation
- 115° viewing angle
- 37.5V forward voltage
- 150°C maximum junction temperature

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Off-the-shelf LED holders tailored to Bridgelux Vesta dim-to-warm CoB LEDs

TE Connectivity (TE) has introduced an addition to its LUMAWISE series of LED holders, creating holders for the Bridgelux® Vesta® series of dim-to-warm Chip-on-Board (CoB) LEDs.

These LED holders provide for easy assembly of the Vesta CoB LEDs into the luminaire, and for fast termination. Once mounted, the CoB LED's optics are close to the light-emitting area.

TE's proven LUMAWISE LED holders provide a reliable electrical and mechanical connection for a light fixture's power source, heat-sink and reflector. Clearance was created within the existing one-piece Z45 and Z35 series LED holder housings to accommodate extra components in the Vesta CoB products.

Poke-in wire connections for ease of termination and adhesive tape for CoB retention during assembly are features carried over from the original Z45 and Z35 LED holders.

A standard 35mm screw pitch enables the use of standard heat-sink drilling and mounting procedures. A 120° optic angle incorporated into the housing keeps light loss to a minimum.

TE's LUMAWISE Z45 and Z35 LED holders are compatible with the Zhaga Book 3 standard, and with other Zhaga LED lighting components.

Part Number	Description	Bridgelux Vesta Product Compatibility
2-2325811-1	LUMAWISE Z45 LED holder for pan-head screws	13mm and 15mm light-emitting surface
3-2325811-1	LUMAWISE Z45 LED holder for countersunk screws	13mm and 15mm light-emitting surface
3-2213678-3	LUMAWISE Z35 LED holder for pan-head screws	9mm light-emitting surface
3-2213678-4	LUMAWISE Z35 LED holder for countersunk screws	9mm light-emitting surface

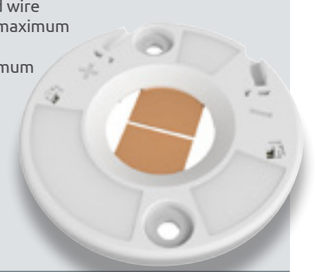
ENERGY **INDUSTRIAL** **LIGHTING** MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Spotlights, downlights and tracklights
- Streetlights
- General lighting
- Horticultural lighting

FEATURES

- Operating temperature range: -40°C to 105°C
- Accommodates 18 to 22 AWG solid, fused or stranded wire
- 60V DC maximum voltage
- 3A maximum current



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TE Connectivity, LUMAWISE, TE and TE Connectivity (logo) are trademarks.

LEDs with special spectral profile for human-centric lighting systems

Nichia has introduced its Vitasolis LED lighting technology for human-centric lighting systems. Nichia's Vitasolis LEDs may be used to help control users' circadian rhythm via a unique spectrum which is intended to stimulate activity.

The introduction of Vitasolis comes in response to the growing demand for LED lighting to provide not only low power consumption, but also to provide high quality of light. To do so, Nichia has drawn on more than 50 years of research into the production and application of phosphor coatings.

Circadian effects are produced by specific wavelengths of light, especially in the cyan region. For example, lighting can have an influence on activity throughout the day, including waking up in the morning and inducing sleep at night. While Vitasolis provides a natural white color, part of its spectrum contains a larger amount of energy in the cyan region, between the wavelengths of 470nm and 520nm. This spectral power distribution helps control the human circadian rhythm.

Physiology of the human eye

Circadian rhythms are regulated by various cues, including light. The body's response is triggered by intrinsically photosensitive Retinal Ganglion Cells (ipRGCs), the eyes' non-image forming photoreceptors. Through ipRGCs, lights of high frequency and intensity promote alertness; the lack of this stimulus causes the body to reduce its expenditure of energy and to prepare for rest.

The sensitivity curve for ipRGCs peaks in the cyan region. There is also a correlation between age and transmittance in the cyan region, due to yellowing of the crystalline lens over time.

Nichia's Vitasolis LEDs produce a comfortable light for people of all ages, emphasising the 470nm to 520nm cyan region more than conventional LEDs for general lighting. The Vitasolis range of LEDs also features a broad spectrum to minimize visual fatigue.

ENERGY **INDUSTRIAL** **LIGHTING** MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Office and commercial lighting
- Lighting in schools and hospitals
- Color-tunable lighting systems

FEATURES

- NF2W757G-V3F1 Vitasolis LED in 3mm x 3mm x 0.65mm package
- Luminous output:
  - 35.6lm at 5,000K
  - 33.2lm at 3,000K
- Minimum 80 CRI
- 65mA forward current
- 120° viewing angle

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LED emitters' natural light closely matches spectral profile of sunlight

Nichia's Optisolis™ LED emitters provide a natural light source with a spectrum which achieves the industry's closest match to that of the standard illuminants, sunlight and incandescent artificial light.

The Optisolis full-spectrum LEDs are intended for use in high-end general lighting. They are fabricated from Nichia's own blue chip and phosphor technologies.

Lighting equipment manufacturers can use Nichia's Optisolis technology to produce luminaires in which all colors are rendered in the same way as under a standard light. In addition, the almost non-existent ultraviolet content of Optisolis LEDs' output dramatically reduces the degradation of materials compared to that of other LED light sources.

The Optisolis LED products are available as surface-mount chip-style packages with specifications shown below:

Part Number	Surface-mount Package Dimensions (mm)	Typical Luminous Flux	Minimum CRI (Ra)	Forward Voltage	Forward Current
NF2W757G-F1	3 x 3 x 0.65	23lm	95	2.9V	65mA
NF2L757G-F1	3 x 3 x 0.65	24lm	95	2.76V	65mA

The Optisolis range is also supplied in the form of Chip-on-Board (CoB) emitters which have a maximum luminous output of 3,200lm at a junction temperature of 85°C. The Optisolis emitters are available in versions with a correlated color temperature ranging from 2700K or 6500K.

ENERGY **INDUSTRIAL** **LIGHTING** MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Museum lighting
- Art galleries
- Hospital lighting
- Color evaluation
- Commercial lighting
- Retail lighting

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New: LUXEON HL2X breakthrough raises operational light output

When it comes to white light sources for illumination, light output and efficiency have long been the first two criteria of product selection. Though many quality of light factors are important, light output and efficacy are still the starting point for product evaluation.

In the mid-2000s, Lumileds introduced hot testing at 85°C. It simply made sense to evaluate the light output and efficiency at operating temperature, not at a laboratory specification which is not easily replicated in the real world. Now, with the introduction of the LUXEON HL2X LED, Lumileds is resetting the way the industry measures and evaluates light output from an optical perspective, emphasizing a new measure: usable lumens.

It turns out that in many cases, not all the light produced from an LED, even at operating temperature, can be used in the application. For instance, an LED might produce 300lm at 85°C, but optically, because of the native radiation pattern, only 270lm are available to illuminate the target.

Enter LUXEON HL2X

LUXEON HL2X is a 2mm² CSP high-power emitter intended for outdoor and industrial applications such as streetlights and high-bay luminaires. Development of this new LED started with consideration of the application challenges faced by luminaire engineers, whose priority is in-application light output.

No other LED in this segment provides as many usable lumens as the LUXEON HL2X. By giving special attention to beam angle, field angle, color over angle and optical efficiency, Lumileds has paved a new path for evaluating LED performance based on usable light in the application.

To support design implementation using the LUXEON HL2X, Future Lighting Solutions (FLS) offers optical systems expertise and a portfolio which enables it to work with luminaire manufacturers to optimize their outdoor and industrial luminaires for visual and optical performance. Lumileds recommends working closely with the FLS team to ensure that you achieve the greatest value from your LED selection.

We think that, on evaluation, you will find that LUXEON HL2X delivers superior results.

LUXEON HL2X Quick Facts

- Typical lumen output: 317lm at 700mA, 85°C
- Typical efficiency: 160lm/W
- Color over angle: 45pts
- Light under horizon: less than 0.1%
- Industry-standard 3535 three-stripe footprint

LUMILEDS

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Standard base connector for streetlights includes vent to minimize condensation

TE connectivity

TE Connectivity's (TE) LUMAWISE Endurance S base connector for LED luminaires has an integral vent to minimize condensation in outdoor lamps exposed to cold ambient temperatures.

Endurance S base: Compatible with Zhaga Book 18

The vent maintains the enclosure's sealing while providing pressure equalization inside the sealed base assembly. The base's diameter is 80mm.

Compatible with the Zhaga Book 18 specification, the LUMAWISE Endurance S connectors consist of a standard receptacle interface on the lighting fixture and the base and dome components which combine to house a control module. The IP66-rated receptacle assembly, base and dome combinations provide a sealed electrical interface between new slim LED streetlights and their associated sensor modules.

Use of the LUMAWISE Endurance S base with vent enables the luminaire manufacturer to extend product life in harsh environments.

The IK09 assembly is resistant to strong impacts. The base may be mounted upwards, downwards or facing sideways.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Street and area lighting
- Sensor-ready control applications
- Outdoor luminaires
  - Wall packs
  - Parking lots
  - Walkways
- Photo-control units
- Central management systems
- City management system
- Occupancy sensor modules

FEATURES

- 1.5A/30V contact rating
- 10kV dielectric withstand voltage
- Secure, low-torque mating of base and receptacle

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Flexible 12-channel LED driver for cars' rear lights eases production of novel visual effects

STMicroelectronics' new ALED1262ZT 12-channel LED driver for automotive rear combination lamps and interior lighting offers features which support the creation of complex and innovative visual effects.

Independent 7-bit PWM dimming on all channels allows for the flexible control of tail, brake and turn lights which produce dynamic effects. Each channel supplies a constant output current at 19V to drive strings of LEDs in series. Adjustment of the output current between 6mA and 60mA provides a wide dimming range, and high maximum brightness.

The LED lighting driver responds to I²C commands from a host microcontroller. It provides two pre-programmed configurations which enable stand-alone operation for extra flexibility.

The ALED1262ZT gives reliable and stable operation and a long lifetime in automotive applications, offering diagnostic and protection features including open-LED detection and an over-temperature warning to trigger thermal shut-down.

A wide input-voltage range of 5.5V to 38V enables use in systems which are connected directly to the vehicle's battery. The ALED1262ZT includes features to minimize electro-magnetic emissions, including a slow turn-on/-off time at each channel, and a spread-spectrum clock.

The driver is supplied in a 24-lead, 6.4mm x 7.8mm thermally-efficient SSOP package.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Vehicle rear lights
- Automotive interior lighting

FEATURES

- Current programmable via a single external resistor
- 7-bit PWM local brightness control
- Stand-alone and bus-driven modes
- Wired-OR error flag connection

FREE DEVELOPMENT BOARD

The STEVAL-LLL002V1 evaluation kit's main board features a matrix of 48 red LEDs driven by four ALED1262ZT LED drivers. An A7986A DC-DC converter provides the board's power supply.

Orderable Part Number: STEVAL-LLL002V1

Apply at: www.my-boardclub.com

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LED driver generates very low distortion in energy-saving lighting applications

The new HVLED007 AC-DC LED driver IC from STMicroelectronics achieves very low Total Harmonic Distortion (THD) across a wide range of load conditions by implementing Input-Current Shaping (ICS), a technique which helps energy-saving LED luminaires to comply with new, more stringent lighting regulations.

The HVLED007 is a current-mode PFC controller for use with isolated, quasi-resonant flyback converters operating directly from a rectified mains supply. The ICS function shapes the input as a sinusoidal waveform, resulting in very low Total Harmonic Distortion (THD) over the full load and input-voltage range: THD is below 5% at full load. The controller also produces a power factor of close to unity. Maximum energy efficiency is higher than 90%.

These capabilities mean that the HVLED007 provides designers of LED luminaires with a single control IC to support multiple medium- and high-power LED-lighting applications for loads up to 80W.

The totem-pole output stage can source 600mA and sink 800mA, enabling use in EN61000-3-2-compliant switched-mode power supplies supporting loads up to 100W, as well as in lighting circuits.

FREE DEVELOPMENT BOARD

The EVLHVLED007W35F provides a stable and isolated 48V output suitable for secondary-side circuits supplying a maximum output of 35W from a wide input-voltage range of 90V to 265V AC. Power factor is higher than 0.98 with a 230V AC input. An auxiliary 12V output can supply small circuits drawing a maximum current of 15mA.

Orderable Part Number: EVLHVLED007W35F

Apply at: www.my-boardclub.com

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- AC-DC LED drivers for domestic, commercial and industrial lighting
- Street lighting
- EN61000-3-2-compliant switch-mode power supplies

FEATURES

- Control input for isolated feedback and optocoupler driving
- Output over-voltage protection
- Overload and short-circuit protection
- ≤60µA start-up current
- ≤4mA quiescent current
- Digital leading-edge blanking on current sense
- Junction-temperature range: -40°C to 150°C

EVLHVLED007W35F

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Power LEDs produce high brightness for outdoor and area lighting fixtures

SEOUL SEMICONDUCTOR

The Z Power Z5-M4 series of LEDs from Seoul Semiconductor is ideal for applications which draw a high current to produce a high-intensity light output.

The Z5-M4 LEDs feature a state-of-the-art Wicop chip surface-mount package made from a material which offers low thermal resistance. This eases thermal management, and can enable luminaire manufacturers to reduce the size of the heat-sink in their application.

The 3.5mm x 3.5mm package also gives the LEDs very high reliability because it has no bond wires.

Z5-M4 power LEDs are an ideal light source for directional lighting applications such as spotlights, outdoor lighting, automotive lights and high-performance torches. Their high maximum current capability of 2A and maximum forward voltage of 2.95V at a junction temperature of 85°C make them suitable for use in high-power fixtures. Luminous flux is a maximum of 355lm at a forward current of 700mA.

Correlated color temperature options are 2700K, 3000K, 3500K, 4000K, 5000K, 5700K and 6500K.

Z5-M4 Wicop chip: Improved thermal management offers a reduction in heat-sink size

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Architectural lighting
- Industrial lighting
- Area lighting
- Exterior lighting
- Commercial lighting

FEATURES

- Minimum 70 CRI
- High efficacy
- ANSI-compliant binning
- Ceramic package based on Wicop technology
- 150°C maximum junction temperature

Wicop

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REFERENCE NUMBER 20-iii 30

Mid-power LEDs in standard package footprint offer wide range of options

SEOUL SEMICONDUCTOR

The 3528 series of mid-power white LEDs from Seoul Semiconductor offers highly reliable operation over a long lifetime, and resists the effects of corrosive agents.

The LEDs' substrate is made of a molded plastic reflector on top of a leadframe. The die is attached within the reflector cavity, and the cavity is encapsulated by silicone. The benefit of this package design is highly reliable operation over a long lifetime.

Seoul Semiconductor also offers a coated version to increase resistance to corrosive agents.

The 3528 series LEDs are available in cool-white, neutral-white and warm-white versions at correlated color temperatures of 2700K, 3000K, 3500K, 4000K, 5000K, 5700K and 6500K. The minimum luminous flux produced by the 4000K variant is 35.2lm.

Typical efficacy is as high as 210lm/W at a drive current of 65mA.

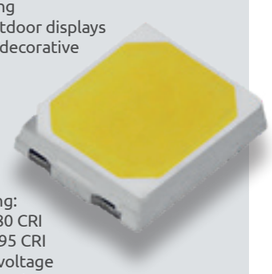
The LEDs are supplied in a standard 3.5mm x 2.8mm package footprint, and are just 0.7mm high.

Seoul Semiconductor's 3528 series LEDs: A coated version is resistive to corrosive agents

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Interior lighting
- General lighting
- Indoor and outdoor displays
- Architectural/decorative lighting



FEATURES

- Color rendering:
  - Minimum 80 CRI
  - Maximum 95 CRI
- 2.7V forward voltage
- 120° viewing angle

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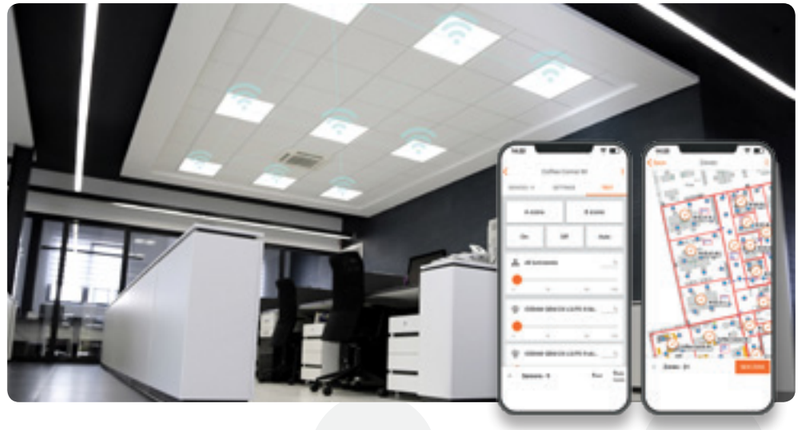
REFERENCE NUMBER 20-iii 31

New wireless control architecture offers easy way to make office lighting intelligent

OSRAM

OSRAM has launched the HubSense® technology, a flexible, wireless lighting infrastructure which transforms the way that radio-based lighting controls are commissioned and configured in existing lighting installations.



The HubSense system is simple and intuitive to use. This easily scalable, retrofit solution makes the planning, configuration and commissioning of wireless lighting control easier than ever. It spans the entire process of implementing radio lighting controls, from convenient planning with a web app, to commissioning via a mobile device app, to simple operation of the system in discrete rooms, corridors, conference rooms or open-plan offices.

The HubSense® Commissioning Tool is used to commission luminaires which contain OSRAM QBM components. The lighting control architecture is based on the Bluetooth® wireless mesh networking protocol. The system supports the EASYFIT EnOcean batteryless wireless switches.

Advantages of the HubSense wireless lighting control architecture are:

Intuitive planning and commissioning
- Creation and pre-commissioning of the project in advance via web app
- On-site commissioning by multiple installers concurrently
- Pre-defined lighting control profiles for office applications
- Easy luminaire localization and zone assignment via mobile app

Fast and flexible installation
- Suitable for existing infrastructures regardless of building layout and materials
- System quickly adaptable to new space usage and conditions
- No gateway required

Sustainable investment
- Three-level safety scheme
- Scalability
- Network interoperability verified by an independent organization

Rewarding project business
- Better payback time than purely switchable lighting solutions
- Higher potential for energy savings because of support for daylight control and presence detection
- Flexible adaptation of lighting controls to various project requirements

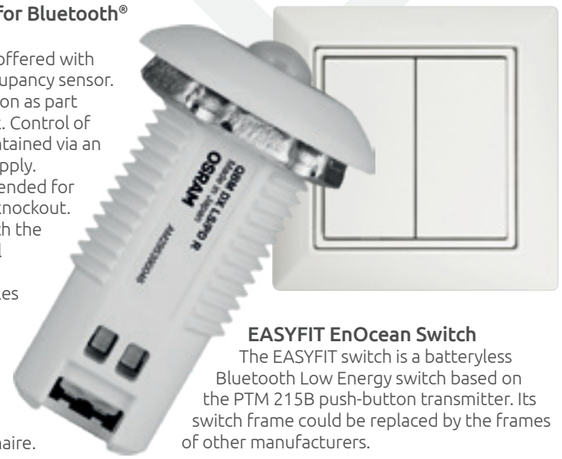
Products compatible with the HubSense lighting control architecture

DEXAL module qualified for Bluetooth® mesh networking

OSRAM DEXAL modules are offered with or without a daylight and occupancy sensor. They are qualified for operation as part of a Bluetooth mesh network. Control of DEXAL or DALI drivers is maintained via an additional DALI bus power supply.

The DEXAL modules are intended for installation in a standard ½" knockout. They are compatible with both the HubSense and DEXAL control technologies.

Compact, the DEXAL modules provide freedom to shape the design of a luminaire's enclosure, and are easy to integrate. When combined with DEXAL drivers, the modules reduce the amount of internal wiring in the luminaire.



EASYFIT EnOcean Switch

The EASYFIT switch is a batteryless Bluetooth Low Energy switch based on the PTM 215B push-button transmitter. Its switch frame could be replaced by the frames of other manufacturers.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Office lighting
- Conference rooms
- Lighting for public areas
- Stairway lighting

OSRAM HubSense-compatible products are certified for sale in Europe and the Middle East

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REFERENCE NUMBER 20-iii 32

Dev kits provide for easy integration of ready-made four-sensor modules

TE Connectivity's (TE) AmbiMate Sensor Module development kits allow a developer, with use of downloadable code, to connect to either a Raspberry Pi or Arduino development platform and start collecting sensor data within 30 minutes.

AmbiMate sensor module: Supplied as a ready-to-attach PCB

The AmbiMate MS4 sensor module series provides an application-specific set of sensors on a ready-to-attach PCB assembly for easy integration into a host product. Use of the AmbiMate module frees up design resources and accelerates time-to-market, providing a ready-made solution with four core sensors for motion, light, temperature and humidity measurement.

Additional options in the MS4 series include a Volatile Organic Compounds (VOC) sensor for air-quality monitoring, an equivalent carbon dioxide (eCO_2) sensor of occupancy detection, and a microphone for sound detection.

Kit Part Number	AmbiMate Part Number	Four Core Sensor Functions	VOC Sensing	eCO_2 Sensing	Microphone
2331211-1	2314277-1	Yes	–	–	–
2331211-2	2314277-2	Yes	–	–	Yes
2331211-3	2314291-1	Yes	Yes	Yes	–

All MS4 series sensor modules offer the flexibility of a common seven-position connection. This allows the designer to layout a single PCB footprint accommodating all the available sensor configurations in production.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Indoor lighting
- Building automation
- Connected home
- Air quality
- Energy management
- Workspace comfort controls
- Zonal environmental controls

FEATURES

- 3.3V DC input
- I²C interface
- Interrupt-driven Event pin for motion detection

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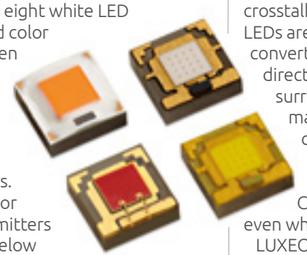
Color LEDs produce higher punch than any other undomed LED

Lumileds' LUXEON CZ Color Line LEDs produce as much as 48% more 'punch', or higher intensity from a smaller Light Emitting Surface (LES), than competing color LEDs supplied in an undomed package style.

The LUXEON CZ Color Line products are intended for use in color-tuning fixtures which have a narrow beam angle and require high punch. The line consists of 21 LED color options: 13 color options, and eight white LED versions at correlated color temperatures between 2200K and 6500K.



The LUXEON CZ Color Line provides exceptional optical design flexibility to fixture manufacturers. Unlike competing color LEDs, the LUXEON emitters cast very little light below the horizon, which means that optics can collect more of the emitted light even in designs which have a narrow beam angle. In a narrow-beam system, the intensity of the light from the LUXEON CZ LEDs is 30% to 50% higher than with other undomed LEDs.

The intensity of light from each color version is similar, ensuring a consistent beam width, and minimizing halos when color mixing.

The LUXEON CZ products also eliminate crosstalk, which can occur when direct color LEDs are closely spaced with phosphor-converted LEDs. The photons from the direct colors can excite the phosphor in the surrounding phosphor-converted LEDs, making it appear as if the phosphor-converted LEDs are on, when in fact only the direct color LED is illuminated.

By eliminating crosstalk, the LUXEON CZ products maintain a true color point even when LEDs are packed closely together.

LUXEON CZ products have a low thermal resistance of between 3.2°C/W and 4°C/W, and feature an isolated thermal path, allowing for easier thermal design. Alternatively, designers have the freedom to raise the drive current to get more light output than in competing color LEDs without affecting system efficiency.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Spotlights
- Wall washers
- Floodlights
- Landscape lighting
- Architectural lighting
- Entertainment lighting
- Dimmable lamps and fixtures
- Emergency vehicle lighting

FEATURES

- Color options: far red, deep red, red, red-orange, amber, phosphor-converted amber, mint, lime, green, cyan, blue, royal blue, violet
- Footprint-compatible with LUXEON C LEDs
- Single focal length across all LUXEON C and CZ LEDs

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Bluetooth Low Energy module supports mesh networking for smart lighting control

The PAN1780 from Panasonic is an integrated Bluetooth® Low Energy wireless module which includes a microcontroller core and generous memory provision for running the host application as well as multiple radio protocols.

Offering Bluetooth mesh networking capability and connectivity to smartphones, the PAN1780 eliminates the need for a dedicated gateway to control lighting systems. This provides a simple implementation of smart lighting control and means that there is no risk of system malfunction caused by a single point of failure.

In addition, the PAN1780 provides the capability to perform software updates over-the-air, and has enough processing power to perform edge-computing functions.

Fully compliant with the standard Bluetooth 5.0 specifications, the PAN1780 also supports the IEEE 802.15.4 and NFC-A radio technologies. When used in other types of applications, the new advertising extensions in the Bluetooth Low Energy specification allow for much larger amounts of data to be broadcast in connectionless scenarios.

Featuring an Arm® Cortex®-M4F processor core, the PAN1780 provides 256kbytes of RAM and 1Mbyte of Flash memory.

This means that it can easily be used in stand-alone mode, eliminating the need for an external processor. This reduces the complexity of the board design, saves space and reduces system cost.

Based on the Nordic nRF52840 single-chip radio controller, the PAN1780 offers a data-transfer rate of 2Mbits/s via its built-in high-speed radio transceiver. Sensitivity is -95dBm at 1Mbit/s and -103dBm at 125kbits/s. Output power is configurable up to a maximum of 8dBm.

The PAN1780's surface-mount package measures 15.6mm x 8.7mm x 2.0mm. Its outline is the same as that of the Panasonic PAN1026A and PAN1762 radio modules.

Smart Lighting: A versatile, safe and secure way to implement lighting control

Smart home devices such as the Amazon Echo or Google Home controllers are growing in popularity. These audio devices which connect to a smartphone are particularly common in North America and Europe.

Comfort and convenience are usually the main reasons for installing such smart home devices. But other factors can also play a role: intelligent door locks or smart meters can enhance the residents' safety and control. For instance, by monitoring daily energy consumption, emissions and costs can be substantially reduced.

All these aspects – safety, comfort and control – apply particularly strongly to home lighting. Efficient and versatile LED lighting solutions are more than just a replacement for the classic light bulb. Since the power consumption of LED lighting devices is much lower and their lifetime is much higher than that of old-fashioned light bulbs, the benefits of LED lighting are obvious.

Now, analysts predict that close to one third of all households in Europe will be using smart home applications by the end of 2023. Applications for entertainment, heating and cooling as well as smart locks and smart lighting are expected to be the most popular.

The introduction of the Bluetooth 5.0 specification for Bluetooth Low Energy connectivity opens up a new set of applications. The key new features of Bluetooth 5.0 are a higher data rate and very low energy consumption, alongside the availability of Bluetooth mesh networking. In the PAN1780 Bluetooth Low Energy module, this is complemented by ZigBee® and Thread, wireless technologies which are also used in lighting control applications.

Once connected, LED lighting installations have the potential to carry other control signals and sensor data. Because lighting is almost everywhere in every building, it is the perfect medium for sharing data on parameters such as temperature or humidity around a building.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Smart homes and buildings
  - Lighting controls
  - Building automation
  - Smart locks
  - Metering
- Medical devices
  - Smart health equipment
  - Secure medical peripherals
- Industrial IoT
  - Smart city infrastructure
  - Industrial mesh networks
  - Robotics

FEATURES

- Arm TrustZone® CryptoCell® 310
  - Supports secure boot including root-of-trust capability
- 4.8mA Transmit current at 0dBm output power
- 4.8mA Receive current at 1Mbit/s
- Up to 48 general-purpose I/Os
- USB 2.0 Full-Speed interface
- Supply-voltage range: 1.7V to 5.5V
- Operating-temperature range: -40°C to 85°C
- Temperature sensor

FREE DEVELOPMENT BOARDS

Orderable Part Numbers:
ENW89854AXKF (Dongle)
ENW89854AWKF (Dongle Kit)

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TECHNICAL VIEW FUTURE ELECTRONICS

Machine learning: the knowledge and skills gaps that developers must bridge

New skill sets will be in demand as embedded developers work on artificial intelligence projects

By Future Electronics

The most loudly heralded breakthroughs in machine learning and the wider domain of Artificial Intelligence (AI) have been made by the computer science community. From autonomous driving to computers which beat chess grand masters, the best known achievements in AI have depended on the deployment of massive computing resources: for example, arrays of ultra high-speed, high-power Graphics Processing Units (GPUs) running millions of lines of code.

With less fanfare, embedded device designers are beginning to bring the benefits of AI to edge devices that impose much tighter constraints than computer scientists face: embedded devices provide orders of magnitude less processor bandwidth and memory than the data centers running large-scale AI applications.

Despite the difference in the hardware resources available to them, embedded engineers today are largely using development processes, tools and frameworks which originated in the world of computer science. This means that the AI development process can appear overwhelming to electronics engineers who have previously used Integrated Development Environments (IDEs) targeted at embedded hardware components such as microcontrollers or FPGAs. AI projects also call for the deployment of skills and knowledge, such as the acquisition, selection and curation of a training data set, which they never needed before in conventional electronic system developments.

But as this article describes, semiconductor manufacturers are starting to extend their products' capabilities and their tool chains to support the requirements of embedded AI projects.

Interestingly, native embedded approaches to machine learning are also emerging which strip out much of the complexity in AI software, eliminating the need for computer science know-how.

Neural networking introduces a new development workflow

As illustrated in Fig. 1, the basic process of machine learning consists of just two stages: training the neural networking model, the 'training phase'; and deploying this neural network on a target device, 'the inference phase'. In an embedded environment, this target device will most often be a local or 'edge' device based on a microcontroller, an applications processor or an FPGA.

So far, so simple, it seems. But within each phase are various development tasks which are unfamiliar to an embedded developer who has no previous experience in machine learning. NXP's diagram, Figure 2, outlines the tasks within each part of the workflow.

Fig.1: The two phases of every machine learning development project. (Image courtesy of NXP Semiconductors.)

Read this to find out about:

- The training and inference phases of a machine learning development project
- The terminology and jargon commonly used by providers of machine learning technology
- The features of the tools and design environments for machine learning development provided by MCU and FPGA manufacturers

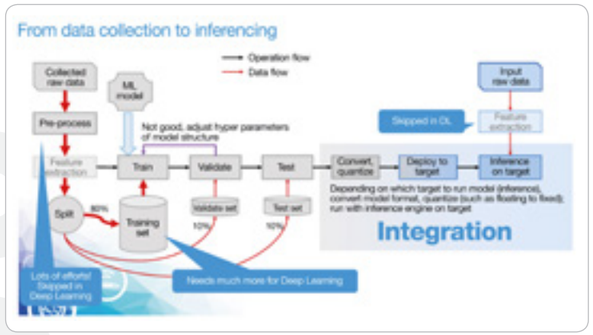
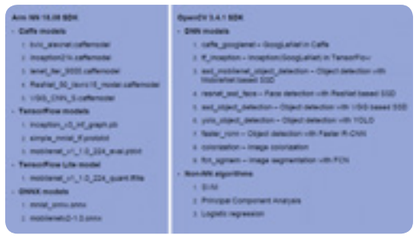


Fig. 2: The basic workflows in an embedded machine learning development. (Image courtesy of NXP Semiconductors.)

Not only is the process itself new to the embedded engineer, so too is much of the technology, terminology and jargon. Before training a neural network, for instance, the developer will need to decide which kind of network is most appropriate for the application. Convolutional Neural Network (CNN) models are widely used for image recognition applications, while a Finite State Machine (FSM) might be appropriate for recognizing patterns in time-series data. A basic catalogue of neural networks hosted at towardsdatascience.com lists more than 25 types.

For each neural network type, there are often hundreds of algorithms optimized for specific functions. These software elements tend to have their own jargon which can be hard for the first-time user to interpret. NXP's list of neural networking models, shown below, supported by its eIQ enablement tool provides examples of neural network algorithms.



None but the largest embedded development teams will have the time and resources to educate themselves on all the key aspects of machine learning before beginning their first AI project. For smaller development teams, there is an alternative: component manufacturers such as NXP and Lattice Semiconductor have developed production-ready reference design hardware and software for applications such as people detection, people counting and speech recognition. QuickLogic also provides a low-power sound detector solution and a speech-recognition solution running on its QuickAI™ platform. These provide the easiest and quickest introduction to machine learning. Lattice even provides its training data sets to enable OEMs to modify the neural networking model contained in each reference design.

Training phase: expert help available from Future Electronics

If the intended application is not supported by a ready-made reference design, the OEM will need to implement the training and inference processes. Of the two phases, the inference phase is the more familiar to embedded developers: essentially, this involves taking a trained model and compiling it for a specific hardware target, such as an i.MX RT crossover microcontroller from NXP, an STM32F7 MCU from STMicroelectronics or QuickLogic's QuickAI platform.

To a greater or lesser extent, the suppliers of these hardware devices provide development tools which make the process of compiling a trained model to target hardware reasonably intuitive and straightforward. NXP, for instance, provides the eIQ enablement tool for its MCUs and applications processors. The eIQ tool supports TensorFlow Lite, Arm® NN, OpenCV and other inference engines. Likewise, ST supplies the STM32Cube.AI tool for converting a neural network into optimized code for specific STM32 MCU parts.

The big difference from a standard embedded development workflow is in the training phase. In a typical MCU development project, the code base for an entire application may be created within a single IDE such as IAR Embedded Workbench or Keil MDK.

In a machine learning project, however, the training phase is not supported within an MCU's, processor's or FPGA's development environment: the embedded engineer is thrown into new territory.

Referring to the NXP workflow diagram above, each stage of the process calls for specialist know-how and techniques. Engineers preparing a training data set for the first time will have much to learn about how to collect raw data, how to label and curate it, how to extract features and so on before submitting it to a model training framework such as TensorFlow Lite, Caffe or Keras. Likewise, each of these frameworks has its own process flow, user interface and data protocols.

There is abundant documentation available online for embedded engineers to study. But no matter how much an engineer has prepared in theory, there is no substitute for getting their hands dirty with a prototype project. In the early stages of a project, developers can gain a huge amount from the advice and guidance of machine learning experts.

This is where Future Electronics has much to offer: its large team of branch-level field applications engineers is supplemented by specialists in high-demand technology areas, of which machine learning/AI is one. Regional Advanced Engineer Specialists in AI are dedicated to this field, and are on hand to guide OEM developers, either up-front in planning a new development project, or during a project to help solve particular problems.

Through the regional Centres of Excellence, an OEM can even outsource part or all of a design project to Future Electronics, providing a complete turnkey solution for machine learning.

An AI toolkit built for the embedded world

As previously described, most of the tools and frameworks supported by MCU, processor and FPGA manufacturers are derived from the computer science world: they are large, sophisticated, highly capable and difficult to learn in a short period of time.

This is why the approach taken by SensiML, a subsidiary of programmable system-on-chip manufacturer QuickLogic, is different and interesting. SensiML, which has its roots in a division of Intel, created its SensiML Edge AI Software Toolkit to provide a complete, end-to-end environment in which embedded developers could be instantly productive, see Figure 3.

According to SensiML, its Edge AI Software Toolkit 'enables developers to build intelligent sensing devices in days or weeks without data science or embedded firmware expertise'. It can be used to develop applications

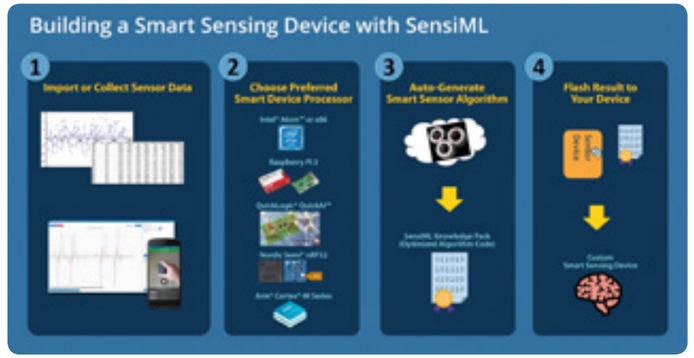


Fig. 3: The simple machine learning workflow provided by SensiML. (Image courtesy of QuickLogic)

such as industrial machine predictive maintenance, activity monitoring in consumer wearable devices, livestock monitoring in smart agriculture, and traffic analysis for retail stores.

The process shown in Figure 1 breaks the development down into a training phase (steps 1-3) and an inference phase (step 4). But the difference, according to SensiML, is that it is fast, intelligent and complete.

- It calls for no hand-coding, but generates code automatically
- It requires no expertise in data pre-processing, all the developer has to do is collect data samples. The toolkit includes the SensiML Data Capture Lab module to support data capture.
- It automates the entire process, from collecting the training data through to the generation of a trained algorithm.

Because the SensiML toolkit was designed for embedded engineers, it does not assume that the output has to be a complex neural network model. For applications that generate time-series data, such as predictive maintenance or personal activity monitoring, a simpler algorithm type such as a classifier is often superior to a neural network. This simpler algorithm is not only easier to generate, modify and refine. It also requires fewer resources in the target hardware, enabling the OEM to build a project around a low-power target such as an Arm Cortex®-M core-based MCU or QuickLogic's own QuickAI programmable platform, whereas a more complex neural network model might typically require an applications processor or mid-density FPGA.

A helping hand as new resources emerge

Machine learning is such a new phenomenon in the embedded world that the offerings from different manufacturers have not become standardized, and there are today wide differences in the scope of the support provided by different suppliers' toolchains for AI projects.

While SensiML provides the most comprehensive toolkit, the environments and services provided by manufacturers such as ST and NXP for MCUs and processors, as well as Lattice and Microchip Technology for FPGAs, support a growing number of the popular training frameworks and provide optimized compilation performance for their own products.

And where a gap between third-party frameworks and the semiconductor manufacturers' tools has to be bridged, specialist experts at Future Electronics are on hand to provide guidance, know-how and hands-on assistance.

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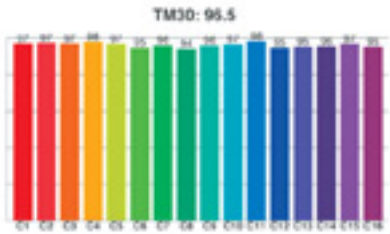

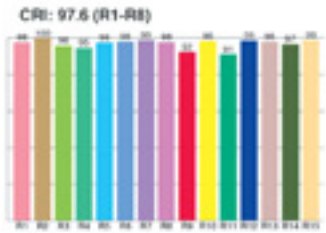

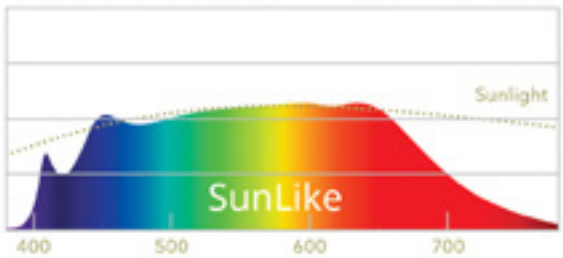

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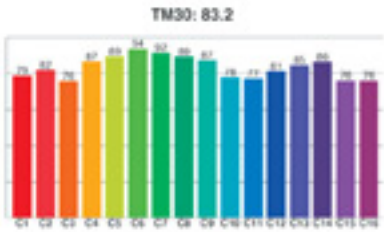

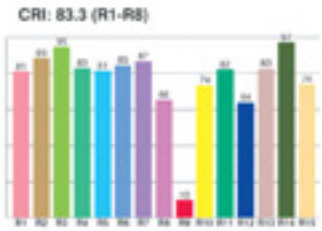

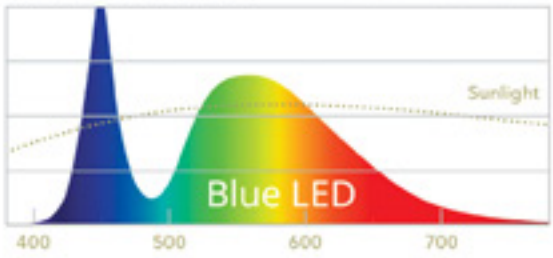

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