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System Solution Guide - Preview

E-bike and E-scooter

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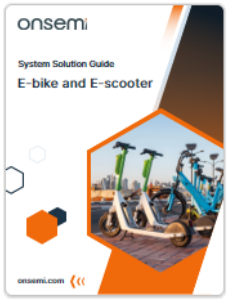

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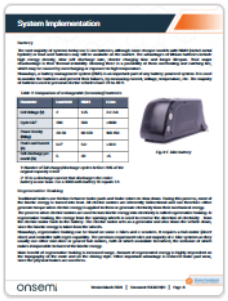

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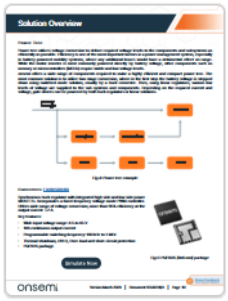

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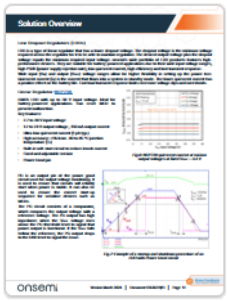

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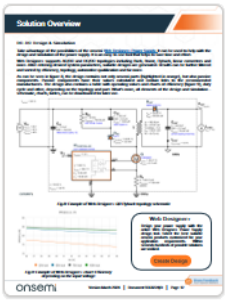

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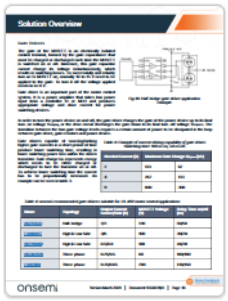

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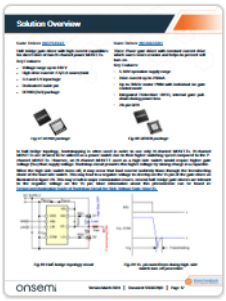

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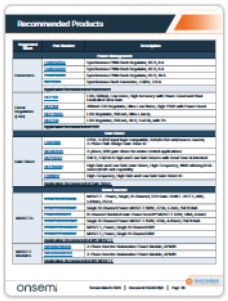

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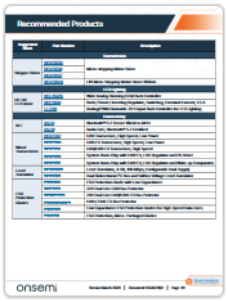

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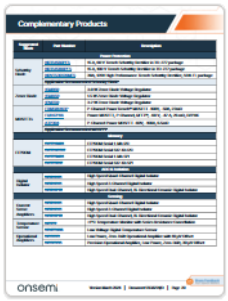

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Block Diagram

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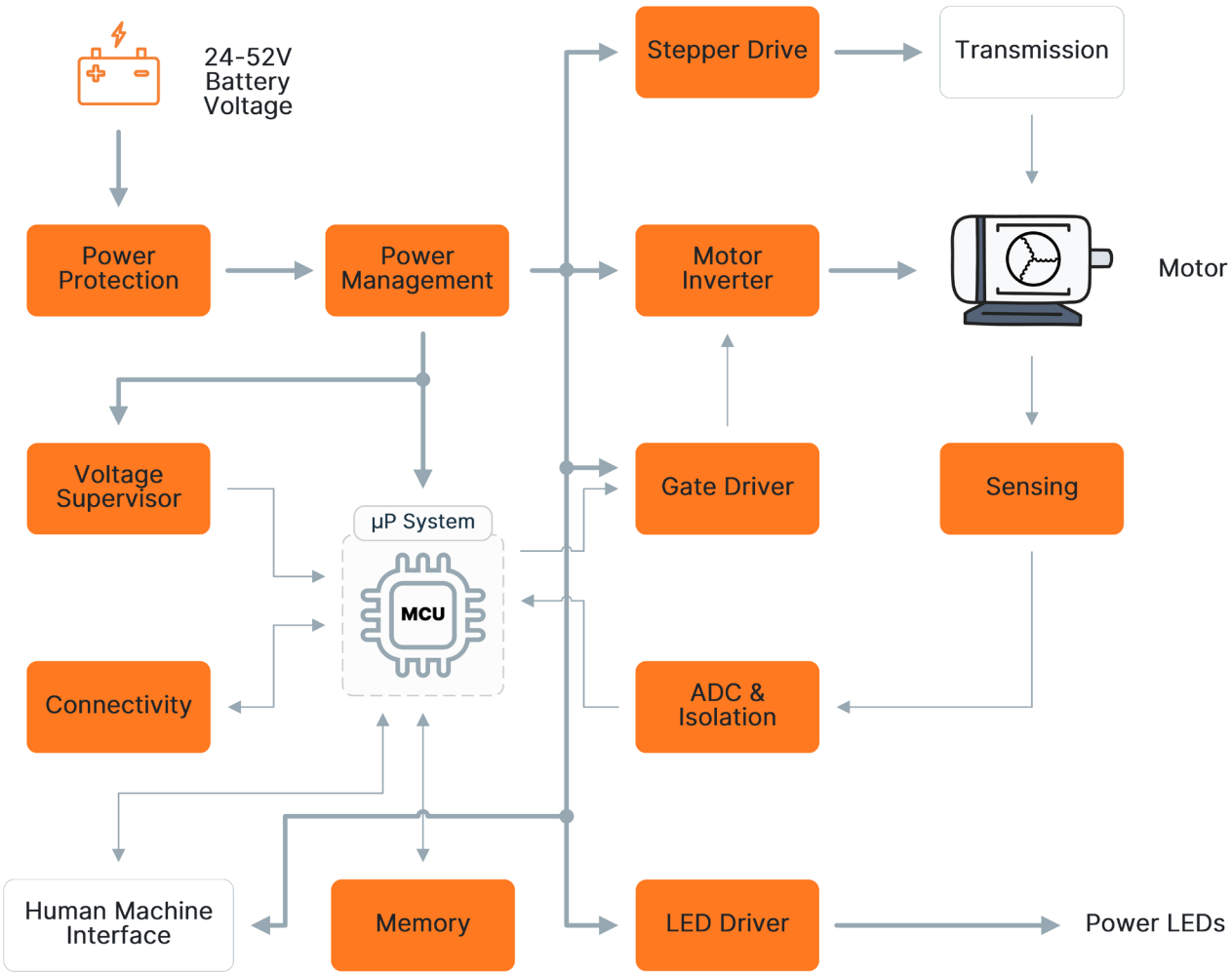
E-bike and E-scooter Top Level Topology

Block diagram below represents urban electric micromobility solution recommended by onsemi. Most important part of the solution is traction, which is comprised of inverter, gate drivers and sensing parts. Battery protection is important to have safe product. onsemi offers other important components for low voltage power conversion using both LDOs and Buck converters.



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Low Dropout Regulators (LDOs)

LDO is a type of linear regulator that has a lower dropout voltage. The dropout voltage is the minimum voltage required across the regulator for it to be able to maintain regulation. The desired output voltage plus the dropout voltage equals the minimum required input voltage. onsemi's wide portfolio of LDO products features high- performance devices. They are suitable for battery-powered applications due to their wide input voltage ranges, high PSRR (power supply rejection rate), low quiescent current, high efficiency and fast transient response.

Wide input (VIN) and output (VOUT) voltage ranges allow for higher flexibility in setting up the power tree. Quiescent current (IQ) is the current that flows into a system in standby mode. The lower quiescent current has a positive effect on the battery life. Fast load transient response limits excessive voltage dips and overshoots.

Linear Regulator NCP730

CMOS LDO with up to 38 V input voltage. Ideal for battery-powered applications. Can reset MCU to prevent malfunction.

Key features:

- 2.7 to 38 V input voltage
- 1.2 to 24 V output voltage , 150 mA output current
- Ultra-low quiescent current (1 µA typ.)
- High accuracy: ±1% from -40 to 85 °C junction temperature (T_J)
- Built-in soft-start circuit to reduce inrush current
- Fixed and adjustable version
- Power Good pin

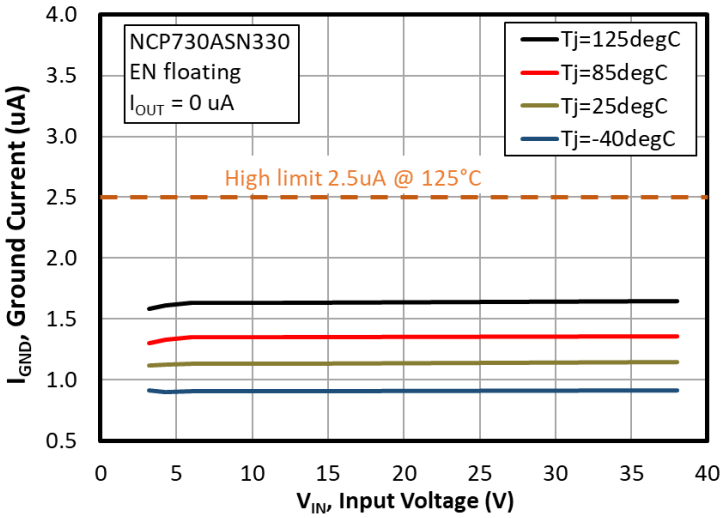

Fig.6: NCP730 quiescent current at various output voltages at fixed V_{OUT} = 3.3 V

PG is an output pin of the power good circuit used for output voltage monitoring. It is used to ensure that circuits will reliably start when power is stable. It can also be used to ensure the correct start-up sequence for sensitive devices such as MCUs.

The PG circuit consists of a comparator, which compares the output voltage with a reference voltage. The PG output has high impedance when the VOUT voltage rises above the PG threshold level to signal that power output is functional. If the VOUT falls bellow the reference, the PG output drops to the GND level to signal the issue.

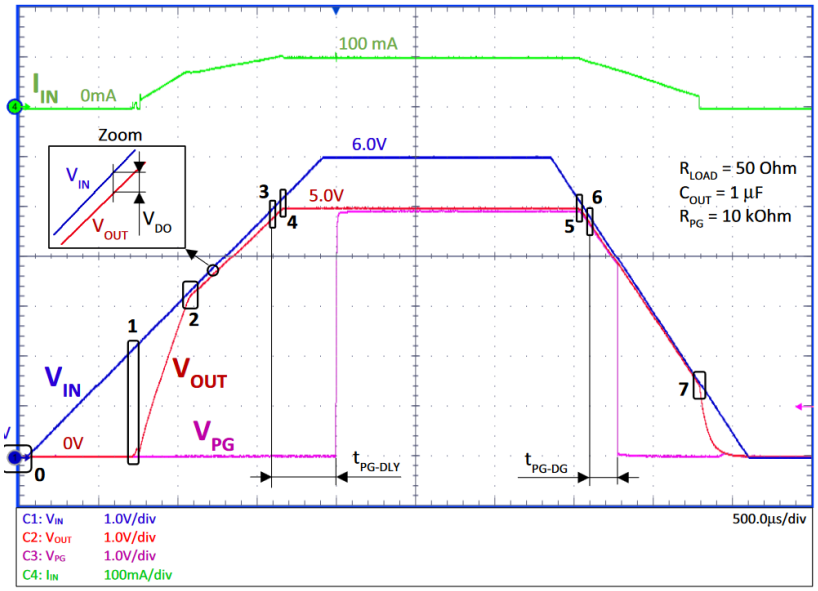

Fig.7: Example of a startup and shutdown procedure of an LDO with Power Good circuit

Medium Voltage MOSFETs

In the low voltage battery-powered applications, discrete Si MOSFETs are the preferred inverter switch. For motor applications, the switching speed is not as important, instead the focus lies in minimizing the conduction and switching losses. Voltage class of the MOSFET should be carefully chosen depending on the battery voltage. It is important to have sufficient headroom in the MOSFET V_{DS} as the voltage may spike due to the inductive kick and cause damage to the power switch. The correct MOSFET voltage class for the most used battery voltages and suitable MOSFETs can be chosen according to the table 2.

Table 2: Suitable MOSFET voltage class depending on the battery voltage

Battery Voltage (V)	Protection MOSFET V_{DS} Voltage (V)	Inverter MOSFET V_{DS} Voltage (V)	
24	60	60	View Product
36	60	80	View Product
48	80	100	View Product

onsemi MV (medium voltage) MOSFETs enhanced for motor control applications use shielded gate technology, which offers various advantages over trench gate technology. These advantages include improved conduction losses due to lower $R_{DS(on)}$, lowered switching losses thanks to lower Qg, and less overshoot and ringing.

Explore new **onsemi** T10 portfolio, which allows higher power density, reduced switching losses and less conduction and driving losses. It comprises of 40 and 80 V products with other voltage classes in development. The T10 portfolio boasts low $R_{DS(on)}$ ranging from 0.42 to 5.3 mΩ. Explore the entire portfolio on the **onsemi** webpage or contact sales to order your samples today.

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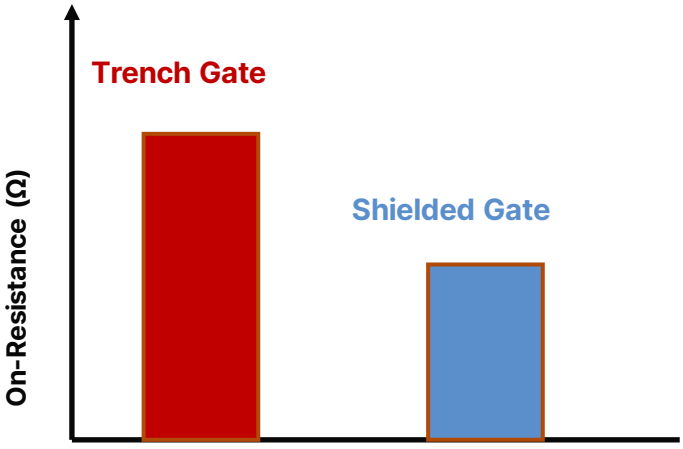

Fig.11: Lower on-resistance of Shielded Gate MOSFET technology

MOSFET NTMJST1D4N06CL

T6 60V MOSFET optimized for motor control applications.

Key Features:

- 60 V, 1.49 mΩ, 198 A
- Low $R_{DS(on)}$ to minimize conduction losses
- Optimized top cool package to optimize heat path
- TCPAK10 (5x7 mm) package

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