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LIGHTING
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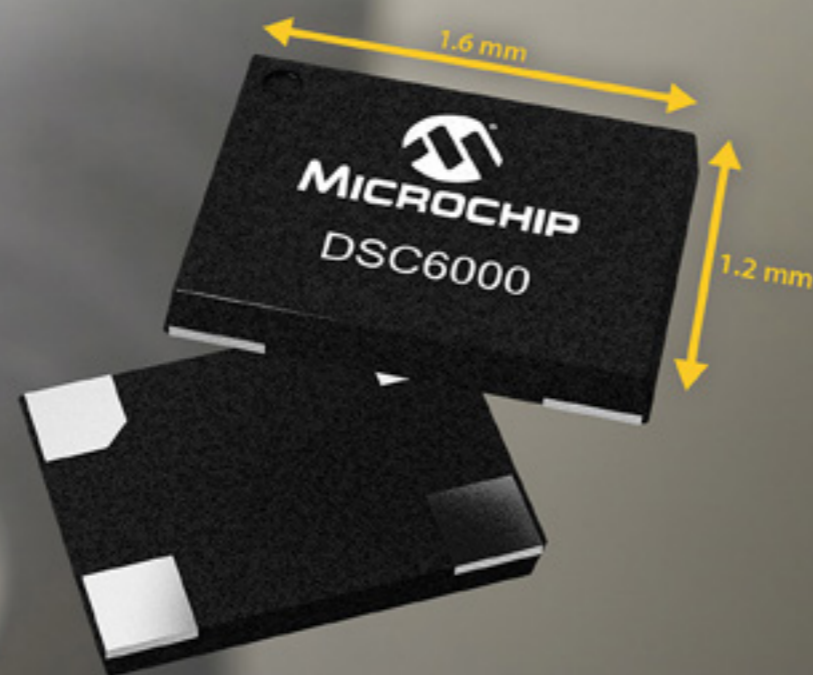
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MICROCHIP



Industry's smallest MHz oscillator offers high stability and very low power consumption

Microchip has enhanced its DSC6000 family of miniature low-power MEMS oscillators, which provide any frequency from 2kHz to 80MHz. The new DSC60xxB series of products offers improved jitter performance and a wider temperature range than earlier DSC6000 parts.

The single-output DSC6000B MEMS oscillators are notable for their small size and ultra-low power consumption. The oscillator's active current is just 1.3 mA, and it draws 1.5µA in stand-by mode.

The DSC6000B Family is available in three package options: the land-grid array packages are supplied with a footprint of 1.6mm x 1.2mm, 2.0mm x 1.6mm, or 2.5mm x 2.0mm. These packages are drop-in replacements for standard four-pin CMOS quartz crystal oscillators, giving manufacturers a simple way to replace a legacy crystal oscillator with a more reliable MEMS device without the need to redesign their board.

The robust MEMS construction of the DSC6000B family gives the products a mean time to failure some 20 times longer than that of a typical quartz oscillator. The Microchip oscillators are also qualified to MIL-STD-883, demonstrating their excellent immunity to shock and vibration.

This combination of attributes means that the DSC6000B MEMS oscillators are excellent clock

references in small, battery-powered devices in which small size, low power consumption, and long-term reliability are important requirements.

The new DSC6000B products also offer exceptional frequency stability and improved jitter performance. Microchip offers three stability options in the DSC6000B range: ±20ppm, ±25ppm, and ±50ppm, including both temperature and voltage drift. Cycle-to-cycle jitter is as low as 90ps.

Optional features in the DSC6000B family include three levels of output drive, a choice which gives the designer the flexibility to optimize signal integrity and minimize the effects of EMI in their application.

The designer can also choose from four temperature-range options:

- Automotive: -40°C to 125°C
- Extended industrial: -40°C to 105°C
- Industrial: -40°C to 85°C
- Extended commercial: -20°C to 70°C

The DSC6x2xB oscillators also offer a Frequency Select pin which allows the user to switch between two output frequencies.



APPLICATIONS

- IoT devices
- Wearable electronics
- Home healthcare equipment
- Fitness monitoring devices
- Home automation equipment
- Industrial systems:
 - Building/factory automation
 - Surveillance cameras

FEATURES

- Supply-voltage range: 1.71V to 3.63V
- LVCMOS output logic
- Output-frequency range: 2kHz to 80MHz
- 144ps peak-to-peak period jitter at an output of 27MHz
- 150°C maximum junction temperature

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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.

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.

- 100Mbps/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.



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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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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Embrace Process Driven and Quality Assurance for Exceptional Products
 Design exceptional products through rigorous processes and quality assurance



Partnership / Continuity
 Develop a partnership with Future Electronics to ensure continuity and success



Low-cost wire-to-board connectors offer high current capability



TE Connectivity's (TE) Economy Power and Economy Power II wire-to-board connectors are widely used in power circuits which have a large current-carrying capacity.

The Economy Power series of connectors is rated for a continuous current of up to 7.5A. In the Economy Power II series, this maximum current value rises to 11A.

Terminal Position Assurance (TPA) devices are available in the Economy Power II connector series. TPAs ensure that the contacts are fully seated in the housing. This helps to avoid downtime and costly service calls to repair equipment failures that are due to a backed-out contact. In addition, a latch helps to prevent unintended disconnection.

TE also offers Economy Power II Glow Wire connectors in many different styles and configurations to meet safety and environmental requirements set by the home appliances industry. Several connector housing and header styles and configurations are available in Glow Wire compatible material which also conforms to UL 94 V-0 specifications.

The use of Glow Wire test-compliant components can allow users to reduce the time and expense of end-product testing associated with the Glow Wire ignition and Glow Wire flammability index.



- APPLICATIONS**
- Household appliances
 - Industrial machinery
 - Lighting
 - HVAC equipment
 - Commercial and building equipment
 - Vending machines
 - Coin changers

- FEATURES**
- 3.96mm, 5.08mm and 7.92mm centerline options
 - Voltage rating:
 - 250V AC for Economy Power range
 - 600V AC for Economy Power II range
 - Wire-to-board, shrouded and unshrouded header configurations
 - Operating-temperature range:
 - -25°C to 105°C for Economy Power range
 - -55°C to 105°C for Economy Power II range
 - Models available that comply with GWEPT 750°C and UL94 V-0 flammability standards
 - UL recognized

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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



- 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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New digital LED driver IC produces high system efficiency and reliability



Infineon Technologies has extended its XDP™ portfolio of LED driver ICs with the XDPL8218, a constant voltage-output flyback converter IC which maintains a high power factor across a wide input-voltage and output-load range.

The XDPL8218 driver integrates a quasi-resonant digital flyback controller with algorithms which regulate the power factor and maintain low Total Harmonic Distortion (THD). The XDPL8218 is intended for use in two-stage designs, with a DC-DC converter on the secondary side and the XDPL8218 on the primary side.

The LED driver operates in multiple modes to enable optimization of efficiency and speed of response. At full loads, it operates in quasi-resonant mode, in discontinuous-conduction mode at medium power, and in active burst mode at low power to maintain high efficiency over the full output-power range. The XDPL8218 handles a wide range of loads and reacts fast and predictably to dynamic load changes.

The device includes embedded digital filters which reduce noise, as well as programmable blanking times for signal measurements.



The device's digital parameter configuration allows real-time changes to system designs. This, coupled with easy-to-use development tools, shortens the product development time and cuts time-to-market. The

XDPL8218 may also be used to implement custom LED driver designs, and simplifies the generation and maintenance of multiple product variants while avoiding the need to hold multiple driver stock-keeping units.

The XDPL8218 includes an isolated auxiliary 20mA power output which may be used to supply external devices. It implements an adaptive temperature guard which protects the driver hardware from thermal stress.



APPLICATIONS

- General lighting

FEATURES

- Input-voltage range:
 - 100V to 277V AC
 - 127V to 430V DC
- >0.9 power factor
- <15% THD
- <100mW standby power
- Under-voltage protection
- Over-voltage protection
- Open-load protection
- Output short-circuit protection

FTM DEVELOPMENT BOARD

The REF-XDPL8218-U40W reference design board demonstrates the XDPL8218 driving a 40W LED lighting load with a replaceable feedback circuit.

Orderable Part Number: REF XDPL8218U40WTOBO1

Available at FutureElectronics.com

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



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	Output Current	Part Number	LED/CoB Size (mm)	Global Trade Item Number
350mA	2316511-1	24 x 24	9421027422100	700mA	2-2316511-1	24 x 24	9421027422186
350mA	2316511-2	20 x 24	9421027422117	700mA	2-2316511-2	20 x 24	9421027422193
350mA	2316511-3	19 x 19	9421027422124	700mA	2-2316511-3	19 x 19	9421027422209
350mA	2316511-4	16 x 19	9421027422131	700mA	2-2316511-4	16 x 19	9421027422216
500mA	1-2316511-1	24 x 24	9421027422148	1,050mA	3-2316511-1	24 x 24	9421027422223
500mA	1-2316511-2	20 x 24	9421027422155	1,050mA	3-2316511-2	20 x 24	9421027422230
500mA	1-2316511-3	19 x 19	9421027422162	1,050mA	3-2316511-3	19 x 19	9421027422247
500mA	1-2316511-4	16 x 19	9421027422179	1,050mA	3-2316511-4	16 x 19	9421027422254



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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Buck LED driver IC performs hybrid dimming down to 0.5%

The ILD8150 is an 80V DC-DC converter IC for driving high-power LEDs. In applications operating at close to the limit of Safety Extra-Low Voltage (SELV) equipment, the ILD8150 provides a high safety voltage margin.

This buck LED driver IC is for LEDs in general lighting applications operating with average drive current up to 1.5A. Several performance and protection features provide an ideal fit for professional LED lighting.

A PWM input signal between 250Hz and 20kHz controls dimming of the LED current. The ILD8150 uses innovative hybrid dimming: in the analog mode it dims from 100% to 12.5%, and between 12.5% to 0.5% it dims in PWM mode with a flicker-free modulation frequency of 3.4kHz. Analog dimming at a higher LED current is silent, producing no audible noise from the circuit's inductors and ceramic capacitors.



Features:

- Input-voltage range: 8V to 80V DC
- Maximum output current adjustable via shunt resistor
- Typical ±3% output-current accuracy
- Over-temperature protection

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Linear LED controllers provide dimming and protection functions

Infineon's BCR601 and BCR602 are linear LED controller ICs which regulate the current supplied to an array of LEDs with an external transistor. They support either NPN bipolar transistors or N-channel MOSFETs, operating over a wide LED current and power range.

The BCR601 provides feedback to the primary side via an optocoupler to control the output voltage of the primary-side converter. Direct control of the voltage feedback loop minimizes the voltage overhead and power dissipation at the external driver transistor. The LED current from the BCR601 is fully scalable and can be configured via an external resistor.

AC line ripple suppression, flexible dimming options and protection features make the BCR602 a perfect fit for LED modules which need to produce dimmable, flicker-free light and extend the life of LEDs.

Features:

- Supply-voltage range: 8V to 60V
- 10mA gate driver current
- Analog dimming down to 3%
- Hot-plug capable
- LED current regulation accurate to ±3%
- Over-voltage protection
- Over-temperature protection



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



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



APPLICATIONS

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

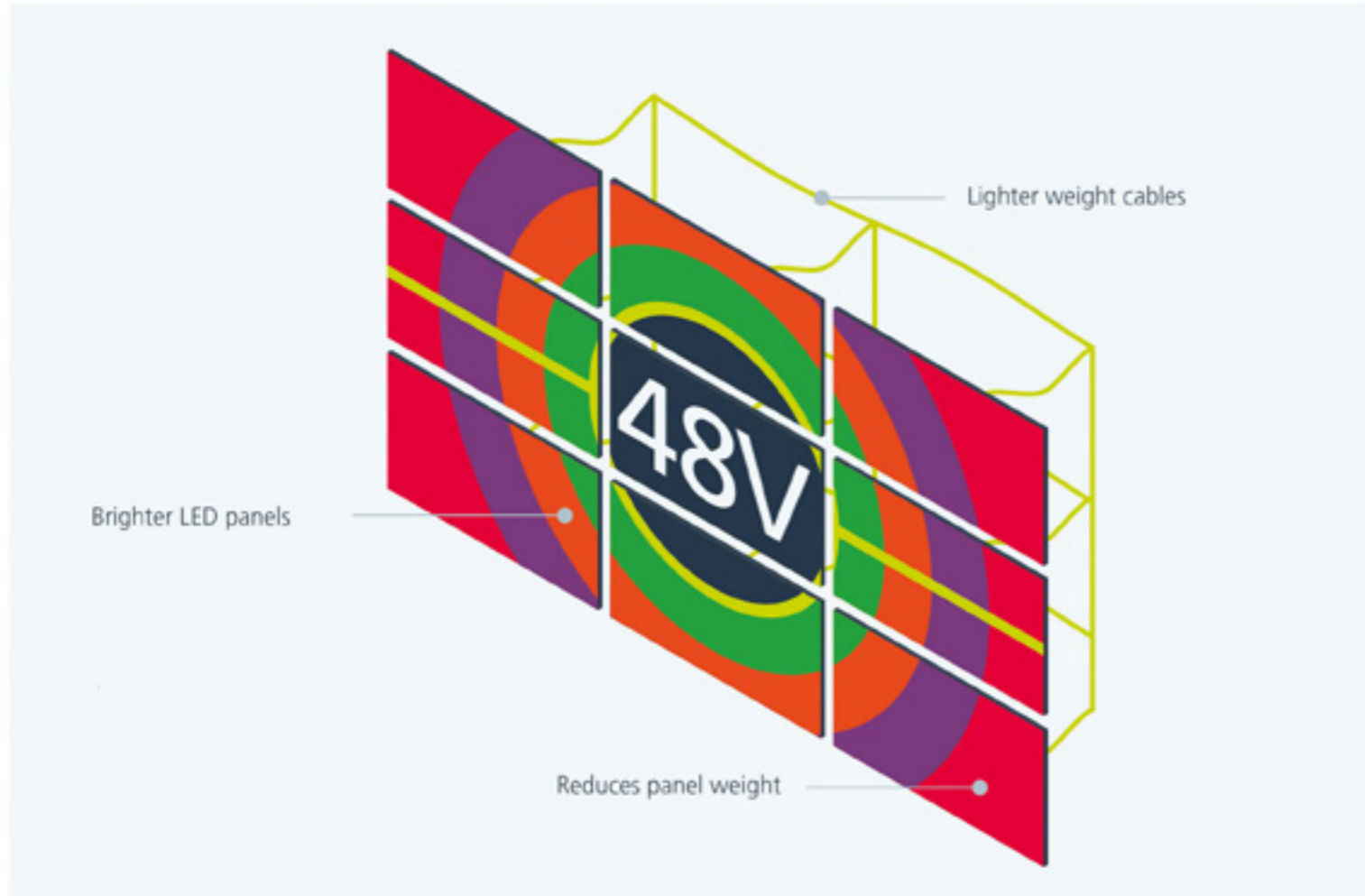


FEATURES

- 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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Delivering lighter, brighter LED panels with 48V high-density, high-efficiency converters



PI354x
ZVS buck regulators offer 48V input and 2.5V to 12V output up to 10A with efficiency >95%.
10.0 x 10.0 x 2.5mm

NBM2317
Bidirectional DC-DC converter enables 12V to 48V or 48V to 12V at 800W with 98% efficiency.
22.8 x 17.3 x 7.4mm

Learn a more efficient way to power your LEDs at vicorpower.com



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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.



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

FTM DEVELOPMENT BOARDS
Orderable Part Numbers:
LIGHTING-1-GEVK
LIGHTING-POWER-POE-GEVB
Available at FutureElectronics.com

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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, U51MFA
Lighting-Power-POE-GEVB	PoE power module for the connected lighting platform	2N7002LT1G, BC846BDW1T1G, BC846BPDW1T1G FDMQ8205A FXL6408UMX, LC03-6R2G, MM3Z5V1B MMBZ27VALT1G NCP1096PAG, NSP4201MR6T1G NSR30CM3T5G

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.



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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New CoB LEDs offer higher intensity in spotlights and downlights



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.



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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Advance Xitanium LED Drivers with ComfortFade

Now available in 30W, 40W, 50W and 75W Models

Features & Benefits

- ComfortFade Technology for Smooth Dim to Off Functionality
- Auxiliary Power Supply for Third-Party Sensors
- SimpleSet NFC Based Programming
- 1% Minimum Dim
- 0-10V Dimming
- CSA, ETL, and UL Class P
- 50,000+ Hour Lifetime*
- 5-Year Limited Warranty

Applications

- Indoor Linear
 - Troffers
 - Suspended
 - Retrofit

*Advance Xitanium LED drivers are manufactured to engineering standards correlating to a designed and average life expectancy of 50,000 hours of operation at maximum rated case temperature. Minimum 90% survivals based on MTBF modeling.

For up to date warranty information please go to <https://www.signify.com/en-us/support/warranties>



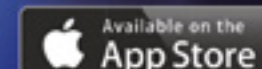
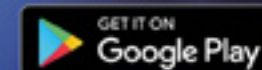
Selecting LED system components has never been so easy!

Introducing the FLS Lighting System Selector

- Free offline App for iOS and Android
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 - Light source
 - LED driver
 - Optic
 - Connector (for COBs)
 - Heat sink (for COBs)
 - Lighting control
- Guides users towards most appropriate and readily available components
- Emails PDF and Excel reports



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Robust LED drivers for outdoor lighting offer constant power option



MEAN WELL has introduced the XLG series of LED drivers, which offers robust performance in outdoor as well as indoor lighting applications.

The XLG series AC-DC LED drivers are supplied in an IP67-rated metal housing for use over a broad case-temperature range between -40°C and 90°C. This enables lighting equipment manufacturers to implement fanless designs.

The XLG series LED drivers are available in constant voltage and constant power versions, and with power ratings ranging from 25W to 240W.

The XLG constant power LED drivers can directly drive LED arrays, and the XLG constant voltage models are suitable for LED luminaires which have a built-in DC-DC converter. The 12V and 24V models that have a power rating of 75W, 100W or 150W are also UL 879 recognized for use in LED signage equipment.

Reliable operation in cold start-up conditions

In the XLG series, MEAN WELL has introduced new constant power drivers, which provide reliable operation in cold start-up conditions. The constant power models allow the driver to operate at maximum power rating over a wide current range: this means that the output current can be increased to maintain a

constant power output when the LEDs' forward voltage drops.

This constant power capability can be illustrated by comparing the 150W XLG-150-H-AB with the HLG-150H-54AB, another 150W driver from MEAN WELL. The HLG-150H-54AB's output power is limited to 134.4W when the LED array's forward voltage is 48V DC.

Using the XLG-150-H-AB to drive the same 48V LED array, the driver's constant current output can be adjusted to yield an output power of 150W. Luminaire manufacturers can take advantage of this constant power function to design for installations that have a varying LED voltage, such as outdoor lighting applications which are exposed to cold start-up conditions.

The XLG-150-H-AB's maximum 60V DC open-circuit voltage allows the driver to operate in constant-current mode when the LED voltage is 52V DC at room temperature, but rises to 54V or even higher in cold temperatures. In these conditions, the HLG-150H-54AB operating in constant-voltage mode would supply a lower power output.



APPLICATIONS

- Architectural lighting
- Streetlights
- Floodlights
- Stage lighting
- Horticultural lighting
- High-bay lamps
- DMX power supplies
- Outdoor lighting

FEATURES

- Input-voltage range: 90V to 305V AC
- Output voltage: 12V or 24V DC
- Maximum output-power options: 50W, 75W, 100W, 150W, 200W, 240W
- Surge-voltage protection options: 4kV/6kV AC or 10kV/6kV AC
- Safety certifications:
 - UL 8750
 - IEC 61347/GB 7000.1
- Five years' warranty
- >50,000 hours lifetime rating
- Dimming options:
 - 0V to 10V
 - PWM
 - Resistor setting

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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, emphasizing 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.



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.



APPLICATIONS

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

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Standard base connector for streetlights includes vent to minimize condensation



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.



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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CHAMELEON

RGB+IC LED

- Addressable intelligent control PLCC-6 package with integrated control circuit for complete control of each pixel
- The smart IC integrated in the LED enables a simple circuit, small size and convenient installation
- Intelligent protection against reverse connection
- Built-in electric reset and power lost reset circuit
- 256-level grayscale adjustable circuit
- Built-in signal reshaping circuit
- Cascade port transmission signal by single line

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Digital signal controllers provide fast and flexible platform for lighting power supply designs

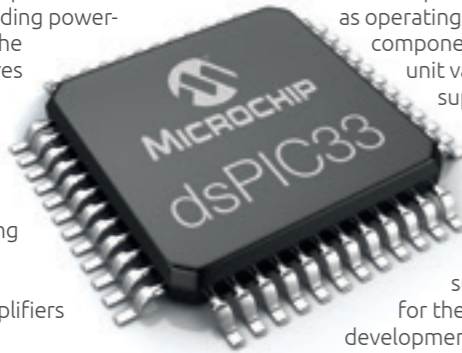


Microchip's dsPIC33 Digital Signal Controller (DSC) family provides an ideal combination of high Digital Signal Processor (DSP) performance and a microcontroller-like peripheral set for use in efficient power supplies for lighting equipment.

Offering DSP throughput of up to 100 MIPS, the dsPIC33 family's fast, deterministic performance gives rapid response to changes in operating conditions.

The high-performance dsPIC33 DSCs feature a DSP engine for the high-speed execution of the control loop in demanding power-conversion applications. The dsPIC33 DSCs offer features such as:

- Dual, independent cores, to isolate the system to isolate time-critical control loops from housekeeping functions
- High-speed ADCs, programmable gain amplifiers and a CPU with fast and predictable interrupts
- PWM controllers operating at a resolution of up to 250ps, giving the flexibility to control numerous power topologies



In LED lighting equipment, algorithms running on the dsPIC33 controller can control the brightness and even adjust the color temperature of the light that is emitted from an LED. Other advanced capabilities include compensating for factors such as operating temperature changes, component aging and unit to unit variations to produce superior light quality and a consistently good customer experience. For high reliability systems, the dsPIC33 can detect and report failing LEDs. Microchip supplies LED demo code for the dsPIC33CK Curiosity development board referenced below. In addition to controlling the current into an LED, a dsPIC33 can also control an AC/DC power supply or a DC/DC converter for the power to system.



APPLICATIONS

- LED and HID control
- AC/DC and DC/DC power supplies
- Motor control systems

FEATURES (DSPIC33CK):

- 100MIPS DSP performance
 - Single-cycle multiply-accumulate function
 - 16 x 16 fractional multiply/divide operations
- Up to 256kbytes Flash program memory
- Up to 24kbytes data SRAM
- Analog peripherals include:
 - Three 12-bit, 3.5Msamples/s ADC
 - Three analog comparators with 12-bit reference DACs
 - Three op amps
- I²C, UART and serial peripheral interfaces

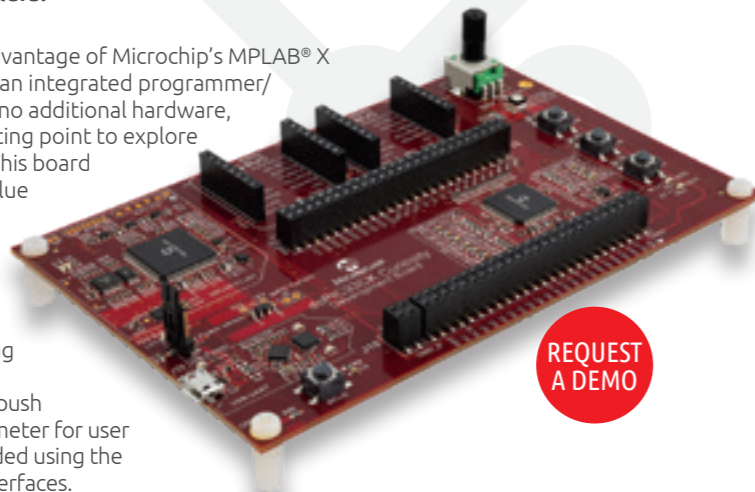
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Explore the features of the dsPIC33CK family

The dsPIC33CK Curiosity development board is a cost-effective development and demonstration platform for the dsPIC33CK family of single-core high performance digital signal controllers.

Designed to take full advantage of Microchip's MPLAB[®] X IDE, the board includes an integrated programmer/debugger and requires no additional hardware, making it a perfect starting point to explore the dsPIC33CK family. This board includes a Red/Green/Blue (RGB) LED, two general purpose green LEDs and is powered through the USB port. Code examples are available for color mixing and color sequencing.

The board has three push buttons and a potentiometer for user input and can be expanded using the onboard mikroBUS[™] interfaces.



REQUEST A DEMO

URL: <https://www.microchip.com/DevelopmentTools/ProductDetails/dm330030>



APPLICATIONS

- dsPIC33 DSC evaluation
- LED lighting experiments

FEATURES

- dsPIC33CK256MP controller
- Integrated programmer/debugger
- RGB LED
- 2 x green LEDs
- 3 x push buttons
- Potentiometer
- USB interface

REFERENCE DESIGN

This reference design hardware is not currently available for purchase, but you can request a demonstration. Please contact your local sales office for further information.

Part Number: DM330030

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Advance Fortimo InstantFit

The First Truly Field Replaceable Linear LED Module

Are you looking for the flexibility of simple, last minute configuration for your LED troffer? How does configuration in the field sound? The Fortimo InstantFit makes late stage configuration a snap. No screws, no tools, no expensive labor. It's as easy as you expect inserting a light source to be.



Key Benefits

- Simple, last minute (mechanical) configuration
- Failed light source can be replaced at any time, as easily as changing a lamp
- Open standard product, eliminates warranty and spare parts management for light source by OEM

Target Applications

- Office
- Education
- Retail

For the latest information on Signify products contact your local FLS sales representative.

This information is accurate at the time of writing. Neither Signify nor its agents assume any liability for inaccuracies or losses incurred by use or misuse of this information. Check manufacturer's website for the most recent information.

Fortimo InstantFit has been accepted into the 2019 IES Progress Report, recognizing it as a unique and significant advancement to the art and science of lighting



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 (eCO₂) 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.



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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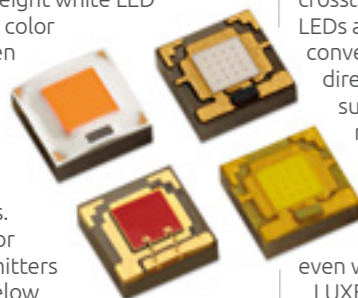
Color LEDs produce higher punch than any other undomed LED



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.



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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Panasonic



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.

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.

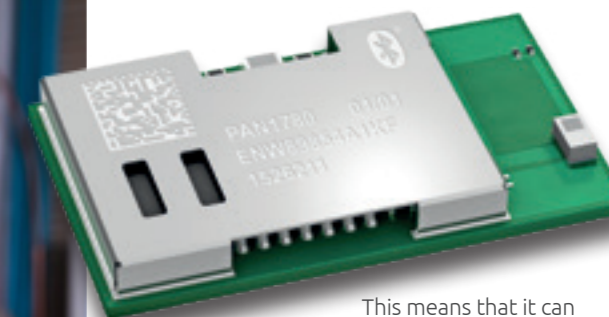
Comfort and convenience are usually the main reasons for installing such smart home devices. But other factors can also play a role: intelligent door locks or smart meters can enhance the residents' safety and control. For instance, by monitoring daily energy consumption, emissions and costs can be substantially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



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 2Mbps/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.



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

FTM DEVELOPMENT BOARDS

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

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Single-pole spring-type terminal blocks



METZ CONNECT's SM99 and SR99 are spring-clamp terminal blocks which have a compact footprint, and accept wire sizes up to 16 AWG.

The SM99 blocks are for surface-mount assembly, and the SR99 are for through-hole mounting. Both types are reflow-capable according to the JEDEC 20 MSL 1 standard.

Featuring a push-in method for wire insertion and a large finger push-button for wire release, they are easy to install and use.

The SM99 and SR99 series offer good connection reliability, thanks to a wire connection indicator and a test point for a continuity check. They give the board designer great flexibility, as they can be placed as single poles nearly anywhere on a PCB.



METZ CONNECT terminal blocks: Available in versions for surface and through-hole mounting



APPLICATIONS

- Consumer devices
- Lighting
- Heating, ventilation and air-conditioning units
- Security systems
- Industrial equipment

FEATURES

- 90° connection angle
- Single wire size range: 24 AWG to 16 AWG
- 9A nominal current
- Color variants for finger latch
- IP20 ingress rating

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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.



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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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.

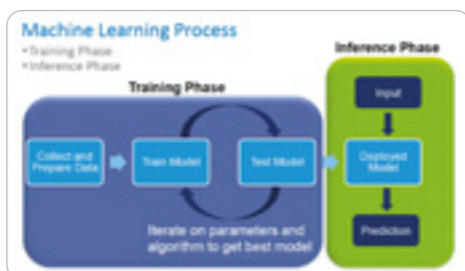


Fig. 1: The two phases of every machine learning development project. (Image courtesy of NXP Semiconductors.)

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

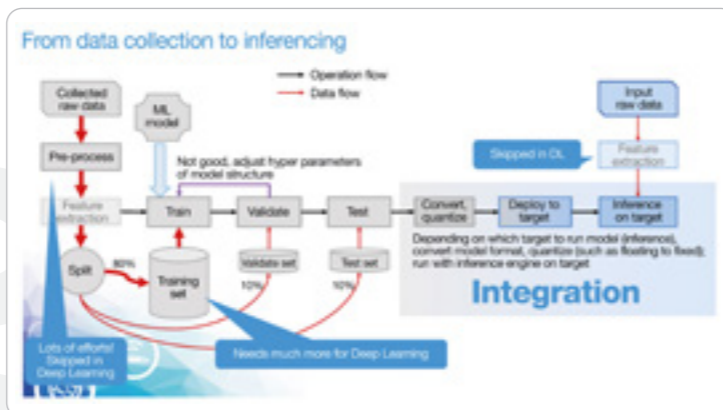


Fig. 2: The basic workflows in an embedded machine learning development. (Image courtesy of NXP Semiconductors.)

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.

Auto ML 1.0 on QMC	Speedy 3.4.1 SDK
<ul style="list-style-type: none"> • Data models • 1.1x1x1 CNN • 1.1x1x1 CNN with 1D pooling • 1.1x1x1 CNN with 2D pooling • 1.1x1x1 CNN with 3D pooling • 1.1x1x1 CNN with 4D pooling • 1.1x1x1 CNN with 5D pooling • 1.1x1x1 CNN with 6D pooling • 1.1x1x1 CNN with 7D pooling • 1.1x1x1 CNN with 8D pooling • 1.1x1x1 CNN with 9D pooling • 1.1x1x1 CNN with 10D pooling • 1.1x1x1 CNN with 11D pooling • 1.1x1x1 CNN with 12D pooling • 1.1x1x1 CNN with 13D pooling • 1.1x1x1 CNN with 14D pooling • 1.1x1x1 CNN with 15D pooling • 1.1x1x1 CNN with 16D pooling • 1.1x1x1 CNN with 17D pooling • 1.1x1x1 CNN with 18D pooling • 1.1x1x1 CNN with 19D pooling • 1.1x1x1 CNN with 20D pooling 	<ul style="list-style-type: none"> • SVM models • 1.1x1x1 SVM • 1.1x1x1 SVM with 1D pooling • 1.1x1x1 SVM with 2D pooling • 1.1x1x1 SVM with 3D pooling • 1.1x1x1 SVM with 4D pooling • 1.1x1x1 SVM with 5D pooling • 1.1x1x1 SVM with 6D pooling • 1.1x1x1 SVM with 7D pooling • 1.1x1x1 SVM with 8D pooling • 1.1x1x1 SVM with 9D pooling • 1.1x1x1 SVM with 10D pooling • 1.1x1x1 SVM with 11D pooling • 1.1x1x1 SVM with 12D pooling • 1.1x1x1 SVM with 13D pooling • 1.1x1x1 SVM with 14D pooling • 1.1x1x1 SVM with 15D pooling • 1.1x1x1 SVM with 16D pooling • 1.1x1x1 SVM with 17D pooling • 1.1x1x1 SVM with 18D pooling • 1.1x1x1 SVM with 19D pooling • 1.1x1x1 SVM with 20D pooling

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 MCU 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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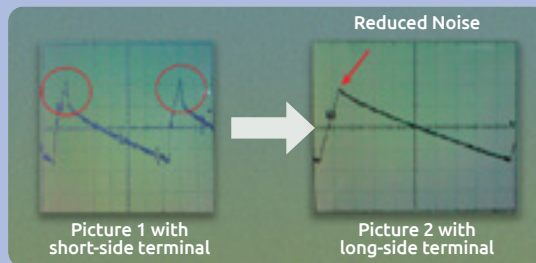


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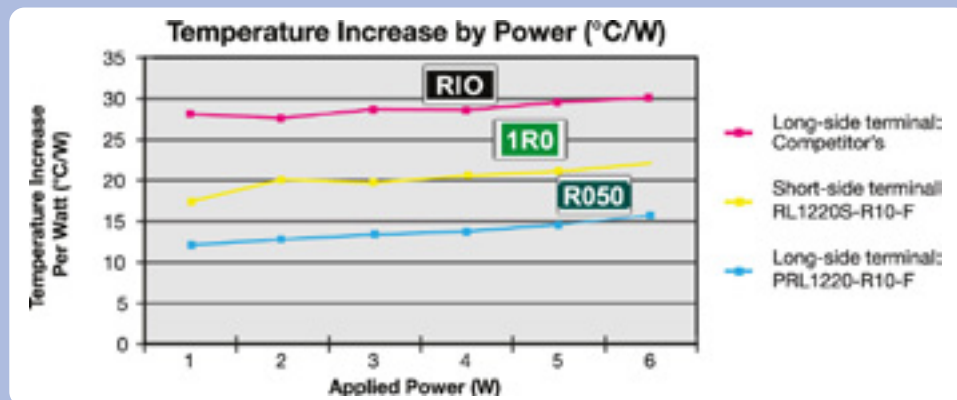


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