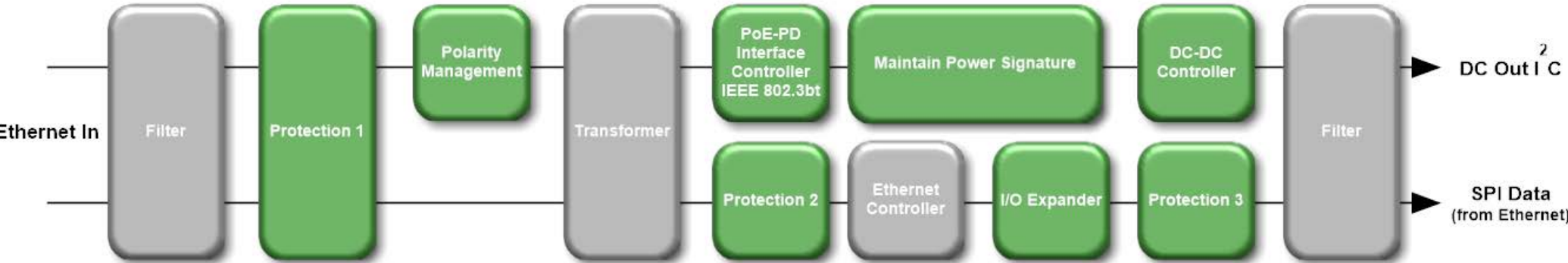
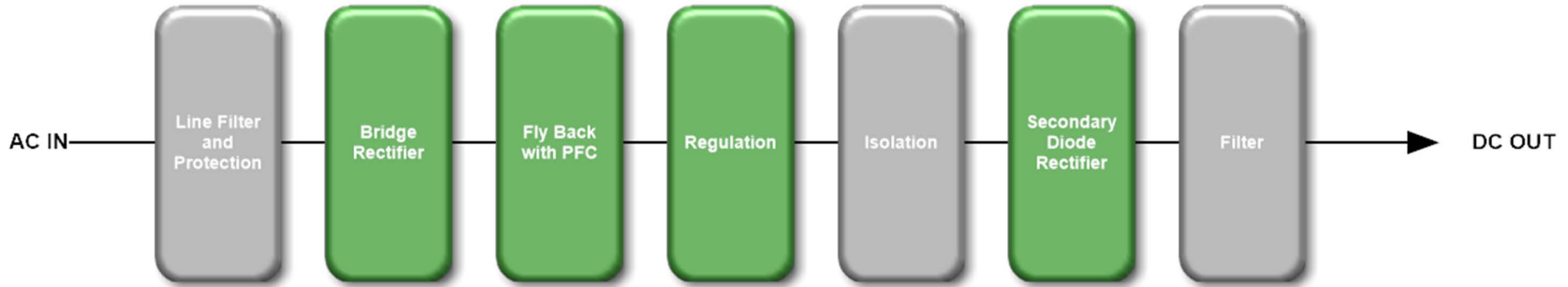


Connected Lighting - Power over Ethernet (PoE) to DC



- [AC to DC Block Diagram](#)
- [LED Driver Block Diagram](#)
- [Connected Lighting Solution Description](#)
- [Product Recommendation Table](#)

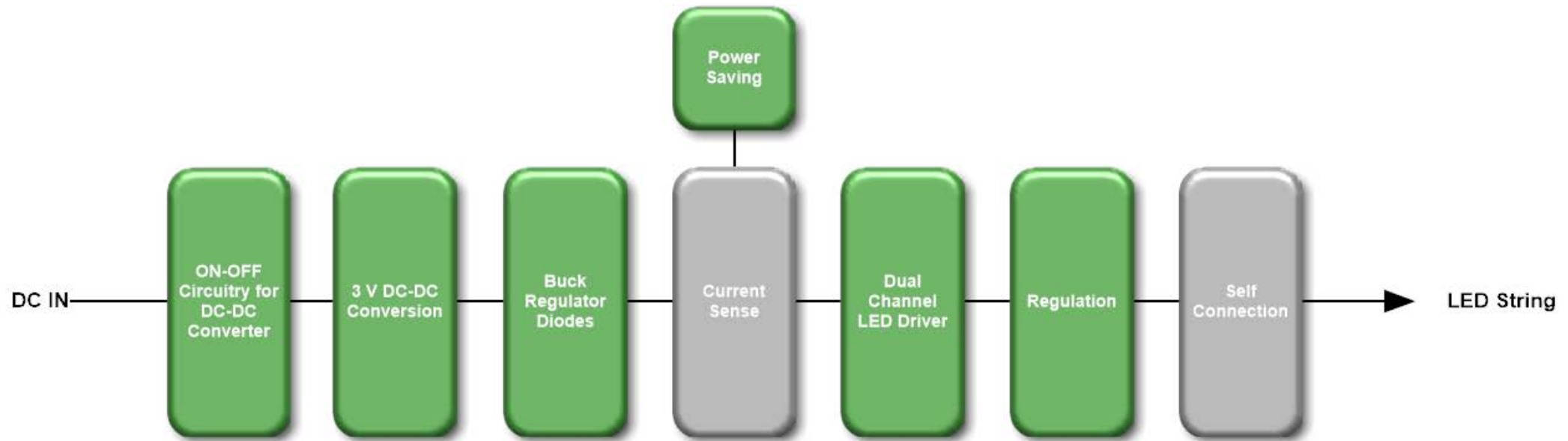
Connected Lighting - AC to DC



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Connected Lighting - LED Driver



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Solution Description - Connected Lighting Block Diagram of the Month

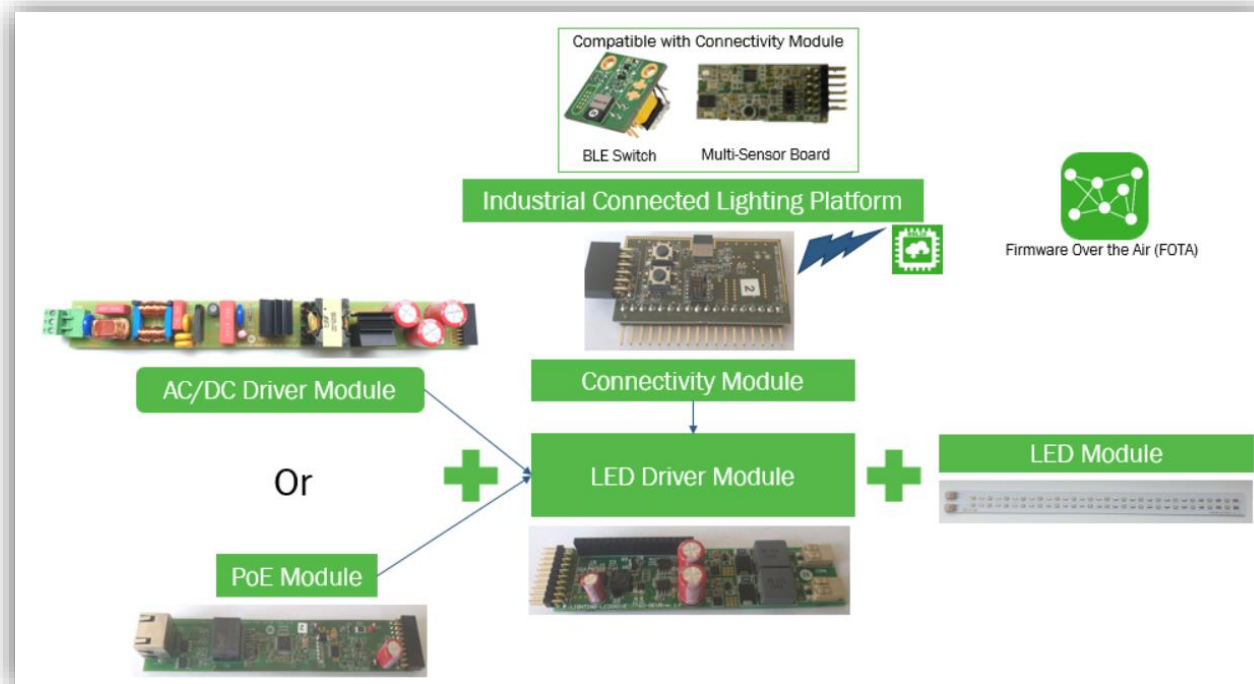
Block Diagram of the Month – Introduction:

High power white LEDs are enabling a market transition to energy efficient Solid State Lighting (SSL). ON Semiconductor provides AC-DC LED drivers, DC-DC LED drivers and linear LED drivers that enable customers to design highly efficient LED lighting solutions.

Connected lighting platforms for LED control is a modular development kit for prototyping cost-effective, industrial LED lighting solutions. This platform is extremely energy efficient and features wireless control (on/off, dimming, etc.), in addition to two independently controlled LED channels that provide a maximum brightness of 7000 lumens.

The development kit is compliant with multiple industry standards, provides high efficiency power conversion (>90% at full load), offers up to two strings of 16 LEDs, white balance control (12-bit dimmer from zero to max) and can be powered by AC-DC or PoE power supply. The kit has 10-70 W output power range with <200 mW standby power (AC-DC powered) in addition to multiple connectivity options: Bluetooth® Low Energy, Power Over Ethernet (PoE), and Zigbee™ GreenPower.

LIGHTING-1-GEVK Hardware



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The Connected Lighting Platform includes:

1. **AC/DC Driver Module (LIGHTING-POWER-AC-GEVB)**

This module holds two FL7740 PSR Flyback controllers with PFC, acting as a power front-end module to deliver desired energy output for LED driver board and LEDs themselves. A simulation model of the Flyback system is available (Simetrix). Board specifications include Vin AC: 86 – 280V, Vout DC: 55V, Pout electrical: 70W, power factor >0.99 at full load and efficiency >91%.

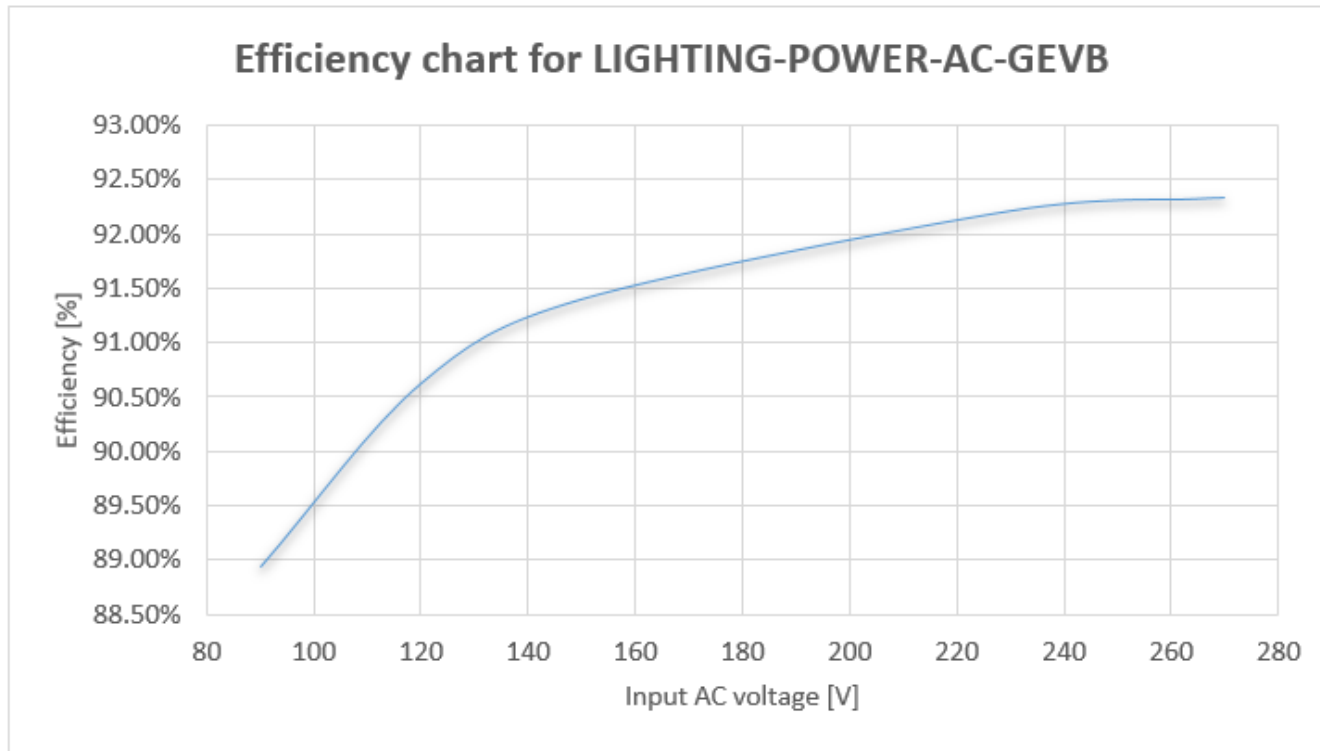


Figure 1. Efficiency chart of LIGHTING-POWER-AC-GEVB vs. Vin AC

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2. PoE Module (LIGHTING-POWER-POE-GEVB)

This module holds two NCP1096 PoE bt controller with PHY layer, acting as a power front-end module to deliver desired energy output for LED driver boards and LEDs themselves. This supports up to 90 watts of power and is IEEE 802.3bt compliant. An automatic MPS circuit maintains power signature (simulation model available), GreenBridge™ two rectifiers and input voltage 55V defined by PoE standards. It features WIZnet W5500 Ethernet controller for easier, more stable WiFi connectivity over SPI.

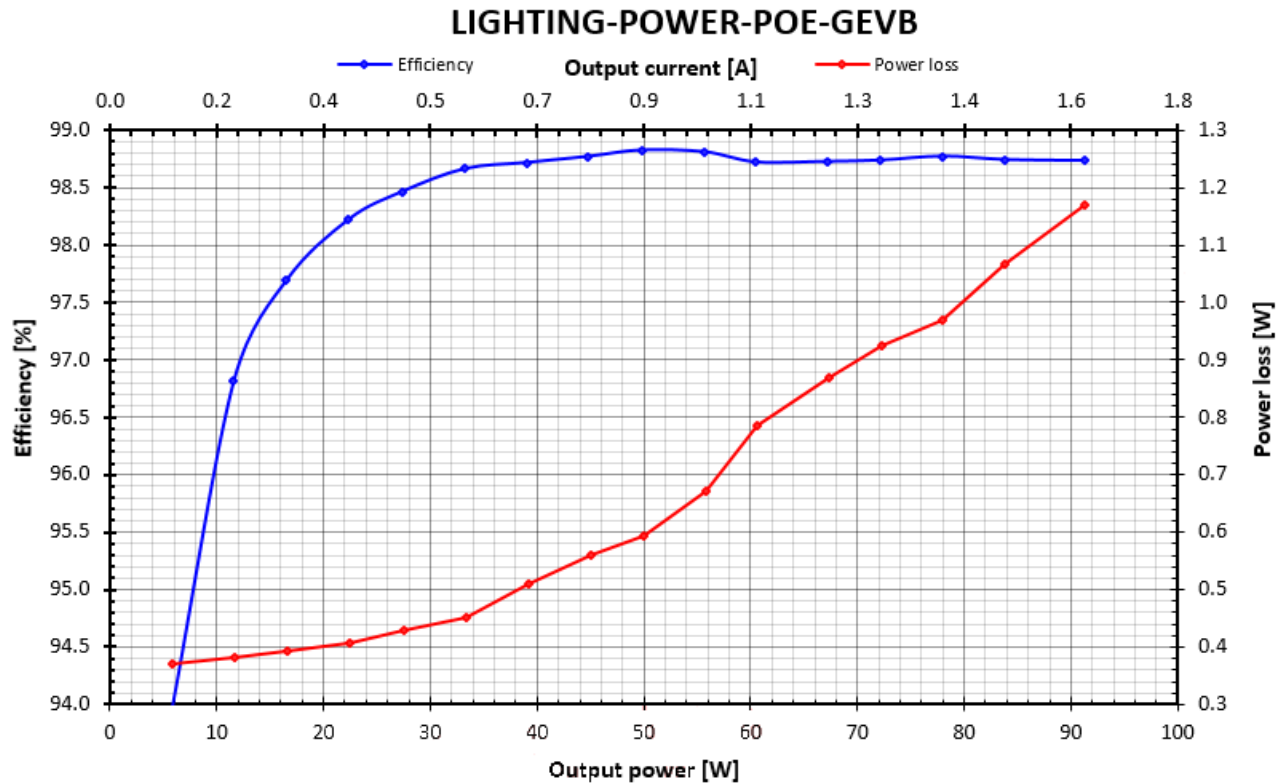


Figure 2. Power losses and efficiency vs. output power for LIGHTING-POWER-POE-GEVB

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3. BLE Connectivity Module (LIGHTING-CONNECTIVITY-GEVB)

MCU module with industry's lowest power Bluetooth 5 connectivity (RSL10 SIP). RSL10 features include Firmware over the Air (FOTA), RSL10 Sense, Control-Dimming and telemetry, RSL10 Mesh App (mesh networking for provisioning and lighting control), enables sensor functionality using the multi-sensor board (IoT Development Kit).

4. LED Driver Module (LIGHTING-LEDDRIVE-7760-GEVB)

This module holds two FL7760 LED drivers, auxiliary power supply generating 3.3V for MCU module, self-supply of Op Amps gathering telemetry data and an auxiliary supply for external PoE module's logic. It features header for pluggable MCU module to enhance wireless connectivity, provides electrical efficiency up to 96%, input voltage 55V by default (ranging from 12 – 60 VDCin depending on the number of LEDs). Telemetry data includes: current and voltage measurement for each LED driver, dimming capability down to 0.6% and 12-bit PWM resolution, DC-DC converter with PG pin and P-FET for PoE bt module.

5. LED Module (LIGHTING-LED-GEVK)

Dual LED string 16x warm white and 16x cool white LEDs. This supports up to 600 mA LED current and external thermistor for additional LED devices, in addition to thermal aluminum clad.

6. Energy harvesting switch BLE-SWITCH001-GEVB

The Energy Harvesting Bluetooth® Low Energy Switch is a complete reference design for energy harvesting lighting applications. Featuring the RSL10 SIP and high-efficiency harvester switch from ZF Electronic, the battery-less switch offers the industry's lowest power consumption and is entirely self-powered. Using the provided firmware and RSL10 Software Development Kit (SDK), the battery-less switch is easily customizable.

- Out of the box configuration allows pairing of multiple switches for implementing ultra-flexible “back and forth” light switching. This implantation withdraws the building architect nightmare of designing inside walls wired back and forth. Dimming of light supported via a unique smart implementation in firmware, benefiting of the advantage of an ultra-low power BLE SIP (RSL10).
- FOTA (Firmware update over the air) supports and requires access to the power supply rail of the battery free switch. Once connected to an external power battery source (ex 3V) the FOTA or OTA DPU (Over the Air Device Program Update) can be implemented. As of today there are no available ways to make battery-free FOTA.
- Multiple switches can be parried to the board so that multiple (4 to 10) switches can be used to implement flexible and redundant back and forth lighting switch implementation.

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7. Multi-Sensor Pmod Shield

ON Semiconductor's Pmod Multi-Sensor Shield can be hooked to the BLE connectivity module. This add-on is combined with application FW provided in RSL10 SDK CMSIS pack to provide the developer with the capability to sense and transmit multiple environmental local parameters measured around the lighting fixture. This includes ambient light sensor, temperature, moisture, barometric pressure and many more (accelerometric, tilt and magnetometric). As some of these parametric influenced by the local light source like temperature. The implementation will be specifically tuned to measure the local ambient temperature (in that case the temperature sensor will be installed far from the heat source of the LED), or in the case it's very close to the LED heat sink plate (the temperature indication is used for monitoring the actual operation of the LED). If the temperature over heating fixture is enclosed or improperly installed, LED failure (no heating), normal operations or predictive maintenance by temperature degradation or thermal disjunction.

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Connected Lighting Solutions

Suggested Block	Option	WPN	Why Select?	WPN Description
PoE to DC Solution				
Protection 1	1	LC03-6R2G		LC03-6: ESD / Surge Protector
Protection 1	1	MMBZ27VALT1G		MMBZ27V: Zener , Dual, 27 V, Common Anode
Polarity Management	1	BC846BPDW1T1G		BC846BPDW1: NPN PNP Bipolar Transistor
Polarity Management	1	FDMQ8205A		FDMQ8205A: GreenBridge™ 2 Series of High-Efficiency Bridge Rectifiers
PoE-PD Interface Controller, IEEE 802.3bt	1	NCP1096		NCP1096: Power Over Ethernet(PoE) – Powered Device Interface Controller with integrated hot swap FET, IEEE 802.3bt
Protection 2	1	NSP4201MR6T1G		NSP4201: Low Clamping Voltage Surge Protection Diode Array
Maintain Power Signature	1	MM3Z5V1T1G		MM3Z5V1: 300 mW 5.1 V ±5% Zener Diode Voltage Regulator
Maintain Power Signature	1	BC846BDW1T1G		BC846BDW1: Dual NPN Bipolar Transistor
Maintain Power Signature	1	2N7002LT1G		2N7002L: N-Channel Small Signal MOSFET 60V 115mA 7.5 Ω
DC-DC Controller	1	FL7740	Non-isolated option	FL7740: PWM Controller, Constant Voltage, Primary Side Regulation for Power Factor Correction
DC-DC Controller	2	NCP1566	Isolated option	NCP1566: Highly Integrated Dual-Mode Active Clamp PWM Controller
IO Expander	1	FXL6408		FXL6408: Fully Configurable 8-Bit I2C-Controlled GPIO Expander
Protection 3	1	NSR30CM3T5G		NSR30CM3: Dual Common Cathode Schottky Diode
AC to DC Solution				
Bridge Rectifier	1	GBU6K		GBU6K: 6 A Bridge Rectifier
Fly Back with PFC	1	FL7740		FL7740: PWM Controller, Constant Voltage, Primary Side Regulation for Power Factor Correction
Regulation	1	US1MFA		US1MFA: Super Fast Surface Mount Rectifiers
Regulation	1	MMSZ22T1G		MMSZ22: 500 mW 22 V ±5% Zener Diode Voltage Regulator
Regulation	1	FCPF400N80Z		FCPF400N80Z: Power MOSFET, N-Channel, SUPERFET® II, 800 V, 14 A, 400 mΩ, TO-220F
Secondary Diode Rectification	1	RURP1560		RURP1560: 15A, 600V, Ultrafast Diode
LED Driver Solution				
ON-OFF Circuitry for DC-DC Converter	1	MM3Z18VT1G		MM3Z18V: 300 mW 18 V ±5% Zener Diode Voltage Regulator
ON-OFF Circuitry for DC-DC Converter	1	FDC3535		FDC3535: P-Channel Power Trench® MOSFET, -80 V, -2.1 A, 183 mΩ
3 V DC-DC Converter	1	NCP10671		NCP10671: High-Voltage Switcher for low Power offline SMPS
3 V DC-DC Converter	1	NCP161		NCP161: LDO Regulator, 450 mA, Ultra-High PSRR, Ultra-Low Noise
Buck Regulator Diodes	1	ES1JFL		ES1JFL: Surface Mount Superfast Rectifier
Buck Regulator Diodes	1	MMSZ4V3T1G		MMSZ4V3: 500 mW, 4.3 V ±5% Zener Diode Voltage Regulator
Power Saving	1	NSBC114EPDXV6T1G		NSBC114EPDXV6: Complementary Bipolar Digital Transistor (BRT)
Current Sense	1	NCS7031	Coming soon	Current Sense Amplifier 80V Common-Mode Voltage, Unidirectional
Dual Channel LED Driver	1	FL7760		FL7760: Analog/PWM Dimmable 60 V input Buck Controller for LED Lighting
Regulation	1	FDD10N20LZTM		FDD10N20LZ: Power MOSFET, N-Channel, Logic Level, UniFET™, 200 V, 7.6 A, 360 mΩ, DPAK
Regulation	1	ES3D		ES3D: 3.0A Ultra Fast Recovery Rectifier

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